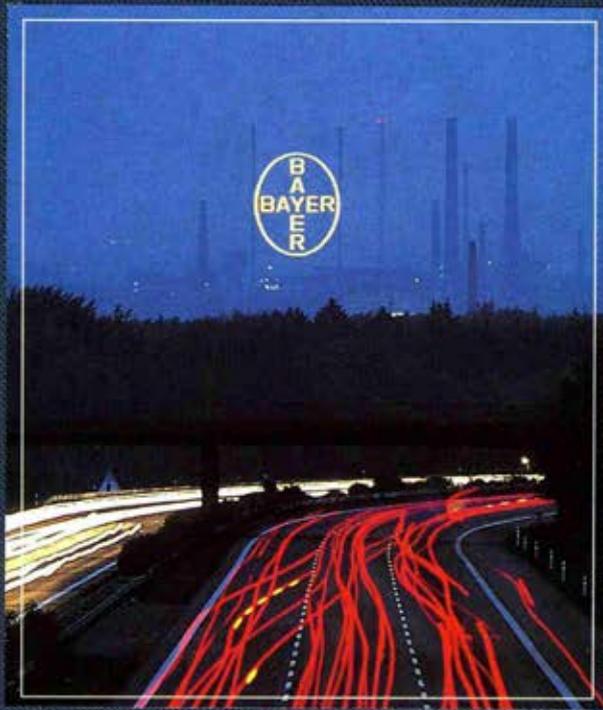
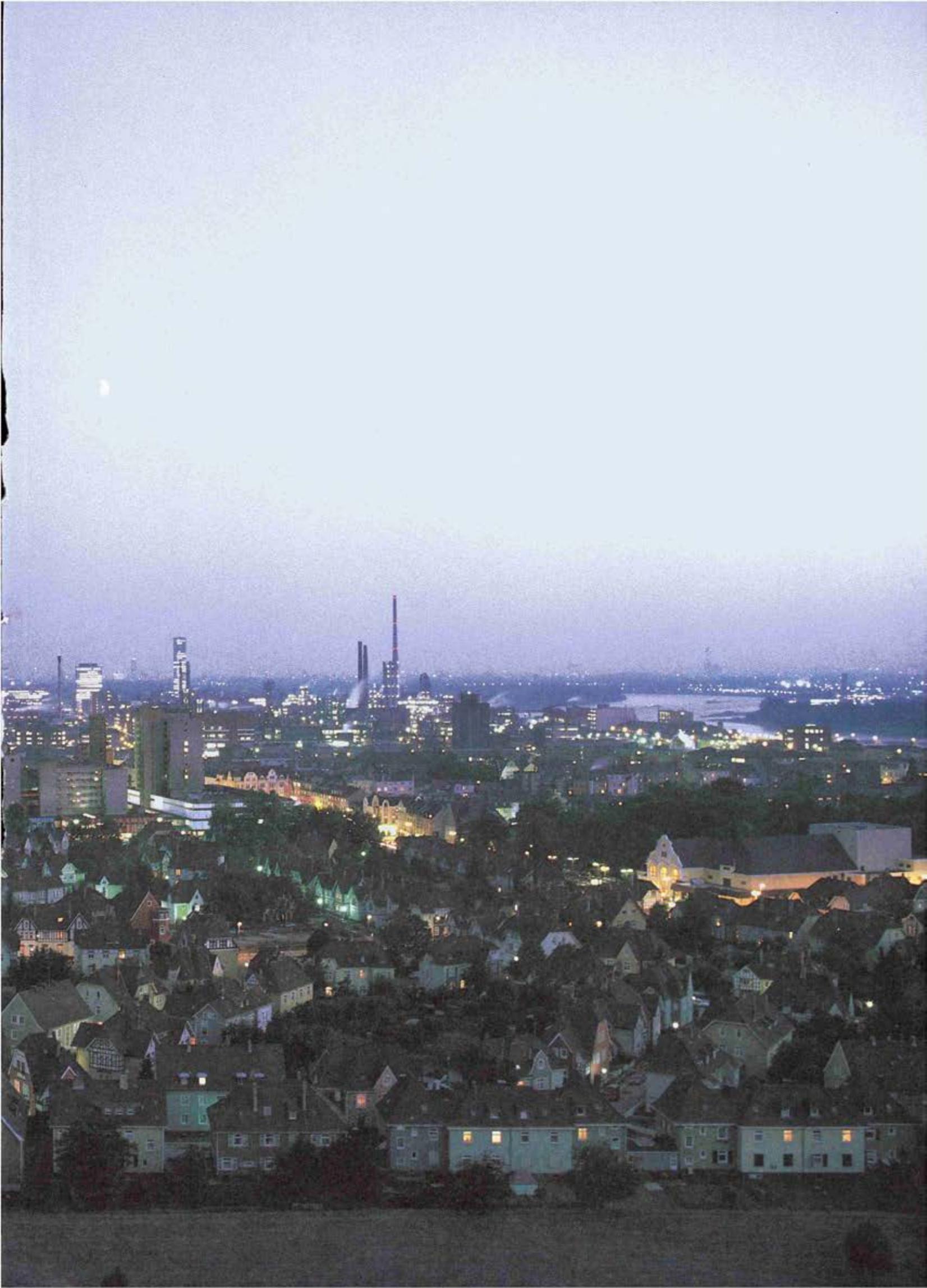

Milestones

The Bayer Story
1863 – 1988





The Bayer Story
1863-1988

Milestones

Erik Verg

Gottfried Plumpe
Heinz Schultheis



Author: Erik Verg

Co-authors:
Gottfried Plumpe
Heinz Schultheis

Project Manager:
Thomas Reinert

Responsible for contents:
Heiner Springer

Consultant, Bayer archives:
Peter Goeb

Scientific advisors:
Gerd Ahrenholz
Gisela Brill

Advisory Board:
Felix Haake
Hans-Günter Appel
Günter Kaebe
Günter Rockstroh

Organization:
Inge Erkes

Photographs and illustrations:
Claus Miltz
Thomas Hoch
Michael Frings
Bettina Goetze

Index:
Michael Pohlenz

Design:
ggmbh, Heidelberg
Thomas Hoch

Phototypesetting:
Aller Type Group,
Frankfurt am Main
Dieter H. Frohnapfel
Sabine Peter
Kathleen Mangold

Lithography:
Mohndruck Graphische
Betriebe GmbH, Gütersloh
Michael Rogatz

Printed and bound by
Mohndruck Graphische
Betriebe GmbH, Gütersloh
Wolfgang Höpping
Rolf Deppe

Typeset from Univers and
Candida on MCS PowerView 10
systems and exposed on the
laser imagesetter CG 9600
made by Bayer's U.S. subsidiary,
Compugraphic Corporation,
Wilmington, MA, using Agfa
film material.

Printed on Ikonofix matte paper
(115 g/sq. m) from ZANDERS
Feinpapiere AG,
Bergisch Gladbach

Distribution:
informedia verlags-gmbh,
Cologne

English edition

Translator:
John Wicks, Richterswil,
Switzerland

Editor:
Cromwell-Ahrens Consultants,
Einbeck
Christine Cromwell-Ahrens

Editorial assistant:
Barbara Owens

We would like to thank all those
who, although not mentioned
by name, contributed their expert
advice and active support to
this project.

The product names mentioned
in this book are predominantly
registered trademarks of Bayer
AG, its subsidiaries or other
companies.

ISBN-No.: 3-921349-48-6

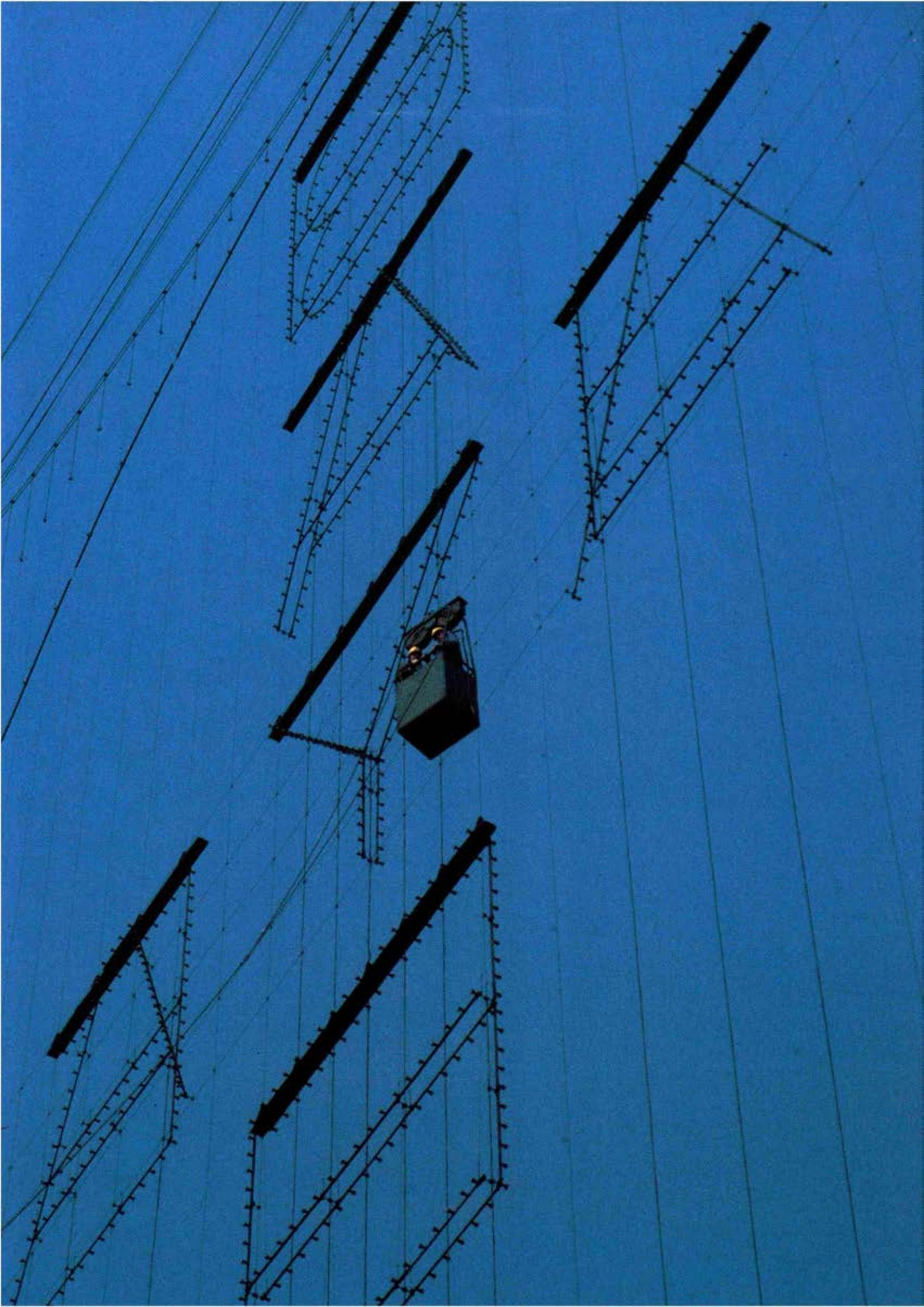
Copyright:
Bayer AG, Leverkusen,
West Germany
August 1988

Printed in the Federal Republic
of Germany

Published by
Bayer AG,
Corporate Staff Division,
Public Relations Department,
Leverkusen, West Germany

The Bayer cross is one of the
world's best-known trademarks.
The picture on the right shows
part of the gigantic cross—233
feet in diameter—that shines
out over the corporate head-
quarters in Leverkusen at night.

These two maintenance men
are making sure that all of
its 1,680 bulbs will light up when
darkness falls. The history of
this huge landmark is described
on page 268.



1863 - 1988

Table of Contents

	"Millipede's Progress," or the author's preface	12
	Introduction: A rainbow of dyes emerges from coal tar	14
	<i>Dyes from plants, snails and lice</i>	16
	<i>Colors and dyes</i>	18
1863	A merchant and a dyer form the company "Bayer"	24
	<i>Fuchsine</i>	26
1867	Arsenic and pancakes are a part of production	30
	<i>Aniline blue</i>	32
1870	The difficult beginnings of alizarin production	34
	<i>Alizarin, anthraquinone, anthracene</i>	36
1873	The Bayer relief fund—ten years before Bismarck's social service legislation	40
1875	Universities and industry work in close cooperation	46
1876	Taking production outside the country	48
1877	Green is in fashion, research is a must	52
	<i>Early green dyestuffs</i>	54
1878	The race for azo dyes gathers speed	56
	<i>The azo dyestuffs</i>	58
	<i>Patents</i>	60
1880	Friedrich Bayer had put his house in order	62
1881	Incorporation—a new era begins	64
1883	A young man named Duisberg	68

The Bayer Story in
130 chapters

The titles in *italics* refer
to boxes featuring special
subjects or providing
scientific and technical
explanations.

1885	Benzopurpurine 4B: Bayer's life-saver <i>Congo red and benzopurpurine</i>	74 76	1900	The hard-won Alizarin Convention <i>Alizarin blue and alizarin bordeaux</i>	142 144
1886	"Faster than indigo"—but only in winter <i>Benzoazurine G</i>	80 82	1901	"Waste Water Commission" asks many questions	146
1887	Dyers, colorists and application technologists	84	1902	The Bayer Fire Department goes professional	150
1888	Phenacetin—the first pharmaceutical product <i>Phenacetin and Sulfonal</i>	90 92	1902	The factory library offers everything from Goethe to videocassettes	152
1888	The Shipping Office serves 10,000 customers	94	1903	Bayer Jr. and Duisberg set up production in the United States	154
1891	The Main Scientific Laboratory—the heart of research	98	1904	Alliances are formed within the dyestuffs industry	158
1893	Two typewriters—for management use only	104	1904	Leisure time activities for Bayer employees	162
1894	Venturing into inorganic chemistry has its price <i>The most important acids</i>	106 108	1905	Carl Duisberg—a patriarch with social vision	166
1895	The brilliant plan for a chemical complex	110	1906	The rocky road from indigo to indanthrene <i>Indanthrene and Algol dyestuffs</i>	170 172
1896	The Patent Department—keeper of the company's intellectual property	118	1907	Bayer secures a stake in the mining business	176
1897	It all started with a "reading circle"	124	1908	Cultural life begins with a brass band	178
1898	More company doctors than the law requires	130	1909	The Staff Suggestion Scheme makes ideas pay	182
1899	Aspirin—a drug that transcends time <i>Acetylsalicylic acid (Aspirin)</i>	134 136	1910	Synthetic rubber—a technological breakthrough <i>Rubber</i>	186 188
			1912	Leverkusen becomes headquarters and Duisberg Chief Executive	194

1913	At the end of its first 50 years, Bayer ranks number three	198	1929	The Great Depression and its disastrous consequences	252
1914– 1918	The First World War hits the chemical industry without warning	200	1930	A new way of tanning for the leather industry <i>Synthetic tannins</i>	254 256
1919	The chemical industry faces a new world	206	1931	Plop, plop, fizz, fizz: the Alka-Seltzer story	258
1920	Business supports the needs of science	210	1932	The battle against the worldwide epidemic of malaria <i>Antimalarial remedies</i>	262 264
1921	Reparations and inflation: one dollar in exchange for 4.2 trillion marks	212	1933	The Bayer cross shines across the Rhine	268
1923	Germanin triumphs over sleeping sickness <i>The birth of chemotherapy</i>	216 218	1935	Domagk's sulfonamides revolutionize medical therapy <i>Zephirol and sulfonamides</i>	272 274
1924	The chemical companies finally get together	222	1936	A dream becomes reality: photography in its true colors <i>Agfa: the "Aktiengesellschaft für Anilinfabrikation"</i>	278 280
1924	The first products for the farming business	226	1937	Polyurethanes—a new class of plastics <i>The principles of polyurethane chemistry</i>	284 286
1925	A new company is born: I.G. Farbenindustrie AG <i>"Interessengemeinschaft"</i>	230 232	1938	The chemical industry relies on international cooperation	290
1926	Bayer's first synthetic fiber— rayon from Dormagen <i>Silk from cellulose</i>	236 238	1933– 1938	The I.G. Farbenindustrie in the Third Reich	292
1926	A successful product evolves from waste <i>Inorganic variegated pigments</i>	240 242	1939– 1945	The I.G. Farbenindustrie during World War II	296
1927	A new chapter opens in the development of coating raw materials <i>The first synthetic coating raw materials</i>	244 246	1946	Picking up the pieces and making a new start	300
1929	Buna is a triumph of chemical research	248	1947	Nuremberg and the end of the I.G. Farbenindustrie	304

1948	The currency reform paves the way for the "economic miracle"	308	1957	Erdölchemie is established in Dormagen <i>What are petrochemicals?</i>	358 360
1949	Bayer makes a new start in France	310	1957	Turning black into white with titanium dioxide <i>Titanium dioxide as a white pigment</i>	362 364
1951	Bayer is incorporated for the second time <i>Ulrich Haberland, Chairman of the Board of Management from 1951 to 1961</i>	314 316	1958	New raw materials revolutionize coatings <i>Unsaturated polyester resins and DD coatings</i>	366 368
1952	Polyurethane foams come in all shapes and sizes <i>Processes and machines for block foaming</i>	318 320	1959	Bayer anticipates the law on employee participation	372
1952	Fighting tuberculosis with Neoteben <i>Conteben and Neoteben</i>	322 324	1960	The Japanese Garden	376
1953	Makrolon is a plastic as transparent as glass <i>The production and processing of plastics</i> <i>Composition of some of Bayer's major plastics</i>	326 328 329	1960	Silicones offer products for a variety of purposes <i>Silanes, siloxanes and silicones</i>	378 380
1954	Dralon becomes a symbol of quality <i>Polyamide and polyacrylonitrile fibers</i>	334 336	1961	The fascinating world of modern colors <i>Reactive dyes and specialties</i> <i>Kurt Hansen, Chairman of the Board of Management from 1961 to 1974</i>	384 386 388
1954	Fragrances, flavors and aromas from Holzminden <i>Vanillin and menthol</i>	342 344	1962	Polyurethane foam penetrates a variety of markets <i>New technology for molded parts made from polyurethane foam</i>	390 392
1955	Power stations at full steam ahead	348	1962	Synthetic rubber—a product with a future <i>New polymers in the rubber sector</i>	394 396
1956	Brazil: South America's most important market <i>Plant planning by Central Engineering</i> <i>Bayer in Latin America</i>	352 354 356	1963	Bayer's centennial marks a century of progress	400
			1964	Double-contact process helps to clean the air	402

1964	A Japanese shrine dedicated to E 605 <i>Agrochemicals based on phosphoric acid esters</i>	404 406	1971	Restructuring the corporate organization <i>Special committees represent middle management</i>	460 462
1964	Agfa-Gevaert makes more than just pretty pictures	408	1971	Half of Spanish sales stem from local production	464
1965	Bayer Antwerp—a pioneer on the river Schelde	414	1971	Sencor—the story of a superlative <i>Sencor, a herbicide on the basis of triazinone</i>	466 468
1966	Organic chemicals—at the core of chemical production	418	1972	A long tradition of worldwide advertising	470
1966	Environmental protection has a long tradition at Bayer <i>Waste treatment at Bayer</i>	422 424	1972	Lampit, the first remedy against Chagas' disease <i>The fight against Chagas' disease</i> <i>Bayer in Africa</i>	474 475 476
1967	Plastics capture the automobile market <i>Integral-skin foams and other interesting developments in the plastics field</i>	430 432	1973	Brunsbüttel: a new industrial complex is born	478
1967	A market with potential—Bayer in Italy <i>Enamel puts a shine on metal</i>	436 438	1973	Winning the fight against fungal diseases <i>Canesten and Mycospor</i>	482 484
1967	Mobay becomes a full-fledged Bayer company	440	1974	Systematic expansion in the United States <i>Herbert Grünewald, Chairman of the Board of Management from 1974 to 1984</i>	486 488
1968	The fight against the “scourge of Allah” <i>The fight against bilharzia</i>	442 444	1974	Safety measures keep accidents to a minimum	490
1969	From adult education to top-notch cultural events	448	1975	Adalat heralds a new era in cardiovascular medicine <i>Calcium antagonists, sympathetic nerve inhibitors and beta blockers</i>	494 496
1969	Having the right education to qualify for success	450			
1970	Adjusting to local cultures: case study Thailand	454			
1970	To be or not to be “Indian”	456			

1976	Plant safety is not left to luck <i>Factory and central workshops at Bayer</i>	500 502	1984	Product ranges geared to the needs of the consumer <i>Central Committee Marketing</i>	564 566
1977	Medical therapy enters the antibiotics era <i>Penicillin and other antibiotics</i>	506 508	1984	Biotechnology enters a new era with genetic engineering <i>DNA, RNA, plasmids and genetic engineering</i>	568 570
1978	Miles—an ideal partner for Bayer <i>An office in the Soviet Union</i>	514 516	1985	Pharmaceutical research: the never-ending story	578
1979	Take a break in the canteen	520	1986	Bayer faces the Japanese challenge	584
1979	Works Security keeps order and protects the plant	522	1986	A glass that supports bridges, and other specialties <i>Bayer in China</i>	590 592
1980	Tower Biology: high-tech waste water treatment <i>The principles of Tower Biology</i>	524 526	1986	Rare metals and high-performance ceramic materials <i>Special metals and engineering ceramics</i>	594 596
1980	Keeping production under control <i>Special tasks for physicists and process engineers</i>	530 532	1987	Looking ahead for the benefit of the environment <i>Central Analytics</i>	600 602
1981	Bayer's fire department sets an example	536	1988	Leverkusen works: the face will change but the essence remains	606
1981	Logistics—juggling with numbers and tons	540	1988	Innovation is the basis for success	608
1982	A research center for the agricultural sector <i>Bayleton and Baytan</i>	544 546			
1983	Bayer in the U.K. has its origins in Manchester	552			
1983	Bayer helps employees help themselves	554			
1984	Corporate structure of the company <i>Hermann J. Strenger, Chairman of the Board of Management since 1984</i>	560 562			
				Index	610
				Photographs and illustrations	624



“Millipede’s Progress,” or the author’s preface

The author’s foreword is really an afterword because most of the things that he can say at the end of his work were not known at the beginning.

When Bayer entrusted me with the task of writing this book, I drew up a rough draft of the proposed contents and suggested the title. On the basis of this concept, we reached an agreement and decided what the book should and should not be. It was to be interesting, easy to read and comprehensible for everyone. It was not to be an attempt to compress the entire scientific history of the company into a single volume and then claim to “tell all” in 624 pages.

There are, of course, more than 125 milestones in Bayer’s story, and that is why there are more than 125 subjects included. But even so, not all topics are covered; let it suffice to say that 624 pages are just 624 pages. *“A major chemical firm does not stand on one leg but is more like a millipede,”* Kurt Hansen once said in a speech. This book describes a few hundred of the millipede’s legs.

The company did not assign the task of writing this book to an employee or a scientist but instead to a freelance writer. Both sides realized the risks involved. From the very beginning, however, I was fortunate to have two experts at my side, who are also cited as co-authors: Gottfried Plumpe, a historian who has specialized in the history of the chemical industry, and Heinz Schultheis, a chemist who had worked in the company’s corporate Public Relations Department for many years helping to bridge “language gaps” between the experts, the media and the interested public.

Historical and corporate developments that would actually merit a book of their own are covered here in only a few pages. Researching all the facts would have been impossible in the time available without the help of Gottfried Plumpe, and he is to thank for the succinct but balanced account of complex historical events and circumstances.

Heinz Schultheis supported me throughout the time of my research work within the company, setting up well over a hundred interviews for me in Germany and around the world. He was present at these meetings, ready to “interpret” where necessary, and subsequently, he helped to check the finished manuscripts with the responsible

Erik Verg was born in Dorpat, Estonia, on June 3, 1919. After graduating from high school in 1939 and serving in the army, he worked as a journalist in Hanover and Hamburg. Since 1957, Verg has written various reports and books on Africa, Latin America and the Middle

East. He became the Paris correspondent for the “Hamburger Abendblatt” in 1965 and took over as its city editor in 1971. Since 1975, he has published several books on the history of Hamburg. Verg has been a freelance author since 1984 and now lives in Hamburg.

individuals in the Sectors, Business Groups and Service Divisions.

It is not always easy for a scientist to accept a simplified description of his special field, particularly when it is not in line with the words he would have chosen. I am all the more grateful that my efforts were positively received within Bayer, and this at all levels of the corporate hierarchy. Heinz Schultheis certainly ventured far beyond the call of duty. For example, he wrote the scientific background pieces on subjects that had been left out of the main text because they would have been too specialized for a non-expert audience.

I should also mention that the people who sacrificed hours on end for interviews and tours and whose work is often the subject of whole chapters are not referred to by name in this book. The beginning chapters describe a small company with a few outstanding personalities. Subsequently, more and more people begin to play a role in the Bayer story; all of them deserve to be mentioned, but their sheer number would have made the book that less readable. If we had tried to make a choice, there would still have been far too few individuals mentioned—considering all those who could have been cited. That is why this history concentrates on the performance of the company. It is taken for granted that every company is the sum of its employees—working on their own or in teams.

A bibliography posed similar difficulties. I made use of a great deal of scientific literature, including papers and lectures by many of the people I interviewed. But I also relied on earlier corporate histories, company archives, papers of the various Business Groups, biographies, reference books and numerous publications produced by the Public Relations Department. One of the most useful of these popularized publications was "Bayer Reports," which, in its 20 years of existence, has featured portraits of numerous Group operations authored by the responsible executives. The articles were so good that they often proved more valuable than the purely scientific sources. With all this in mind,

I came to the conclusion that it would be acceptable to leave out a bibliography altogether.

The organization of the whole project lay with Thomas Reinert, also of Bayer's corporate Public Relations Department. He handled the authors' contributions, acted as picture editor and designer and worked closely with the composers and the printers. Thomas Reinert, Gottfried Plumpe and Heinz Schultheis formed the editorial team.

But a millipede has so many legs that even the historian and the chemist were unable to check and double-check all the facts. Thus, a special advisory board headed by Felix Haake was set up to give additional support. The PR Department's Inge Erkes saw to it that even the most minor comment was followed-up, every correction was made and every manuscript was in the right place at the right time.

One more point: almost everyone with whom I discussed my work asked, "What are you doing about I.G. Farben?" From the very beginning, those involved with the book all shared the same opinion. Nobody thought that we should take the easy way out by claiming that since Bayer did not exist as an independent entity between 1925 and 1951, the I.G. Farben era does not belong in Bayer's story. No German company can simply disregard this dark period in the country's history. This chapter of the story certainly does not represent a positive landmark, but the truth must be told.

It was not my job to "editorialize" in this book. Nevertheless, with every month of work on "Milestones," I became more and more convinced of the fact that the history of the chemical industry is an integral part of history as a whole. If the only source for a chronicle of the chemical industry had been the published opinions of the past 20 years, the result would have definitely been tendentious. Little would have been said about the significant role that chemistry plays in the very existence and future of society. I made it my task to attempt to correct this distorted picture. In that respect, I suppose that I, too, was tendentious.

Erik Verg

A rainbow of dyes emerges from coal tar

Company histories generally begin with a portrait of the founder. This one starts with the story of a discovery.

Notwithstanding the great entrepreneurial ability, daring and perseverance that Friedrich Bayer and Friedrich Weskott undoubtedly possessed, the former would probably have remained a respected and possibly wealthy merchant and the latter a similarly distinguished dyer had it not been for the invention of coal-tar dyes. And without this invention, they would not have become the founders of a major international concern. With all due respect to Friedrich Bayer, the man who gave the company its name, and to his partner, Friedrich Weskott, this story will begin by honoring August Wilhelm Hofmann from Germany and William Henry Perkin from England.

In the mid 1800s, people sensed that life was rapidly and radically changing. The Machine Age had begun, and contemporaries were already talking about the "Industrial Revolution." Until about 1800, men were still working with the plow and anvil and using the spade and hammer. Little technological progress had occurred since the Egypt of the Pharaohs, Greece during its classical era or since Rome at the time of Christ. The advent of machinery led to industrial production—the basis for unprecedented and rapid growth.

The steam engine was developed first. It powered the trains and ships that transported goods quickly and easily to places which used to be impossible to reach. By 1850, there were more than 10,000 kilometers of railroad tracks in the United Kingdom, almost 15,000 kilometers in the United States and some 6,000 in Germany, where the first services had been inaugurated between Nuremberg and Fürth in 1835.

These steam engines were fueled with coal, which meant that the collieries flourished. Ferrous metal industries grew as well, since the ships and locomotives needed iron and steel.

The transatlantic telegraph cable was the next major breakthrough. A message from London reached New York faster than a messenger could carry it from Trafalgar Square to the London Stock Exchange.

When England defeated the Spanish Armada in 1588, its exchequer had been smaller than that of

Coal, the "black gold" created over a period of millions of years, was instrumental in promoting the industrial revolution. Initially, the coal tar obtained during the production of gas and coke was used as a fuel oil, as a wood varnish or in the manufacture of carbon black.

It was not until the mid 19th century that chemists were able to isolate aniline from the sticky mixture. With this development, the foundations of the synthetic dyestuffs industry were laid.



Dyes from plants, snails and lice

The dyes available to ancient civilizations were limited. Purple, the most costly dye, was the coveted symbol of power in Imperial Rome, and was therefore reserved for the robes of the Caesars, consuls and high-ranking officials. Citizens were forbidden to wear clothes dyed purple. Nero even made this an offense punishable by death.

The Phoenicians first reported on the use of purple dyes. They probably learned of it from the Minoans of Crete.

The dye was obtained from a particular strain of Mediterranean snails. Between 10,000 and 12,000 snails were



needed to produce a single gram of purple dye. It is not surprising that purple-colored clothing was so expensive.

Later, during the times of the ancient Roman Republic, the use of purple dye was limited to one stripe on the consuls' togas. The Roman Empire was much more extravagant: even by today's standards, one of Caesar Augustus' robes would be literally worth a fortune.

Unfortunately, the exact color of this ancient purple will forever remain a mystery. The shades of purple varied

from bright red to deep violet, depending on the kind of snails, their combination and the dyeing conditions. One of these variations was called the "color principalis," the main color.

However, the color of another famous natural red dye has been handed down to posterity. When the Spaniards conquered Mexico in the 16th century, they found that the Aztecs had brilliant red fabrics at their disposal. It turned out that the dye was produced from the scale louse. Some 150,000 dried female lice were needed to yield one kilogram of cochineal scarlet. The low yield and the labor-intensive production fetched a correspondingly exorbitant price for the exotic red dye.

Other dyes—more or less cheap and fast—were processed out of such bases as madder (below right) and different kinds of Indigofera plants, such as the anil (below left). Woad, the kermes insect, orseille, safflower and the alkanna plant were also used to produce dyes.

But Hofmann's prophecy heralded a new era in which every man and woman could finally dress up in color.



From time immemorial, fashions have been a symbol of status and personal vanity. Color has played a central role in determining the latest fashion. The changes in tastes helped to spur the success of coal-tar dyestuffs.

the merchant city of Florence, Italy. Some 250 years later, it became the cradle of the Industrial Revolution and the home of numerous significant inventions. Germany, on the other hand, was still a conglomerate of small states that had only started to move towards economic coherence after the Customs Union of 1834.

Industrialization also had its drawbacks, and so new social problems developed. People who no longer could find work in the country or in small towns moved to the main industrial centers, became wage earners and formed a "proletariat." Of course, it could not be foreseen that the Industrial Revolution itself would in time permit the effective control of such age-old scourges as disease, hunger and poverty, at least for part of the population.

The production of textiles was the first trade to develop into an industry. Spinning machines called the "Spinning Jenny" replaced hand-operated spinning wheels. In 1789, Edmund Cartwright invented the weaving loom. Spinners and weavers were slowly reduced to poverty. But in the wake of these developments an industry came into being—initially in England—which was able to mass-produce yarns and fabrics. Cotton eventually became the most important raw material in world trade because it was easier to process with the new machines than wool or flax. Textiles became cheap, but dyes remained expensive. And this is where the Bayer story begins.

In 1862, the World Exhibition was held in London. One of the official speakers was German chemist August Wilhelm Hofmann. After greeting the guests in English, German, French and Italian, he told them that chemistry was now in the vanguard of the technical sciences.

Hofmann then drew attention to a series of fascinating exhibits at the show: various silks, cashmeres, ostrich plumes and the like were dyed in a diversity of novel colors which everyone believed to be the most superb and brilliant that ever met the human eye. In enthusiastic language he described crimsons of the most gorgeous intensity, purples of more than Tyrian magnificance, and blues ranging from light

azure to the deepest cobalt. Contrasted with these were the most delicate roseate and softest tints of violet and mauve.

In addition to the exhibits of dyed fabrics, the actual dyestuffs—in the form of inconspicuous granules, crystals and powders—were on display. They had been made from what had up until now been considered a rather annoying by-product of coke and gas production: coal tar.

Hofmann went on to express the hope that *"for every one of the various natural dyes that can only be gained from such costly plant or animal material as colored insects, bark, flowers or roots, it will be possible to produce equally good dyestuffs made out of coal tar."*

These statements were not well received. In the presence of the Queen, James Mansfield protested, *"in the name of all English and Dutch indigo planters."* He called on Her Majesty's Government to protect their trade from what he considered to be a sham. The new colors were unnatural and tasteless imitations, he claimed. *"As an Englishman, I ask, does this country still have a culture, or have its inhabitants become like savages who pay in good ivory for glass diamonds to bedeck themselves with?"*

Mansfield's moral indignation was understandable, but nevertheless misplaced. Some 322 British-Indian firms alone, not counting the Dutch companies in the East Indies, produced six million kilograms of indigo annually on their huge plantations with a combined value of £4 million. As much as 100 kilograms of indigo leaves were needed to make one and a half to two kilograms of dye. All this was only made possible by plundering the natural raw materials and severely exploiting the Indian and Indonesian workers.

Hofmann's predictions became a reality: inexpensive, colorful clothing became available to all. But it was a long way to the colorful brilliance of dyestuffs from the sticky, black coal tar. At the start of the 19th century, "Chemische Produkten-Fabrik zu Oranienburg" was operating near Berlin. It was managed by the "Seehandlungsgesellschaft"

Colors and dyes

The pioneers of synthetic dyestuffs commonly spoke of their products as "Teerfarben," or "coal-tar dyes." Bayer also proudly left the word "Farben" in its company name for more than 90 years.

Today, the same German word can mean dyes, paints or colors. Thus, as well as describing such visual impressions as green, red and yellow, the word is now also used to describe color pigments in their forms and applications. One example is paint.

In fact, what Hofmann, Perkin and other researchers discovered and presented to the London public in 1862 were dyestuffs rather than dyes. They differ fundamentally from pigment colors in both their chemical composition and their various applications.

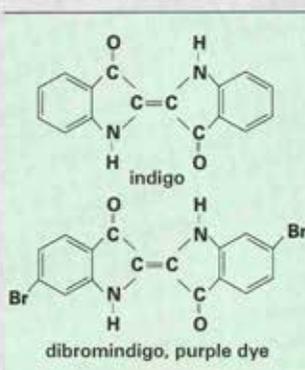
Pigments are insoluble particles such as crushed ferrous or chrome oxides, or insoluble organic dyes. Suspended in a binding agent, they are applied to cover a surface so that only their own color shows in the end.

Dyestuffs, on the other hand, are natural or synthetic substances that are soluble in water. They can also be an organic solvent, which means that they actually bind together with the material to which they are applied, such as fabric, paper or leather. In contrast to a coat of paint, dyeing does not bring about a change in the structure of the surface—it merely gives it color.

Both natural and synthetic dyestuffs can belong to very

different chemical categories. The one thing they have in common is that they are always "unsaturated" compounds with several double bonds, benzene rings or heterocyclic molecules, which cause the coloring effect.

The dyestuffs mentioned in the text show this clearly:



Indigo is a good example of how human creativity was put to use in the search for an attractive blue color.

As a so-called vat dye, indigo is not at all easy to work with. Inventive power was needed to devise a process to treat the raw material with alkali and reagent in order to produce the light, soluble dyeing liquid necessary for processing.

By examining the structural formulas of the two substances, it can be seen that, with the exception of two bromine atoms, the vegetable dyestuff indigo is chemically identical to the famous red dye of the purple snail.

Given the diverse chemical compositions of the many

different natural dyestuffs, and the same is true of the synthetic dyestuffs, this marked similarity between two substances that have completely different sources is quite astonishing.

Perkin discovered dyestuffs that have a totally different constitution. Working from the aniline contained in coal tar, he added bichromate and thus oxidized four aniline molecules to produce a complicated compound.

The formula shows that a total of ten hydrogen atoms have been extracted from four aniline molecules. In the subsequent oxidation process, these atoms combine with the oxygen from the bichromate to produce five molecules of water.

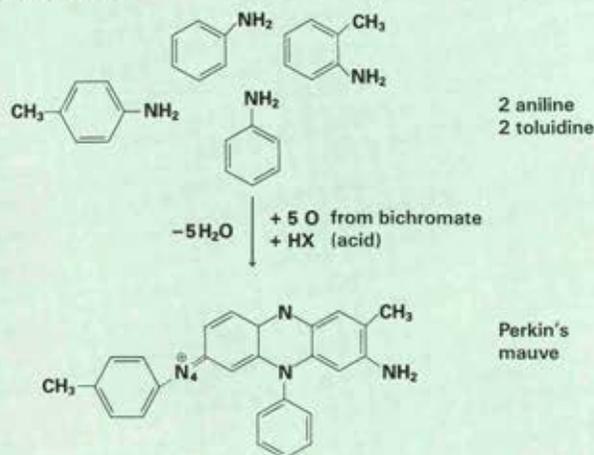
Another phenomenon demonstrated by this formula is that one of the nitrogen atoms with a positive electrical charge can be neutralized by a negative charge called an anion. This can be, for example, a sulfate from sulfuric acid.

The structural formula for mauve shown below reveals a fascinating picture of a dyestuff molecule captured at one precise moment.

The double bonds are in reality pairs of electrons in which electrical charges oscillate billions of times per second in the molecule. In doing so, they produce a violet color.

The intensity of the color depends on the amount of energy necessary to induce the movement of the electrons.

An example:



(the Prussian State Bank) that was set up in 1772 by Frederick the Great. In 1832, the head chemist of this early industrial plant, Friedlieb Ferdinand Runge, was given the task of investigating hard-coal tar to see if it contained any usable compounds. Working with retorts, acids and alkalies, he tried to break the tar down into its constituent parts. In his countless experiments, he noticed that one particular oily component took on a violet color when treated with a solution of chlorinated lime. Runge named his discovery kyanol from the Greek word "kyanos" (blue). He also observed something else: *"Stranger even than this was the mutability of the substance when treated with different chemicals. Depending on whether I exposed it to chlorine, chromic acid, nitric acid, copper chloride, gold chloride, etc., violet, blue and red dyestuffs developed before my eyes."* These were the first of the aniline dyestuffs.



What Runge had isolated from the coal tar was aniline, a substance discovered independently four times within 15 years and given a different name each time:

- 1826 Otto Unverdorben—krystallin
- 1834 Friedlieb Ferdinand Runge—kyanol
- 1841 Nikolai N. Zinin—benzidam
- 1841 Carl J. von Fritzsche—aniline

In 1834, Runge reported on his findings in the "Annalen der Physik und Chemie," published by physicist Johann Christian Poggendorf. Runge also drew the Seehandlung's attention to the favorable prospects of synthetic dyestuffs production. The company showed no interest, nor did outside experts. The time was simply not ripe for the bold idea of industrial application.

At about the same time, August Wilhelm Hofmann was studying law in his hometown of Giessen. Like many others, he also attended Liebig's lectures on analytical chemistry. Fascinated by the great chemist's personality and the new, methodical system of teaching practiced at his institute, Hofmann

spontaneously put his lawbooks aside in favor of test tubes, first as a student and later as Liebig's assistant.

On Liebig's instructions, he joined the ranks of the researchers investigating coal tar. He came across Runge's "kyanol" and confirmed its chemical identity as being identical to krystallin, benzidam and aniline.

He recommended use of the name krystallin until an exact chemical term could be found. In modern terminology, the substance is known as phenylamine or amino-benzene. Up to today, however, the word "aniline," taken from "anil," the Portuguese word for indigo, has remained the most common name.

Hofmann also discovered a chemical process for the synthesis of aniline, deriving nitrobenzene from a reaction of benzene and nitric acid, then reducing

this with hydrogen to get amino-benzene—in other words, aniline.

At this point, the scene changed to England, where the Royal College of Chemistry had been founded as a private venture in 1845. Its founding was preceded by an intense interest in Liebig's book "Die Chemie in ihrer Anwendung auf Agricultur und Physiologie," which was heralded in England and elsewhere as introducing a new era in farming—that of synthetic fertilizers.

The country's leading landowners were particularly taken by Liebig's theories and were eager to promote the new agrochemicals. Other influential persons, including Liebig's British pupils, recognized the urgency and necessity to set up a proper teaching laboratory for the training of chemists. Their education had been rather biased and inadequate up to this time. Since this institute was to be run according to Liebig's principles, it could only be headed by one of his pupils. Liebig himself recommended two of his assistants and August Wilhelm Hofmann, professor of chemistry at Bonn University at the time. In the end, Hofmann accepted the invitation to go to London. This proved to be a blessing for British chemistry. On the basis of an agreement

Friedlieb Ferdinand Runge (1795–1867) isolated aniline from coal tar. Born in Billwerder—today part of Hamburg—chemist Runge is considered a pioneer in the field of dyestuffs.

After a brief period as a professor at Breslau University, he worked as an industrial chemist in Berlin and Oranienburg.

between the British and Prussian governments, he was to have stayed for two years. He remained for 20.

Hofmann accepted a new pupil in 1853. His name was William Henry Perkin from the City of London School, all of 15 years old and full of enthusiasm for chemistry. Within two years, the gifted youth had become Hofmann's paid assistant. In this post he was given a problem to solve that had interested his teacher for years: the synthesis of quinine. Made from the bark of the cinchona tree, quinine was, at the time, the sole treatment for malaria and other fevers. As a leading colonial power, Britain naturally needed large quantities of it. In the search for a process to synthesize quinine, Perkin tried using aniline. The aniline he had on hand, however, contained toluidine as a contaminant. Acting on an idea of Hofmann's, he treated it with potassium bichromate. Instead of the quinine he had hoped for, he obtained a dark, greasy precipitate. Contrary to the custom of the day, he did not simply throw away the disappointing results, but submitted it to a thorough examination—evidence of remarkable perseverance in an 18-year-old. One of the components of the precipitate turned out to be a dyeing compound. *"I discovered mauve during the 1856 Easter vacation,"* said Perkin. Moreover, he discovered it in a primitive little laboratory he had set up in his parents' house since his work at the college left him no time for his own research.

Perkin tested his new dyestuff on silk and found that it yielded a deep and attractive shade of violet never seen before. He immediately recognized the value of his invention and confided it to his friend Arthur Church, also a chemist. Church recommended that Perkin patent the discovery right away. He was eventually granted British patent number 36 140 on August 26, 1856. Perkin had originally named his dye "Aniline Purple," since he saw a connection between the dye's color and the imperial purple of ancient times. The French called the shade "mauve," after their name for mallow. The color remained in fashion for a full decade.

In the summer vacation of 1856, Perkin and his elder brother Thomas made sufficient quantities of mauve to be able to test and demonstrate the dye. Hofmann did not hear about this or of Perkin's intention to make the mauve in a factory of his own until October. He warned against such an uncertain venture, but his assistant was not to be deterred.

The famous 19th-century German philosopher Friedrich Nietzsche, who called for the critical reassessment of all values, was to write years later: *"The most important thing in any invention is coincidence—but most people do not happen to meet up with coincidences."*

This coincidence factor occurs again and again in Bayer's history. But even those people who do meet up with coincidences often fail to take advantage of their opportunities.

The young Englishman was an excellent example of the combination of impassioned scientist and astute entrepreneur. Perkin's father, a builder, recognized this quality and invested most of his own money in Perkin & Sons, established in Greenford Green near Sudbury, England. It was the world's first coal-tar dye works.

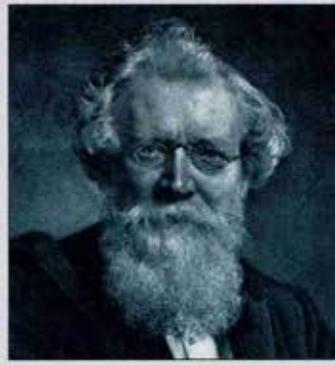
The teacher carried on with the research that his pupil had started. Hofmann concentrated his efforts on aniline and its derivatives, and drew his own "colorful conclusions."

He developed dyestuffs, analyzed their compositions and generally laid out the groundwork for taking the rainbow out of the retort. This earned him his fame in England as the virtual father of the dyestuffs industry. Hofmann was to win a similar accolade in Germany when he went home in 1865.

Protected by his patent, Perkin was able to manufacture in Britain without competition. He became a successful and admired businessman. In Germany, however, there was no patent law at the time and, since the first of the coal-tar dyes were easy to make, factories began to spring up all over the country.

Mauve was the world's first synthetic dyestuff. Seen here on silk, this color helped its inventor Sir William Henry Perkin (1838–1907) earn a worldwide reputation. Perkin, pictured below right, created mauve in 1856, after having studied under Professor August Wilhelm

Hofmann (1818–1892) at the Royal College of Chemistry in London. Hofmann (above right) is considered the father of synthetic dyestuffs chemistry. Bayer chemists reproduced Perkin's successful experiment specially for this book.



August Wilhelm Hofmann
1818–1892



William Henry Perkin
1838–1907

"Without a scrupulous study of chemistry and physics, the sciences of physiology and medicine will not gain insight into their most important tasks, i.e. probing the laws which govern life and curing or even eradicating abnormal conditions of the organism. Without knowledge of chemistry, the statesman will remain ignorant of the true life of the state, its organic evolution and consummation. His vision will lack discernment, his intellect will not be able to distinguish between what is truly beneficial or detrimental to the common weal. The loftiest material interests, the increased and more profitable production of food for man and beast, the maintenance and restoration of good health are all closely associated with the dissemination and study of natural sciences, and particularly that of chemistry. Without knowledge of natural laws and natural phenomena, the human mind fails in the attempt to understand the greatness and unfathomable wisdom of the Creator; for all that the richest imagination and the highest intellect can possibly picture is a bright, sparkling and empty bubble compared with reality."

Justus von Liebig (1803–1873)

Hundreds of thousands, perhaps even millions of people have grasped this bronze door handle since the former main administration building was constructed in 1912. It still adorns the portal of this building (now known as Q 26) in the Kaiser-Wilhelm-Allee, Leverkusen.

Like so many arts and crafts from this era, the handle is an example of the art nouveau movement.

Milestones



A merchant and a dyer form the company “Bayer”

On August 1, 1863, the merchant Friedrich Bayer and the dyer Johann Friedrich Weskott established the general partnership “Friedr. Bayer et Comp.” Six days later, it was formally registered in Elberfeld. Its initial articles of association provided for the manufacture of aniline dyestuffs.

Friedrich Bayer’s great-grandfather had been a dyer and a draper in the Bavarian town of Nördlingen. Friedrich’s grandfather was a weaver, who settled down in Barmen, a community near Elberfeld in the 1770s. His son (Bayer’s father) was a silk weaver. Friedrich, the only boy in a family of six children, was born in 1825. He started his working life as an apprentice to a chemical merchant in Barmen. With his background and training, it seemed a logical step to set up his own business trading in natural dyes and dyer’s auxiliaries in 1848.

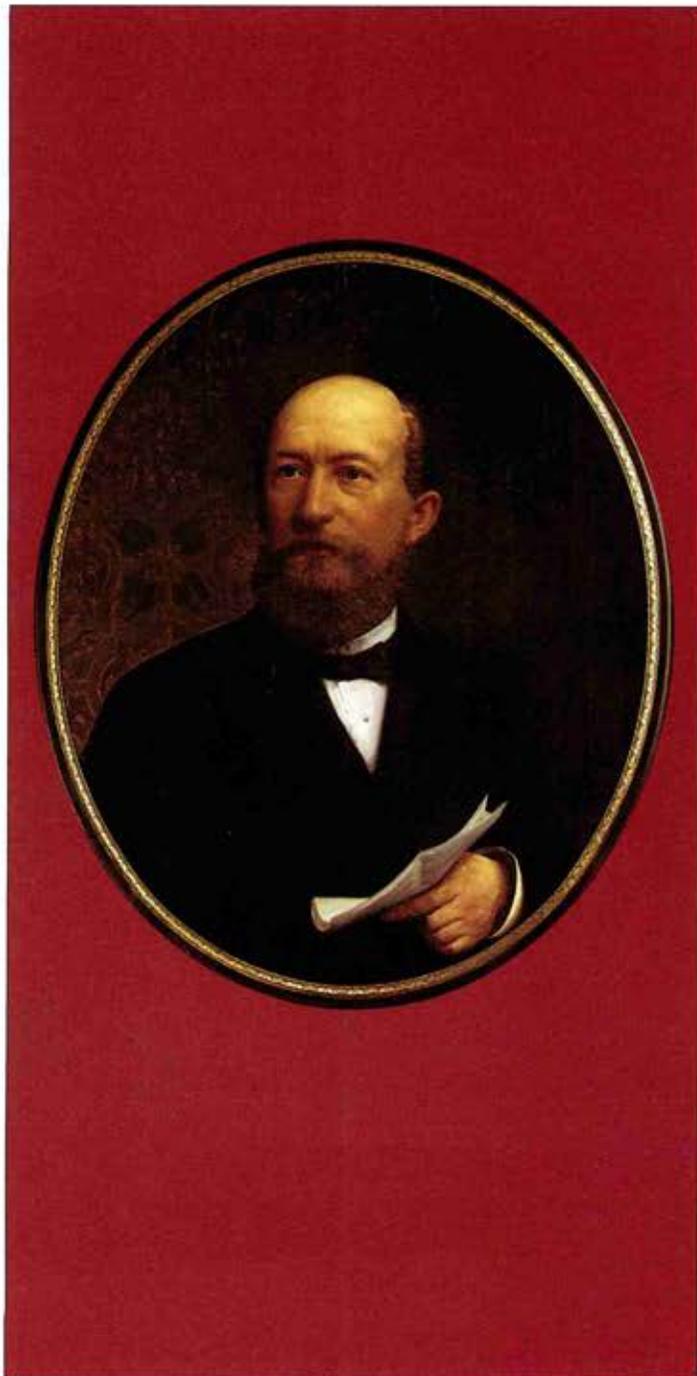
The location was well-chosen in a region that included the Krefeld silk industry, the Elberfeld linen weavers and the ribbon-makers of the Bergisches Land. The textile industry was unusually successful at the time, having capitalized on the emergence of the German industrial economy in the 1750s and 1760s.

Young Bayer’s business flourished. By 1860, he owned five acres of land, including farm buildings and two houses. His business connections extended from numerous German cities, to Brussels, Belgium; Amsterdam in the Netherlands; Bradford, England; St. Petersburg, Russia; and even New York in the United States.

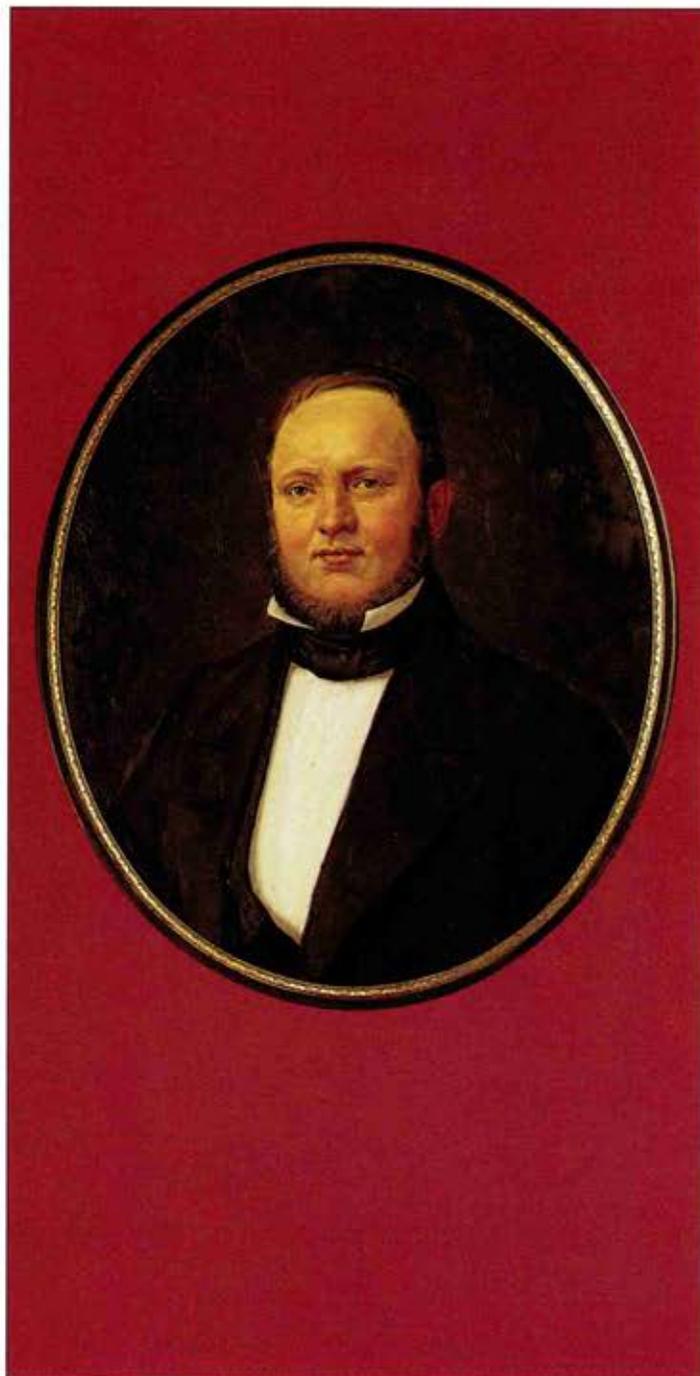
At about the same time, Friedrich Weskott operated a small cotton-yarn dye works in Barmen. His ancestors belonged to one of the oldest families in the district, taking their name from the village of Westkotten near Wichlinghausen, where they had owned a bleaching ground as well as a farm. Weskott’s grandfather had, in fact, moved to Barmen because the river meadows of the Wupper offered a better location for bleaching.

The third of 13 children, Weskott learned the dyer’s trade and started his own business in 1849, just one year after Bayer. He proved to be another successful young man. Because of a long-term and exclusive contract he had with a local firm, his business also flourished.

While Bayer’s chemical knowledge was limited, he had enough imagination to realize the potential of the aniline dyestuffs resulting from Perkin’s discovery.



Founder Friedrich Bayer (1825–1880) was born to a family of silk weavers in Barmen. After training as a merchant with a chemicals trading house in his hometown, he set up his own business in natural dyes and auxiliary products for dyeworks in 1848.



Founder Friedrich Weskott (1821–1876) was a farmer's son. His family took its name from their home village of Westkotten. Apart from farming, the family had a small bleaching operation. After an apprenticeship as a dyer, Weskott set up his own factory for dyeing cotton hanks.

Fuchsine

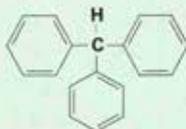
This major product of the newly formed company of Friedr. Bayer & Co. belongs to the large family of triphenylmethane dyestuffs. The name is derived from the simplest organic compound, methane (CH_4). Substitution of three of the four hydrogen atoms by phenyl residues (C_6H_5-) results in the basic substance triphenylmethane:

The triphenylmethane dyestuffs contain hydroxy or amino groups on the opposite side of the central carbon atom—which is its para-position.

Hydroxy or amino-triphenylmethanes are, however, not dyestuffs in themselves but rather intermediary (leuco) compounds.



methane



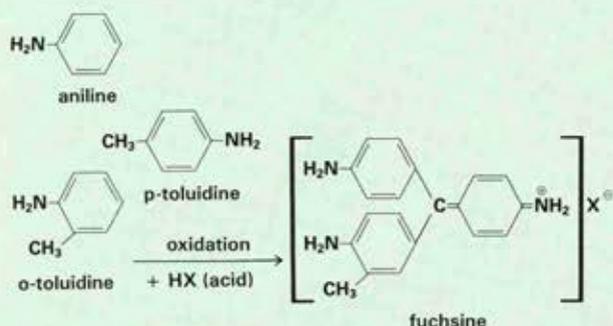
triphenylmethane

Dyeing properties are evident only after oxidation and removal of two hydrogen atoms to give structures like those described below for fuchsine.

The process referred to in the text involved the direct

oxidation of appropriate quantities of aniline and toluidine into a dyestuff.

In the early days, arsenic acid (As_2O_5) was used as an oxidizing agent (see following chapter).



He was not the only one. Apart from British production, dyestuffs firms had already started up in France and Switzerland. Long before August Wilhelm Hofmann had presented the new colors to the general public with a fanfare at the 1862 London Exhibition, Bayer had shown color samples to his customers.

At first they laughed at what they considered new-fangled rubbish. But his friend Friedrich Weskott believed in the potential of dyestuffs. Evenings, they often sat and drank wine in Barmen's Hotel zur Pfalz and made plans. But that wasn't all they did. They also tried their hand at synthesizing dyestuffs themselves.

This began quite literally as a kitchen sink operation, with the earliest "laboratory" and "factory" in the family kitchen. They stirred, boiled and melted chemicals in earthenware pots on either the Bayer or the Weskott hearth. It took them six months to find out how to make fuchsine. This coal tar dyestuff, named after the fuchsia flower, had already been discovered and described by Runge and Hofmann and manufactured by Emanuel Verguin. Fuchsine consisted of yellow-green crystals which, together with water and alcohol, yielded a bright red color with a greenish tinge.

On December 8, 1862, Bayer wrote a letter to Berlin to a Mr. Griess, probably one of his customers: "I should like to inform you that I have now set up a factory for the manufacture of New Blue, Aniline de Nuit, Aniline Violet and Fuchsine," while on July 17 of the following year he concluded a letter to a Mr. Schifflin in New York with the words: "Would you please address your next letter to me at Messrs. Friedr. Bayer & Co." Two weeks later, the company was officially registered.

The company had its headquarters in the dye warehouse adjacent to Bayer's residence in Barmen-Rittershausen's Heckinghauser Street. The factory was located on Weskott's Berliner Street property. But despite all this enthusiasm, the partners were circumspect enough not to give up their own firms.

In 1863, the modest headquarters of "Friedr. Bayer et Comp." was situated in Heckinghauser Street in the Rittershausen section of Barmen. The building on the right in this picture had originally served as a dye warehouse for Friedrich Bayer's trading company until the new

firm was founded. The inset shows the entry of the company's registration in the official city records of Elberfeld on August 7, 1863. Bayer and Weskott are cited as the founders.

A merchant and a dyer
form the company
"Bayer"

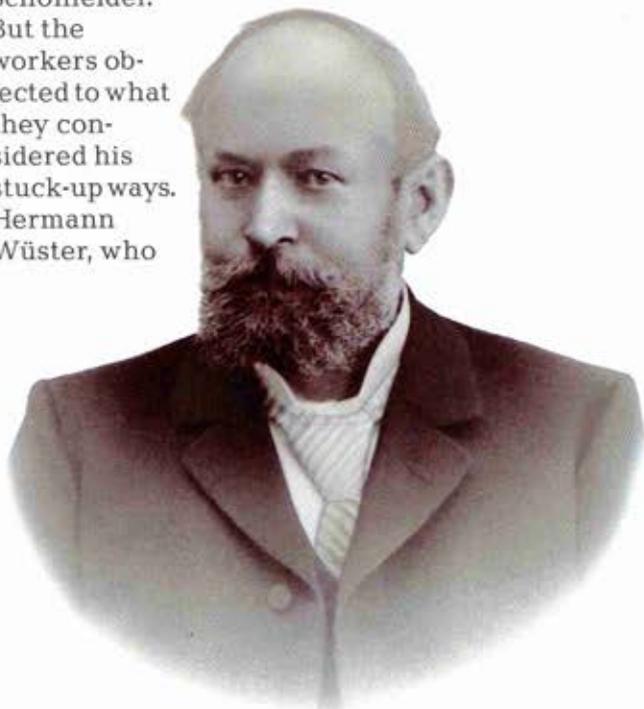
The factory had a single worker. His name was Daniel Preiss and he was to spend a total of 40 years "at Bayer's." The office work was the domain of Mrs. Caroline Juliane Bayer, née Hülsenbusch. Weskott was in charge of production and quality control, while Bayer looked after the acquisition of new business.

In the fall of the same year, two more employees were engaged, and by the end of 1863, the payroll had grown to 12. The output was approximately 20 to 25 pounds of fuchsine a day, which sold for about 20 Prussian talers per pound. But that did not mean the firm had the field to itself.

With growing competition, the fuchsine price fell in the following year to only eight talers per pound. Since production costs remained unchanged, something had to be done. The partners needed a chemist who was able to comprehend and evaluate publications in chemical journals and, more importantly, analyze the competitors' products and develop something better.

In about 1864, there seems to have been a university graduate in the company, a Dr. Schönfeld or Schönfelder.

But the workers objected to what they considered his stuck-up ways. Hermann Wüster, who

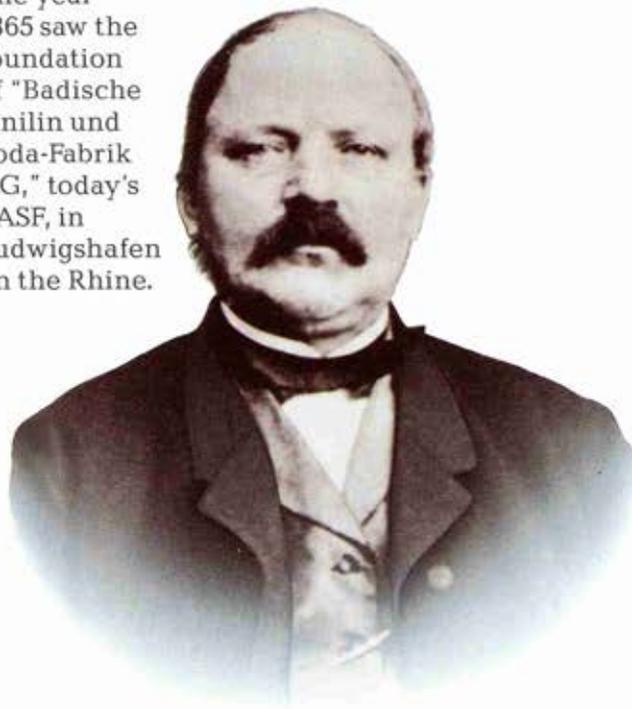


became one of the pillars of Bayer & Co., was an eyewitness of what happened. In his memoirs, he later wrote, "(the graduate) was forced to leave after the workers put black soap in the fuchsine."

Bayer finally found what they were looking for in the 22-year-old August Siller, a graduate of the Chemical Department of Krefeld Technical School. He proved to be just what the company needed. He developed a number of blue and violet dyestuffs himself, and along with Wüster soon became the motivating power behind the little factory.

Continental Europe's first tar dye factory had been in operation in Switzerland since 1859 and was later to assume the name of "Chemische Industrie in Basel"—CIBA for short. Other competitors came into existence at about the same time as Bayer. In 1864, the company "J.J. Müller & Cie." (founded in 1860) was acquired in 1864 by Johann Rudolf Geigy. In 1863, "Meister Lucius und Brüning," later Hoechst AG, was established in Höchst am Main just outside of Frankfurt; Kalle & Co. was set up in Biebrich; and "Chemische Fabrik" was established in Griesheim near Frankfurt.

The year 1865 saw the foundation of "Badische Anilin und Soda-Fabrik AG," today's BASF, in Ludwigshafen on the Rhine.

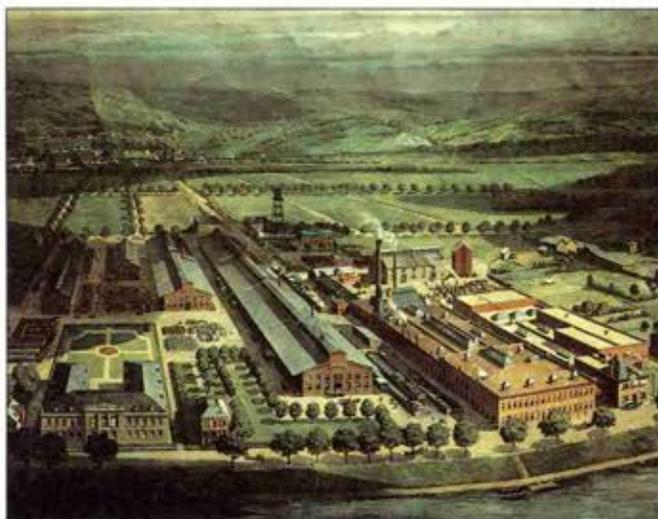


The first worker, Daniel Preiss (1841–1908), joined the company in 1863. Probably brought in by Friedrich Weskott, he stayed with the firm for 40 years. He served first as foreman in the fuchsine plant and later in the shipping yard.

The first chemist was August Siller (1843–1908). After attending the chemical course at the Krefeld technical college, he joined the company in 1864. He subsequently became a partner and later Vice Chairman of the Supervisory Board. Siller was Weskott's son-in-law.

Bayer chronicle 1865

Fuchsine production is increased from 50 to 100 pounds a day.



Bayer acquires a holding in the first U.S. coal tar dye plant in Albany, New York (above), and begins overseas deliveries of fuchsine intermediates.

The first commercial clerk and apprentice join the Bayer staff.

Bayer chronicle 1866

Bayer buys a site for a new fuchsine factory on the west side of Elberfeld.

Bayer submits an application to the government of the Prussian kingdom situated in Düsseldorf asking permission to construct an aniline factory at Vogelsaue in Elberfeld. The property is purchased for the aniline factory in Elberfeld.

The Prussian government grants permission to build a factory in Elberfeld on October 17.

Administrative offices of the company move from Heckinghauser Street in Barmen-Rittershausen to the new site on Berliner Street.

World events 1863

President Abraham Lincoln signs the Emancipation Proclamation on January 1, freeing all slaves in the United States.

On September 24, Otto von Bismarck becomes Prussian Prime Minister.

Adolf von Baeyer discovers barbituric acid.

Ernest Solvay develops the ammonia soda process.

World events 1864

Karl Marx is instrumental in forming the International Working Men's Association.

Ferdinand Lassalle, a leader of the German workers, dies in Geneva after a duel.

Siemens-Martin steel manufacturing process is developed.

Nikolaus Otto establishes together with Eugen Langen the Gasmotorenfabrik Deutz, where the first four-cycle gas engine with an intensified charge is built in 1876.

World events 1865

On April 9, General Robert E. Lee, of the Confederate Army, capitulates near Appomattox, thus ending the Civil War in the United States.

President Abraham Lincoln is shot on April 14 in Washington and dies the following day.

August Kekulé identifies the ring structure of the benzene molecule.

World events 1866

After the Battle of Königgrätz, the so-called "German War" ends on August 23 with the signing of the Peace of Prague. The reorganization of Germany, excluding Austria, begins under Prussian leadership.

Werner Siemens invents the generator.

Arsenic and pancakes are a part of production

In the first four years after the establishment of Friedr. Bayer & Co., fuchsine production rose from 25 to 250 pounds a day, and the labor force grew from 12 to 50. A new dyestuffs plant was built on the western outskirts of Elberfeld.

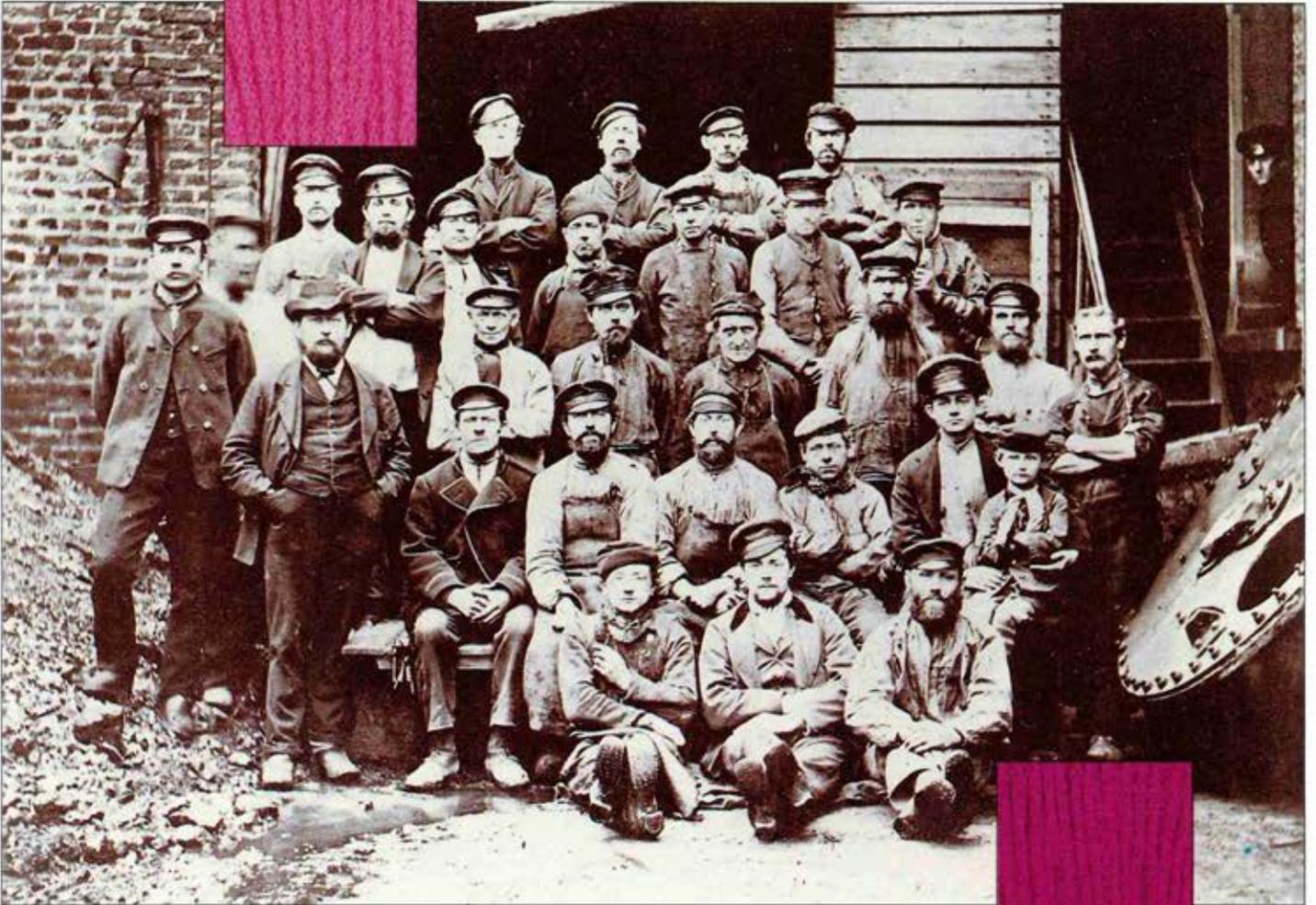
The aniline factory, known at the time as the Aniline Works, remained in Barmen and employed 25 workers. In addition to fuchsine, other dyestuffs such as Fine Blue, Light Blue, Alkali Blue, China Blue, Sea Blue (for wool), Cotton Blue, Methyl Violet and Iodine Green were manufactured. The Iodine Green dyestuff became so popular that the existing production site was no longer big enough. A new plant had to be built, this time at the end of Heckinghauser Street in Barmen.

This was, incidentally, not the only reason for locating outside Elberfeld. The company also had had problems with the old fuchsine factory in connection with the use of arsenic acid. Residue containing arsenic had been stored for further use in vats and cauldrons, but they rusted through and allowed arsenic compounds to seep through the ground into neighboring wells.

Quite obviously, the neighbors complained and demanded reimbursement for damages; in fact, things reached the stage where many of them turned up regularly on a given weekday to collect their compensation. The local authorities also objected to the state of affairs.

The new fuchsine factory was therefore erected downstream from the towns of Barmen and Elberfeld on the Wupper River. The environmental standards were met, and authorities of the day were satisfied that the water diluted the toxic emissions to lower concentrations. Nevertheless, an arsenic recovery unit was built near Haan as early as 1870. By 1877, Bayer had modified the fuchsine process to make the use of arsenic unnecessary.

Working hours lasted from six in the morning to seven in the evening. For the noontime break, women brought in lunches for their menfolk, or children earned two pfennigs per portion as carriers. Nobody complained when the work sometimes continued on into the night hours, especially since even Friedrich Weskott lent a helping hand. On payday, Friedrich Bayer went through the works with a moneybag and personally paid each worker.



For the well-informed, it was easy to spot the chemist and manager of the Barmen fuchsine plant—he was the one with the slouch hat, while all the workers wore caps. However, there was no hierarchy in the footwear: the universal heavy boots were a sign of the rough terrain in

the works yard. The small insets show hanks of cotton dyed with three intensities of fuchsine: 0.001, 0.01 and one percent from top to bottom.

Arsenic and pancakes are a part of production

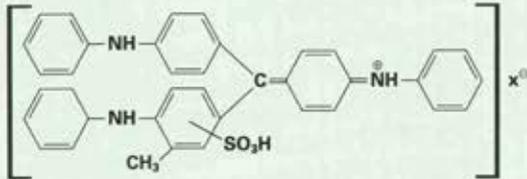
Aniline blue

The aniline blue mentioned in the text is closely related to fuchsine and can be obtained by blending fuchsine with aniline.

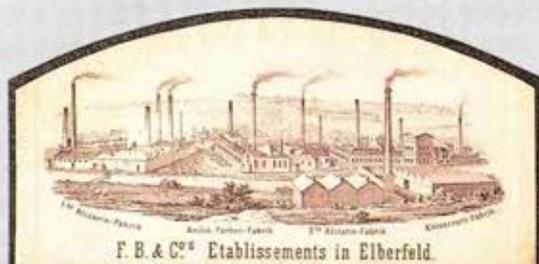
The treatment with concentrated sulfuric acid (H₂SO₄) that is referred to in the text results in the introduction of sulfonic acid groups (-SO₃H) into the

phenyl cores. This makes the dyestuff soluble in water.

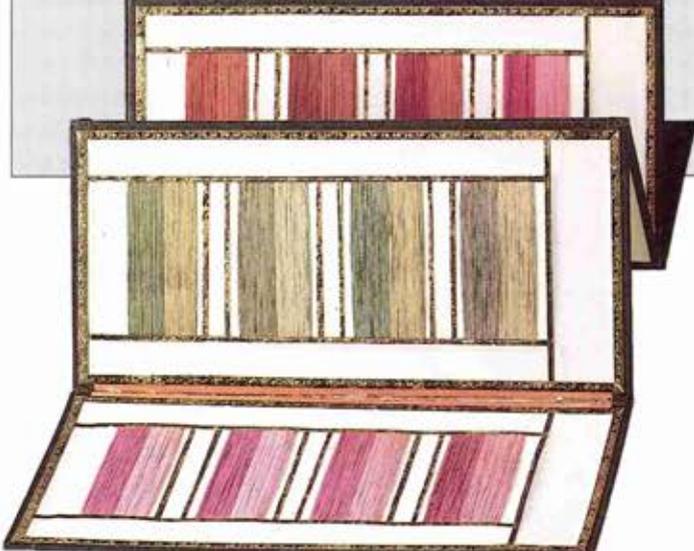
Water solubility is a great advantage because the easiest way to dye materials is with aqueous solutions. For this reason, many dyestuffs (particularly those used for coloring wool and cotton) contain sulfonic acid groups.



aniline blue



F. B. & Co. Etablissements in Elberfeld.



Everything was done by hand. Worker Friedrich Wüster later recalled: "My job was to put the pots on the fire. They had a hole on one side so that they could be stirred with an iron rod. Each pot held 24 pounds of fuchsine and 48 egg whites. When the thermometer reached 150° Celsius (approximately 300° F), the lid was smeared with blood and lime to insulate it and make it hotter. When the pot was ready, the contents were strained through felt hats. The dyestuff remained in the hat. When the dye was finished, it was made into a paste containing ten percent of the dyestuff. For shipments to Russia, we used 20 percent to make it thicker."

Actually, things were not quite so easy. The fuchsine factory had a steam engine and four batch boilers. The most unpleasant part of the work was when the lid was taken off and the batch was poured into the cauldrons.

This process gave off dangerous fumes, which occasionally led to cases of poisoning. Anyone who took over this job voluntarily was given two and a half silver groschen by his fellow workers. There was never a lack of volunteers.

Back then few people would have imagined that there would one day be a special department to control air pollution in the workplace.

The production of other dyestuffs was not without its problems either. For example, Aniline Blue was made soluble

Roth u. Scharlach.		pr. Ko.
302	Deltapapruin G	10.50
303	" 5 B	12.50
304	" 7 B	8.
1	Diamant-Fuchsin gr. Cryst. bläul.	7.50
3	" " " " " " " " " " " "	10.50
303	Diamant-Roth B	12.50
304	" " " " " " " " " " " "	7.50
323	Diaz-Horblau	1.95
307	Echthroth B T	2.05
308	" E	2.50
481	" A	5.70
101	Echt-Säure-Fuchsin II	6.
21	Eosin I gelblich	3.20
22	" I bläulich	10.50
13	Fuchsin IV	7.50
200	Geraun G	3.50
200	" II	
10	Grenadin gelblich	
16a	" bläulich	

FARBENFABRIKEN v. FRIEDR. BAYER & CO.

Bayer's oldest color sample card showed examples of the early synthetic dyestuffs, which were applied with tannin to cotton. Fuchsine, methyl green and methyl violet are shown in this picture.

in water by treatment with concentrated sulfuric acid. The vessels used for sulfurization were open clay pots. They were placed outside to allow the fumes to be carried away by the breeze. A few years later, these pots were replaced by sealable cast-iron containers very similar to the later autoclaves.

Naturally, the mixing process was also improved; mechanical stirrers were introduced in 1871, and the containers were given outlets to obviate their manual discharge.

At one point in his memoirs, Friedrich Wüster was wrong. The 48 egg whites were not used in fuchsine production, but in the manufacture of a clear light blue dyestuff with no red tinge. The process had one highly gratifying aspect for the employees. The unwanted egg yolks were "processed" on the site into

pancakes for immediate consumption. When even the hungriest laborer could no longer keep up with the number of egg yolks remaining from the dyestuff production, a neighboring baker bought up the excess.

Unfortunately, it soon turned out that egg whites had no effect on the dyestuff after all. But in the meantime, this baker had established his reputation as the best pancake-maker in town.

N	Roth u. Scharlach.	pr. Ko.
302	Hessisch-Purpur B	8
300	" " X	2.50
480	" " X extra	
107	Jute-Scharlach 31H	2.65
9	Magenta MI	2.65
10	" MII	6
11	" MIII	5
12	" MIV	4
817	" X	1.10
285	Neuroth 5R	2.65
287	" 3R	2.55
288	" 2R	2.45
289	" 1R	2.45
400	Oseillin BR	5.25

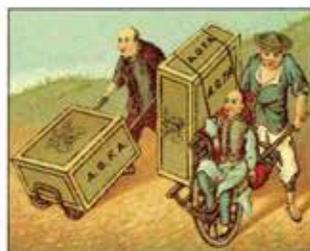
FARBENFABRIKEN VON FRIEDR. BAYER & CO.

Prices were already subject to fluctuation in 1881. The sales representative's list for this year shows handwritten rates per kilogram for fuchsine. Only the descriptions of the "red and scarlet" products were printed in advance.

Bayer chronicle 1867

Sales agencies are set up in Barmen, Elberfeld, Hamburg and Basel. The Basel agency takes over marketing in Switzerland, as well as in Alsace-Lorraine and parts of France.

Dyestuff factory is opened on the banks of the Rummelsburger Lake in Berlin. In 1873, it becomes the Aktien-Gesellschaft für Anilin-Fabrikation.



The labels on its dyestuff cans bear the abbreviation of the company: Agfa.

According to a letter dated June 25: "Our dyestuffs were awarded the silver medal at the World Exhibition in Paris."

The fuchsine factory in Elberfeld and the aniline factory in Barmen each employ 25 workers.

World events 1867

The United States buys Alaska from Russia for \$7.2 million.

The provinces of Quebec, Ontario, Nova Scotia and New Brunswick join up to form the Dominion of Canada.

Karl Marx publishes "Das Kapital."

August Wilhelm Hofmann founds the "Deutsche Chemische Gesellschaft" (German Chemical Society).

World events 1868

Austrian monk Gregor Mendel begins his hybridization experiments on the garden pea.

World events 1869

The first transcontinental railroad in the United States, the Union Pacific, is completed on May 10.

On November 17, Empress Eugénie of France opens the Suez Canal after a ten-year construction period.

Dimitri Mendeleev and Julius Lothar Meyer discover simultaneously and independently the Periodic Table of Elements.

The difficult beginnings of alizarin production

In the south of France, some 50,000 acres were planted with madder. The root of this two- to four-foot tall shrub contains a powerful red dye. Madder had been cultivated since the days of ancient Rome. It was Europe's most common dye plant, and was used widely in the Orient under the name of lizari or alizari.

When the French soldiers went to war against Prussia-Germany in 1870, they were wearing red pants. They were red not only because of tradition, but for economic reasons as well.



Capitaines de grenadiers & voltigeurs.
G^{de} tenue. Tenue de service .

The French Army wore these uniforms when it went to war with Prussia in 1870 and 1871. The red pants were dyed with madder root, a widely used natural color in Europe at that time. In the south of France alone almost 50,000 acres were planted with madder.

The above illustration shows a captain of the grenadiers and one of the "voltigeurs," an elite infantry regiment.

But the madder's days were numbered. French chemist Emanuel Verguin had shown the way to produce fuchsine as madder's first synthetic competitor in 1859, and fuchsine production was started by the Lyons firm of "Renard Frères et Franc."

After mauve, fuchsine became the second dyestuff to be manufactured on an industrial scale. While it competed against natural madder red, it was unable to replace it.

In 1868, 28-year-old chemist Carl Graebe and his colleague Carl Liebermann of the Berlin Gewerbeinstitut succeeded in discovering the nature of the madder dye and thus became the fathers of synthetic alizarin.

Once the characteristics of the dye had been determined, the next step was to reproduce it in the laboratory. A relatively simple process was found for converting anthracene from coal tar into anthraquinone. Alizarin from the test tube was, in fact, purer, more attractive and cheaper than in its natural form.

But the technology itself posed problems. Graebe registered his invention with the Prussian Patent Office, but this was no great help to him since his process was so complicated, it was virtually unusable. Graebe therefore contacted BASF, where Henrich Caro, himself a pioneer in the field of dyestuff research and synthesis, came up with a satisfactory solution.

The Patent Office, however, refused to grant a second patent for alizarin on the grounds that it was too similar to the first version. It was just as important to secure a British patent, but this was granted to Perkin, who registered his almost identical process a day later. He received notification of its acceptance in August, while the Germans heard nothing until January of the following year. In the end, Perkin and BASF agreed to divide up the market.

Justifiably proud of their invention, Graebe and Liebermann reported their findings to a very receptive audience. Hoechst was thus able to begin alizarin production without a patent two months

earlier than BASF's plant in Ludwigshafen, since patents were not required in the 49 German states. In 1870, Hoechst was already selling several thousand marks worth of alizarin. Within three years, its output had risen to a value of over a million.

This was a cause for concern at Bayer, which still was a smaller company than BASF or Hoechst.



Angels were used for advertising purposes without compunction toward the end of the 19th century. In this highly imaginative example of Bayer's advertising, precocious cherubim embellished a label for alizarin red powder. The company's archives revealed that the initials

at the top of the advertisement stood for Bayer's American agent Goodhue & Muirling, of Boston. Labels were of considerable importance as an advertising medium at the time. They were usually produced by lithography.

Alizarin, anthraquinone, anthracene

Alizarin, the red dye contained in the root of the madder, is in its chemical structure a 1,2-dihydroxy-anthraquinone.

In the madder root, it forms a compound with a sugar to become a glucoside. The base of alizarin is anthraquinone, which is derived from anthracene.

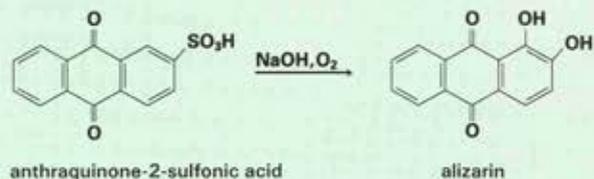
Anthracene itself is a component of coal tar. Since it can be very easily oxidized to yield anthraquinone, it provided a convenient raw material in the early days of dyestuff chemistry. It would one day become the basis for a wide range of anthraquinone dyes, one example being synthetic alizarin.



Treatment of anthraquinone with concentrated sulfuric acid permits the creation of intermediates with one or several sulfonic groups ($-\text{SO}_3\text{H}$), whose location in the molecule can be varied by the use of different production methods.

The early industrial alizarin syntheses were based on the fusion of anthraquinone-2-sulfonic acid with caustic soda (NaOH).

The simultaneous oxidation was brought about by oxygen in the air, but oxidants such as saltpeter were soon being used as well.



Joining in the battle for alizarin production would mean ruinous competition, but staying out would keep the company from growing.

After training at a vocational school, Eduard Tust was employed at the "Elberfelder Alizarin-Fabrik" as a works chemist when Bayer engaged him to develop an alizarin line of production. Tust did his best, but the plant was insufficiently equipped, and the quality of the product was just as unsatisfactory. Bayer and Weskott might well have given up the fight had not a new man appeared on the scene.

This new man was Carl Rumpff, son of a Bad Pyrmont wine merchant. He had emigrated to America at the age of 24 and established a pharmaceutical and dyestuff business. He later became one of the founders of the first American coal tar dye plant in Albany, in which Bayer had a stake. He went on to join Louis Lutz, Bayer's New York agency, and subsequently came to work at the Elberfeld plant near the end of the decade.

The 32-year-old soon became the driving force behind the company. When he proposed that the alizarin production be expanded and moved into a plant of its own, the founders were horrified.

The land in Elberfeld that Rumpff wanted them to buy as a site for the factory would cost six times what the firm had spent on real estate to date. Bayer and Weskott considered the investment to be out of the question, so Rumpff bought the land with his own money and subsequently rented it to the company.

The alizarin plant was opened with 12 workers under Tust's management in 1872. To start with, it was a very simple unit and more like the fuchsine plant mentioned in the previous chapter than a "modern" dyestuffs works.

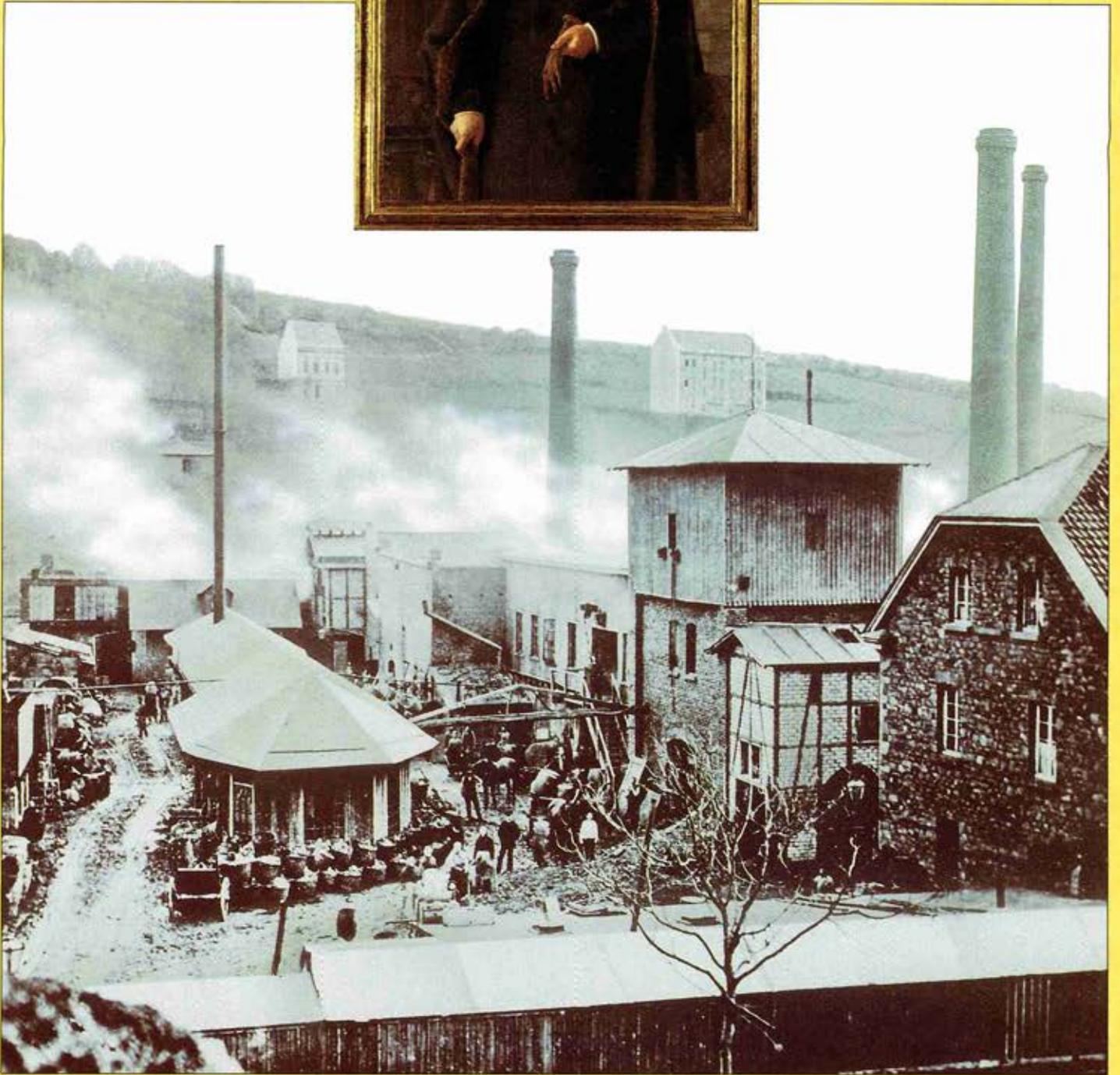
Worker August Kocke reminisced about the early plant: "Rabbits, chickens, ducks, geese, and other creatures wandered around calmly as if they were at home. The animals belonged to the foremen who lived in the factory. The works yard was still only partly paved. As coal and everything else was delivered by horse and cart, things looked pretty bad when

This rather smoky scene is in fact a photograph taken in 1878 of the first alizarin works in Elberfeld. Carl Rumpff (1839–1889) had bought the site in 1871 out of his own pocket and against the wishes of Bayer and Weskott. He then rented it out to the company. At the age of 24, Rumpff

had emigrated to America and set up the first coal tar dyestuffs works in Albany. Bayer subsequently bought a stake in this operation. He came back to work in Elberfeld in the late sixties.



Carl Rumpff
1839-1889



it rained. Mr. Weskott, Mr. Tust and Mr. Bayer Jr. wore clogs to work—they wore them even when they went to breakfast together at Stöcker's Inn nearby."

Chemist Dr. Eugen Schaal, who had been asked to give his critical appraisal, did not mince his words when Rumpff took him on a tour of the works: "You won't make any money in this factory," he said.

Rumpff then started to tackle things himself. A process was introduced to purify the anthracene, the open cauldrons were replaced by dry furnaces, and the alizarin workers got a raise to the then substantial wage of seven talers a week—plus a "loyalty bonus" of 13 talers after they had spent an uninterrupted six months in the works. While Bayer was able to catch up in terms of technology, the business side did not look very promising.

Starting in 1866 and 1867, Germany had first experienced an economic boom. Large investments were made in the railroads, the iron industry and housing; production and national income were rising. But the real boom of Germany's so-called "founders' era" got going after the end of the Franco-Prussian War and with the foundation of the German Empire. France had to pay war reparations of five billion gold francs within three years, which naturally benefited the German economy.

After compulsory licensing of joint-stock companies came to an end, hundreds of new corporations were set up, among them the forerunners of today's leading

banking houses—Deutsche Bank, Dresdner Bank and Commerzbank.

A total of 42 joint-stock companies were formed in the chemical industry. Many of them were in the business of making alizarin, whose synthetic output had surpassed the volume of the madder crop by 1877. In Elberfeld alone, there were six alizarin factories.

The "founders' boom" was followed by the "founders' crisis." The price of a kilogram of alizarin fell from 13 marks in 1870 to 3.5 marks seven years later. By 1872, Bayer was producing 400 kilograms of ten-percent alizarin per day.

Friedrich Bayer had the satisfaction of knowing that most of the next year's production had already been sold to "exclusive customers" by autumn. After closing the books, he was disappointed to discover that the 1873 figures showed a "deficit after necessary depreciation of 40,000 talers."

Things got to the point that when a laboratory boy was sent to the butcher Rügenstrunk to buy some suet, he was told: "See to it that I get the money, lad—Bayer is hard up." And that was only the start of what was to become the "Alizarin War."



Artists put a great deal of effort and imagination into designing Bayer's early printed material. The rather grim-looking "Bayer lion" is featured not once but twice on this 1886 price list for aniline and alizarin dyestuffs.

Bayer chronicle 1870

Permanent agency is opened in Vienna and agent networks are set up in Britain and France.

Bayer chronicle 1871

Carl Rumpff marries Bayer's eldest daughter Clara (below).



Bayer chronicle 1872

On February 11, Carl Rumpff (35), Eduard Tust (32) and August Siller (30) are registered as partners of Friedr. Bayer et comp.

Deutsche Pferde-Eisenbahn-Gesellschaft builds a horse-drawn streetcar valued at 650,000 marks to link Barmen and Elberfeld.

Permanent agency is set up in Rouen, France.

Factory Office with responsibility for all operations is established at Elberfeld and starts to keep a wagebook.

World events 1870

The Franco-Prussian War, which brought on the fall of the Second French Empire, nominally results from a dispute over the Spanish succession. The French government is not prepared to let the hereditary Prince of Hohenzollern-Sigmaringen become King of Spain and thus disturb the balance of power in Europe in favor of Prussia-Germany. Prince Leopold relinquishes his right to the throne, but Bismarck is not ready to concede that this renunciation should be binding in the future. On July 19, France declares war on Prussia. The South German States surprisingly decide to enter the war on the side of Prussia. The French army is decisively beaten at the Battle of Sedan (below). Two days after Napoleon is taken prisoner, the Third Republic is declared in Paris.



Heinrich Schliemann discovers the remains of Troy in April.

Italian troops occupy Rome. Italy thus becomes a unified country, and Rome is declared the capital on September 20.

World events 1870

First underground railroad is opened in London.

Norwegian physician Gerhard Hansen discovers the cause of leprosy.

World events 1871

The German Reich is founded. In the Hall of Mirrors of the Castle of Versailles, King Wilhelm I of Prussia is proclaimed German Emperor (below). Otto von Bismarck becomes Chancellor. Berlin is made the national capital, and the mark is introduced as the general currency.



A revolt in France against the Franco-German Armistice and because of antisocial domestic policy (the Commune of Paris) is suppressed by government troops.

On October 28, Henry Morton Stanley finds the missionary and explorer David Livingstone on Lake Tanganyika in Africa.

World events 1871

With the introduction of the so-called "Chancellor Clause" to the penal code, Bismarck's struggle with the Catholic Church ("Kulturkampf") begins. The clause in question forbids "utterances" by priests that, "endanger the public peace." The battle for power is aggravated further by the federal control of schools and the introduction of civil marriages.

French politician Eugène Pottier writes the text of the "Internationale." The music is written in 1888 by Pierre Degeyter.

World events 1872

Great Britain introduces the secret ballot on July 18.

On Bismarck's initiative, the German Empire, Austria-Hungary and Russia sign the "Three Emperors' League" on September 11.

German Bureau of Statistics is established.

John D. Rockefeller forms the Standard Oil Company of Ohio.

The Bayer relief fund — ten years before Bismarck's social service legislation

In the initial years after the Empire was established, the German economy was consumed with a “founding fever.” A serious economic crisis was to follow. It was during these difficult times that Bayer set up a relief fund. Today, it is one of the Federal Republic's biggest employee medical insurance funds.

On October 28, 1873, the Berlin Stock Exchange crashed. In the worst day of trading it had experienced up to date, shares fell in some cases to only ten percent of their face value. The financial and economic crisis had been heralded by a crash on the Vienna Bourse in May and the bankruptcy of Jay Cook & Co. in New York in September. Germany was suddenly faced with a free fall from the “founders' boom” into the “founders' crisis.”

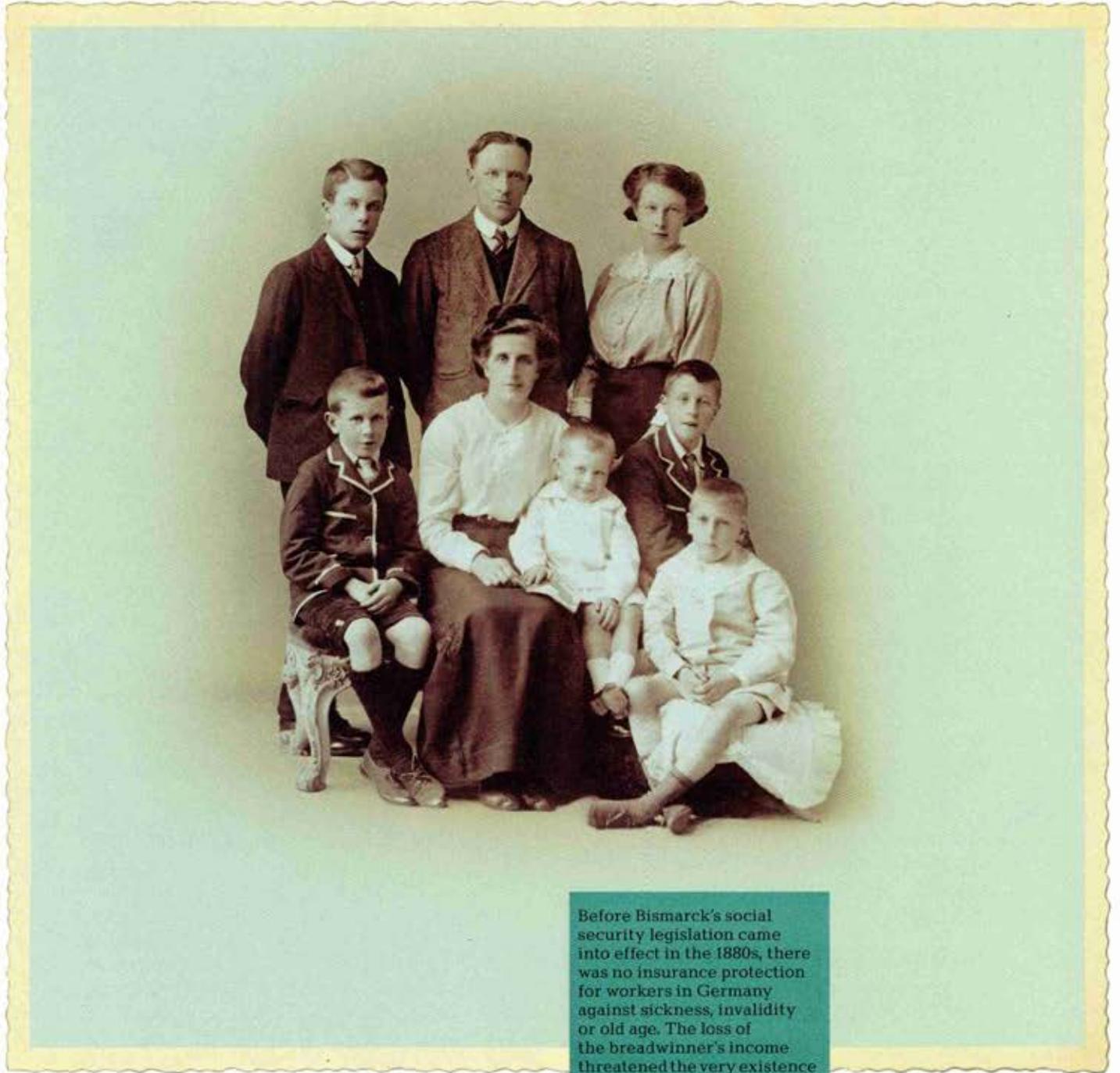
The five billion gold francs paid by France for war reparations had led to an exaggerated expansion of the economy. Many of the newly formed companies had been set up for speculation purposes only. Unjustifiable expectations had forced the share prices up too high, so when more than a hundred of the new joint-stock corporations went broke, they fell all the harder.

Difficult times followed, and the social problems that accompany a major depression grew. Industrialization had created a new stratum of society, the industrial proletariat. Working and living conditions were often harsh and there was no form of social security.

As a remedy, Chancellor von Bismarck devised a system to assuage hardship and also to keep the workers from turning to the Social Democrats, who were in his eyes nothing but revolutionaries. On November 17, 1881, Bismarck announced an Imperial Decree in Parliament: *“greater security and breadth of the support to which they are entitled”* was promised to workers faced with what were often existential risks as a result of the rapid industrialization.

The decree was followed up by Bismarck's various social security laws; these included a medical insurance law (1883), a casualty insurance law (1884), and a law governing support for invalidity and old age (1889). They laid the groundwork for the so-called social “safety net,” which was the first of its kind in any country. It is still considered pioneering legislation even today.

Bayer may have had no great political intentions, but the firm did want to bind the workers to the



Before Bismarck's social security legislation came into effect in the 1880s, there was no insurance protection for workers in Germany against sickness, invalidity or old age. The loss of the breadwinner's income threatened the very existence of the family. Even the early social security system covered only the most basic of needs.

company and to protect them from hardship. In 1873, ten years before the Bismarck program started, the "Relief Fund of the Alizarin Factory of Friedr. Bayer & Co. in Elberfeld" was founded. All 35 of the workers at the plant belonged to this early corporate society.

Tust acted as the fund's chairman and was supported by two representatives of the workers. The society's statutes had 39 clauses, including the provision that 20 pfennigs be withheld from each week's wages and that a further 10 pfennigs be paid in as a contribution from the employer. This entitled the worker to nine marks per week sick pay for up to 26 weeks, and half of that amount for the next 26 weeks.

Members of the worker's family were not insured and no wages were yet paid during sickness, but, as today, an employee could choose his own doctor (even if, at first, the choice was only between two). In the case of death of a worker, his dependents were to receive "succor" of 75 marks.

Paragraph 12 of the fund's statutes stated that sick workers *"stand to lose support payments if they visit public places or taverns, carry out labor or similar activities prejudicial to their recovery, or do not follow doctor's instructions. Furthermore, they may not leave their homes except in cases of urgent need."*

Benefits were delivered by a committee member of the fund, who took them to the sick employee's home on the weekend. Any worker who was trusted by his colleagues could be elected to be a committee member. On the other hand, *"Any person refusing such election without cogent reasons shall pay three marks into the fund."* Fund managers who turned up late for the annual general meeting had to pay a fine of 25 pfennigs. If they were absent, the penalty was 50 pfennigs.

On January 1, 1885, the relief fund, by then fully anchored in Bismarck's social security laws, was converted into a new style of health insurance under the name "Krankenkasse für die Farbenfabriken vorm. Friedr. Bayer & Co. in Elberfeld." It had 583 members.

In July of the same year, a similar fund was set up by the company Tillmanns, E. ter Meer & Co., which was based in Uerdingen. These were to be the forerunners of the two Bayer funds of today.

There was a good reason for the firms to run the funds themselves rather than sending employees to the new local health insurance funds. The daily wage of a worker then averaged 1.90 marks; in the Farbenfabriken, however, employees were earning between 2.60 and 2.75 marks. They were therefore able to pay higher contributions and to receive correspondingly larger benefits.

In Uerdingen, the salaried staff participated in the relief fund project from the start. At Bayer, they did not get their own fund until 1904—and then were not obliged to join if they earned over 2,000 marks a year. Salaried staff members were subject to strict rules of conduct and were obligated to demonstrate "irreproachable behavior."

"Persons who prejudice the fund by committing punishable offenses that result in the loss of their civil rights, or who incur sickness intentionally, through culpable participation in fights, through drunken brawls or through sexual debauch" were debarred from receiving benefits for 12 months, or at least for the duration of the sickness.

After the introduction of a German insurance code in 1911, the corporate insurance programs were granted the status of public bodies and became part of the statutory medical insurance program.

Although the workers' representatives had been members from the very start, the committees were headed by one of the company's managers. This reflected the patriarchal principles of that period in history.

In November 1921, the Free Trade Unions protested against this arrangement in a pamphlet that characterized the company relief funds as "a bosses' muzzle." The unions called for their replacement by broad-based "social" funds. They had their chance. In the 1921 elections to the insurance committee, the union won the absolute majority with 33 members. It is interesting to note that although



Today, the German welfare system provides a large degree of protection against risks. The federal insurance benefits offer adequate coverage for the whole family, also in case of emergencies. In addition to this assistance, employers frequently offer supplementary programs, and private insurance companies can give added coverage as well.

they would then have been able to transfer members to a local relief fund, they refrained from taking this step.

In 1934, the National Socialists extended their "führer principle" to the relief funds. Instead of self-administration by representatives of management and employees, the administrative duties were now the sole responsibility of the fund director. In 1935, wage earners and salaried staff funds were amalgamated.

In 1949, with the passing of the Social Security Adjustment Act, the share of contributions that had to be provided by the employer was increased to 50 percent. Two years later, an act institutionalized the autonomy by stipulating equal representation for employees and employers on the board and at general meetings of the fund. The companies were made responsible for bearing the funds' personnel costs. By 1977, the health insurance fund in Leverkusen alone had 129 employees.

In the history of Bayer's relief funds, there is naturally no lack of anecdotes. A worker in the 1930s, for example, wanted his death benefits paid out immediately. What good would the money do him after he was dead, he asked, when his children needed shoes now.

At the same time, "staff" received sick pay of five marks per day on top of their regular salaries. So when someone came to work dressed up in new clothes, the joke went around that he had probably just "taken his outstanding influenza."

If necessary, the funds could act very unbureaucratically. When an Uerdingen member felt too weak to go for a stay in the country prescribed by his doctor, the fund sent him 30 eggs and a bottle of brandy. A canteen cook was even given a set of steel dentures instead of the usual rubber version, "because rubber could spoil his sense of taste."

In 1987, the Bayer works health insurance funds had a total of 93,800 members (Leverkusen plus Elberfeld, Dormagen, Brunsbüttel, and subsidiaries) and 14,300 in Uerdingen, including pensioners. In addition to these totals, the two funds had 66,000

and 11,000 insured family members, respectively. This adds up to 108,000 members and 77,000 dependants in all. When the members of the funds of Erdölchemie in Dormagen and Wolff Walsrode are included (these funds are managed jointly along with Bayer's), the current total of persons entitled to benefits reaches at least 200,000.

The form of benefits has changed radically since the early days. Three-fourths of all expenditures were formerly accounted for by the money paid to those insured. Today, with employees receiving full pay for the first six weeks of illness, actual sick pay amounts to only some five percent of all benefits. This is quite astounding when one considers that an employee can receive up to 112 marks per day.

The majority of the benefits are used for hospital care, which accounts for 30 percent of all expenditure. Next come doctors' charges, which take up 20 percent of the whole. Dental costs (including dentures) and pharmacy costs each make up around 15 percent of the expenditure. There are also costs that nobody would have dreamt of back in 1873, such as prophylactic and early-warning measures, maternity benefits and household help. In 1985, Bayer opened up its own health advisory service in Leverkusen.

Not all employees are required to join the health insurance fund, but the size of the membership speaks for itself.

In the Federal Republic of Germany as a whole, contributions to statutory medical insurance funds average 12.89 percent of monthly earnings; in the two Bayer funds, 10.2 percent or up to a maximum of 436 marks per month are contributed. This amount is shared equally between employer and employee. In 1987, the total expenditure amounted to an average of 3,548 marks per member in the Leverkusen insurance fund, and 3,507 marks per member in the Uerdingen fund.

Lieber Heinrich!

Die Maschinenfabrik Jung hat mir einige Zeit Aufschub zur Aufarbeitung eines Messers an unsern Herrn: Erbschaft eines Dinges in Elberfeld erhalten. Die Messer ist jedoch schon abgeholt. Nur ich habe dieses Jahr länger von dem Jung unbekannt geblieben. Hoffentlich wird es doch in der nächsten Zeit wieder in Erfahrung gebracht werden. Ich habe mich sehr nach dem Jung erkundigt und hoffe, dass ich bald wieder von ihm hören werde. Bitte um ein möglichst baldiges Bescheid.

Wie ich schon oft geschrieben habe, ich bin sehr gesund und ganz besonnen. Ich habe für den Sommer ein paar Reisen geplant. Ich hoffe, dass ich bald wieder von Ihnen hören werde. Ich bin sehr nach dem Jung erkundigt und hoffe, dass ich bald wieder von ihm hören werde. Bitte um ein möglichst baldiges Bescheid.

Bayer ordered a set of scales from a craftsman named Jung in Giessen. Jung had, in fact, never heard of the company, so he wrote to a friend who had a son in Elberfeld. The father wrote the following letter to his son:

Dear Heinrich:

Some time ago the mechanic Jung received an order to make a pair of scales for Messrs. Friedrich Bayer und Comp. in Elberfeld. It is now ready to be shipped, but Jung does not know this Mr. Bayer and thus has some misgivings. I would therefore like to ask you whether you know this gentlemen and whether Jung is likely to be kept waiting before receiving his payment. Please reply as soon as possible...

Your loving father, H. Bull

Giessen, June 22, 1873

Bayer chronicle 1873

Bayer begins producing such intermediates as methyl aniline, violet oil and methyl iodide. Aniline oil still has to be bought in Krefeld or Elberfeld.

Bayer chronicle 1874

Following improvements in technology, alizarin production rises within three months from 300 to 3,000 kilograms per day. The alizarin plant alone employs 65 workers—more than the fuchsine and aniline plants put together.

Wilhelm Haarmann succeeds in synthesizing the natural spice vanilline. He founds the world's first factory for artificial flavors and aromas in Holzminden. "Haarmann & Reimer" is a subsidiary of Bayer AG today.

Bayer hires a fitter and sets up a workshop for him. Soon afterwards, the firm recruits a carpenter and a cooper. This marks the start of the Craftsmen Department, later to grow into the Engineering Department.

World events 1873

Justus von Liebig dies on April 18 in Munich.

Carl Weigert uses aniline dyes to make visible the bacteria whose existence has been surmised by Louis Pasteur.

World events 1874

The draft is introduced in Russia.

On the initiative of the German Postmaster-General, Heinrich von Stephan, representatives of 21 countries meeting in Bern agree to free passage of mail.

With his painting entitled "Impressions of the Rising Sun" (below), French artist Claude Monet gives the name Impressionists to a group of modern painters.



Americans Carlos Glidden, Christopher Lathan Sholes and Samuel W. Soule start at Remington's with the production of typewriters.

1875

Universities and industry work in close cooperation

In 1875, the world production of synthetic dyestuffs was equivalent to a value of 52 million marks. 57 percent of this total was generated by Germany alone. By 1913, Germany's share had risen to 87 percent.

The United Kingdom, which had been the cradle of the dyestuff industry and was still a major customer, had a market share of only three percent in 1913. France's stake was down to no more than one percent by then, even though it had been in the dyestuff manufacturing business before Germany. This remarkable development over the course of only a few decades was in part a result of the then unprecedented link between industrialists and scientists.

The most famous chemists at the turn of the 18th to 19th century had been working and teaching in Paris, London and Stockholm. The foundations of modern chemistry were laid down by such men as Lavoisier, Berthelot, Proust, Davy, Dalton and Berzelius. But it was Germans like Wöhler, Kolbe, Hofmann, Bunsen, and particularly Justus von Liebig who started to train their students in the practical disciplines of chemistry as well as teaching them scientific theory.

Through their revolutionary teaching laboratories, chemistry departments of German universities achieved international renown. There was hardly a leading figure in the country's dyestuffs industry who did not study under one of these scientists or their pupils. Carl Duisberg, who would play an important role later in Bayer's history, obtained his doctorate from Anton Geuther, one of Wöhler's pupils. Soon Göttingen, Heidelberg, Munich, Giessen, Jena and other German universities came to epitomize academic excellence in chemical studies.

Both the universities and the technical schools of the early days were well aware of their duties to the national economy. They had long been training practitioners for the mines, metal industry, pharmacies, and other trades and industries.

Their work was particularly valuable to the fledgling dyestuffs industry, especially since organic chemistry—the chemistry of hydrocarbons—was developing very rapidly in Germany. Chemists in France, Britain and other countries were initially more interested in other fields of study and thus

unable to offer their national dyestuff manufacturers as much as the German universities and schools could.

The dyestuffs firms needed chemists to develop new colors, to analyze and control raw materials and intermediates, and to supervise processes. They got them from the universities. These young experts had learned to be both researchers and practitioners. And they were successful. Their successes were manifested in fame—and money, for the expanding dyestuffs industry could afford to pay them well.

Give and take between academia and industry was the recipe for success in the German dyestuff sector, and was the basis for the country's headstart in the field of organic synthesis.

When the other industrialized countries became painfully aware that they were lagging behind the Germans, they realized that they had neglected and misunderstood the symbiosis which should exist between science and industry.

Bayer chronicle 1875

The working day at Bayer is shortened from 11 hours (meaning 13 hours on site including breaks) to 10.5 hours. Wages rise to 3.50 marks per day.

A. Cochrane & Co. becomes Bayer's agency in the U.S. Its head office is seated in



Boston with a branch office in New York. (The picture shows a contemporary view of Boston.)

Bayer starts up safranine production.

The number of employees reaches 119.

World events 1875

British Prime Minister Benjamin Disraeli buys 41 percent of the Suez Canal shares from the khedive of Egypt for £4 million. The British government borrows the necessary money from banker Nathan Rothschild.

Socialist Workers Party of Germany is formed in Gotha from the General Workers' Society and the Social Democratic Workers' Party. The so-called Gotha Manifesto includes such demands as the establishment of a socialist society, the abolition of wage labor and the elimination of all social and political inequalities.

British unions obtain the right to strike.



Première of the opera "Carmen" in Paris is unsuccessful. Its composer, Georges Bizet, dies three months later, too soon to experience the later triumph of his work in Vienna. (The wood engraving above shows a scene from the première.)

For many years now, the above glass containers could be found in every laboratory—whether at a university or at an industrial company. They are from left to right the boiling flask, the test tube and the conical, or Erlenmeyer, flask.

Taking production outside the country

In a rented cellar in Moscow equipped only with a hand-operated mixer, workers broke up pressed alizarin. This hardly deserved the pretentious name “factory,” but it was Bayer’s first foreign production unit—and therefore a company milestone.

The mighty Czarist Empire of Russia reached from the Baltic to the Pacific; from Finland to the mountainous Persian frontier. It was a promising market for textile dyes. The Empire’s major textile centers were located in the West, in Poland, the Baltic States, Moscow and St. Petersburg.

Railroad connections from Western Europe to the urban centers of Russia and Baltic ports were good. The decision to produce in Russia rather than to export was certainly not a question of transport problems. The difficulty lay instead in the fact that the Russians imposed high duties on the import of finished goods. Pressed alizarin, on the other hand, was considered an intermediate, from which dyestuffs could be produced in Russia itself.

The first mixers in 1876 naturally accounted for only an insignificant output. A full-scale factory was not to come for some time. But the small factory was an important start.

Working through a Russian partner, since foreigners were not able to buy property in Russia at the time, Bayer purchased a site for a more sizable operation in 1883. This dyestuffs plant belonged to the Russian partner until 1891. It was then transferred to Henry Theodor Böttinger, and subsequently became the Russian joint-stock company Friedr. Bayer & Co. in 1897.

By 1913, the Russian subsidiary was not only the country’s biggest dyestuffs manufacturer, but also the most important foreign holding of the German dyestuffs industry. It employed 414 persons, produced 2,300 metric tons of dyestuffs annually, and had a property value of 8.3 million marks.





Originally, the Elberfeld management had not planned to produce abroad. They had instead intended to concentrate manufacturing at the headquarters and sell as much as possible to as many countries as possible. This, however, presupposed freedom in foreign trade. While almost all countries were proponents of this in theory, many of them were also interested in increasing customs revenue and protecting domestic industry from foreign competitors.

Such was the case in France. It was not a question of the customs duties, but rather of a clause in the national patents law that granted patent protection only to products actually made in France. The only way to get around having new and valuable dye-stuffs taken over by imitators was therefore to set up a plant there.

France had an important and prosperous textile industry, particularly in the Lille/Roubaix area. In this region, at a place called Flers, Bayer rented an empty dyehouse on August 21, 1882, set up the necessary equipment, and began the production of crocein scarlet, crocein orange and acid green.

In January 1883, the amounts produced were generally small—every once in a while, the firm had a notary public certify that production was indeed taking place. The only concern was to be in compliance with the patent laws. But here, too, a start had been made.

When the tenancy expired in 1896, Bayer wanted to buy the premises, but the owner, the widow Descat, asked too high a price. So Bayer bought a site of its own in Flers to build a plant to modern specifications.

Just at this point, however, there was a sharp setback in the market and it turned out to be more economical to accept the widow's demands. Consequently Bayer dropped the plans for the new building.

The "Société Anonyme des Produits Fredr. Bayer & Cie." was then formed, and the factory in the old dyehouse was expanded. By the end of 1898,

Bayer goes abroad: the buildings on the left belong to the branch office in Moscow and the house above is a part of the French subsidiary at Flers, a few miles away from Lille. The elegant old buildings are still a long way from modern industrial sites.

61 employees were working there under the responsibility of a German manager.

By 1913, Bayer's Flers plant was one of the biggest dyestuffs facilities in France, with 168 workers and an output of 1,100 metric tons per year. But, as in Russia, Bayer was not the only German dyestuffs manufacturer with a subsidiary there. The last to join their number was the Uerdingen company "Chemische Fabrik vorm. Weiler-ter Meer AG," which opened a factory in Tourcoing in 1910. (As a historical footnote, the Uerdingen company now also forms part of the Bayer Group.)

Britain still adhered to the principle of free trade, and any divergence from this would have been a political impossibility. But the British economy suffered from crisis conditions at the end of the 19th century and there was considerable disquiet at the rapid growth of new industries in America and Germany. In 1907, the British therefore decided to introduce a local production rule as a condition for patent protection.

Since 1904, Bayer had a working agreement with BASF and Agfa. This "Triple Confederation" (see chapter on 1904) decided to cooperate in Britain. They bought a plot of land from Lever Brothers on the banks of the Mersey in Liverpool and built a dyestuffs and pharmaceuticals plant there. But before the plant really got going, the restrictive patent law provisions were toned down by a court judgment. As a result, Mersey Chemical Works remained only a mini-operation with no more than three salaried staff members and 33 wage earners in 1913, and produced a modest 29 metric tons of dyestuffs.

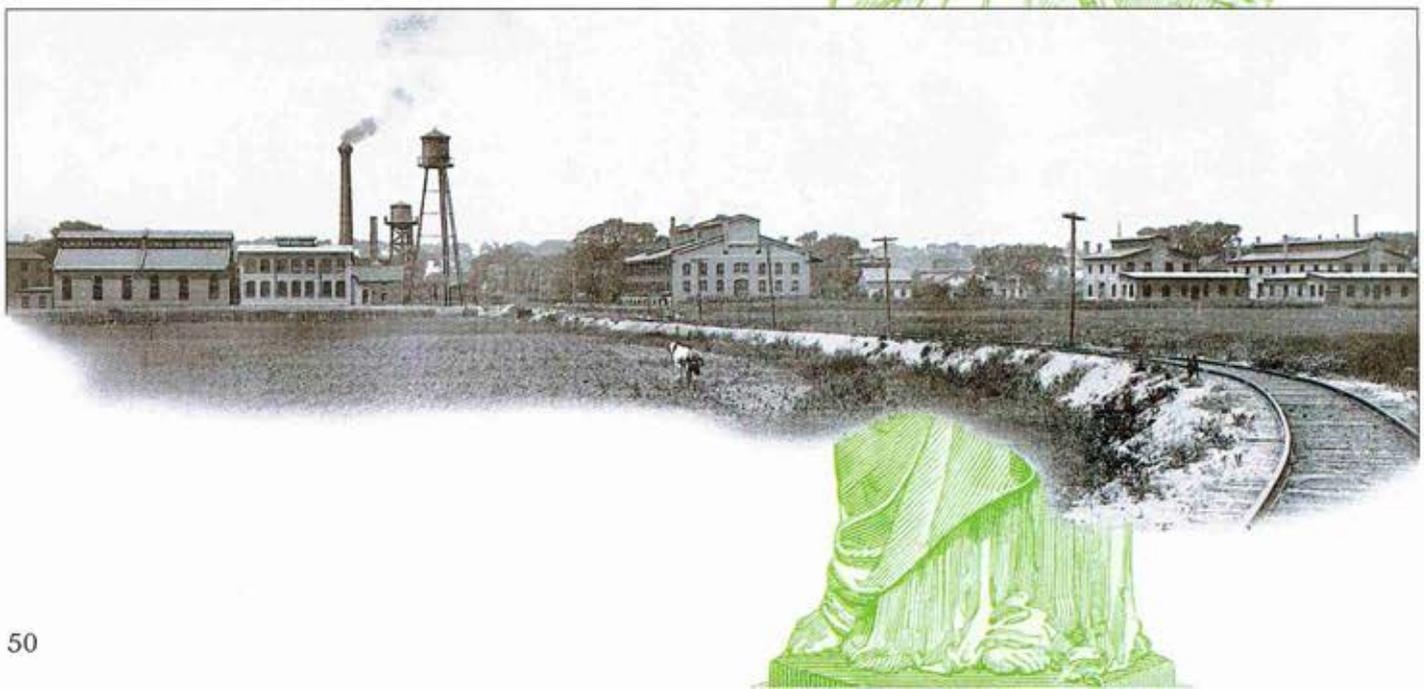
The United States was at this time the biggest and most important market for German dyestuff manufacturers. In spite of America's traditional protectionism, these imports were so small in relation to foreign trade on the whole that nobody took much notice of them. The United States still showed a surplus of almost one billion marks in its merchandise trade with the German Empire in 1913.

The imported German dyestuffs to the United States had a value of only 66 million marks. Pharmaceuticals had a value of seven million. And three-fourths of all German dyestuffs and pharmaceuticals came from Leverkusen and Elberfeld. This may have appeared to be only a small position in foreign-trade statistics for the Americans, but it accounted for 18.4 percent of Bayer's total sales.

Since the United States continued to permit unrestricted entry of dyestuffs and pharmaceuticals, Bayer saw no reason to establish a production unit there, especially because wages were high. Building up a production capacity would have meant sending over valuable works chemists, who were still few and far between in the United States.

Management changed its mind in 1903, however, when patent protection expired for a number of important products. The Supervisory Board was asked to approve the acquisition of the Hudson River Aniline Company of Albany, New York. The board members agreed and the manufacture of pain-killers started there in 1905.

The factory on the Hudson remained largely a pharmaceuticals plant until 1913. Dyestuff production was gradually introduced after a change in the U.S. customs tariff permitted the duty-free import of



intermediates. A sales staff of 12 and 72 workers turned out 276 metric tons of dyestuffs with a value of 1.4 million marks by 1913, in addition to pharmaceuticals.

In order to avoid paying the newly introduced taxes on joint-stock companies like Hudson River Aniline, Bayer's American interests were reorganized. On June 3, 1913, the Bayer Company Inc. was established in New York. A day later, Synthetic Patents Company, Inc. was founded. Bayer transferred the property rights to the Hudson River Company, and the Synthetic Patents Company obtained the rights to all Bayer's American patents and trademarks. Synthetic Patents then leased the Albany premises to Bayer Co. and granted the corresponding licenses for production.

This corporate strategy was to have serious consequences for Bayer. Both companies and all of their assets were confiscated as alien property in World War I. Not only did Bayer lose its companies and production units, but it also lost the rights to its patents, trade names and trademarks in the United States (see chapter on World War I).

Bayer expanded in Belgium for a totally different reason. The company had to buy numerous raw materials and intermediates from tar processors who made naphthalene, anthracene, etc. from tar produced in coking plants. These companies had joined forces to form a syndicate that was able to dictate prices. When a tar-processing company was up for sale in Belgium, Bayer saw its chance to become independent of the syndicate (see chapter on 1907).

By the beginning of this century, Bayer had become a multinational concern with subsidiaries in Russia, France, Belgium, Britain and the United States, plus branches in all other major countries around the world. And by 1897, the United States had even replaced Germany as Bayer's biggest market. In 1913, some 840 workers, ten percent of the total staff, were employed in Bayer's foreign plants.

The factory of the Hudson River Aniline Company in New York State stretches along the river bank. Farbenfabriken Bayer acquired the U.S. company in 1903.

Bayer chronicle 1876

Friedrich Weskott Sr., co-founder of the company, dies on October 4 at the age of 55.

Bayer buys the alizarin factory site from the "Chemische Industrie AG," formerly "Gebrüder Gessert," in Elberfeld.



Bayer dyestuffs receive the bronze medal (above) at the International Exhibition in Philadelphia.

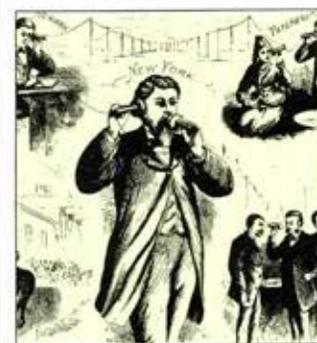
The number of employees reaches 139.

World events 1876

Reichsbank becomes the central bank of the German Empire. The Zentralverband Deutscher Industrieller (Central Association of German Industrialists) is formed.

German Robert Koch discovers the spores of anthrax. Rapid development of bacteriology begins.

American Alexander Graham Bell introduces the first serviceable telephone and sets up the Bell Telephone Company. German teacher Johann Philipp Reis had already succeeded in transmitting the human voice by electrical means in 1861, but the invention had found no practical use. (This picture, showing various possible applications for Bell's inventions, was first published in "Scientific American" on October 6, 1877.)



Siou and Cheyenne Indians defeat a unit of the U.S. Cavalry at Little Big Horn.

Green is in fashion, research is a must

The aniline factory producing blue and violet dyestuffs in Heckinghausen had been working satisfactorily. Then the fashions changed: women discovered their preference for green.

Now the emphasis had to be put on green production. Up to this time, Bayer had been producing iodine green. Then the firm switched to an upgraded methyl green. In 1876, 21 “green workers” produced 22,000 kilograms at a price of 50 marks per kilogram, bringing sales up to over a million marks. Unfortunately, Bayer’s green was unexpectedly faced with a dangerous competitor. The malachite green made by Agfa was better—and it was protected by a patent.

The “Patents Department” at Bayer at the time consisted of a drawer in Eduard Tust’s writing desk—a modest start for what was to become an important responsibility within the company. The first patent which the Elberfelders had to seriously take issue with was Agfa’s malachite green.

Bayer had hoped to develop a product—and corresponding process—of equal quality.



The men and boys working in Bayer’s “green” unit at Elberfeld (right) are among the pioneers of the dyestuffs industry. The loose wool shown in front of the photograph has been colored with malachite green. Introduced by Bayer in 1878 as “New Green No. 1,” it is long out of use as

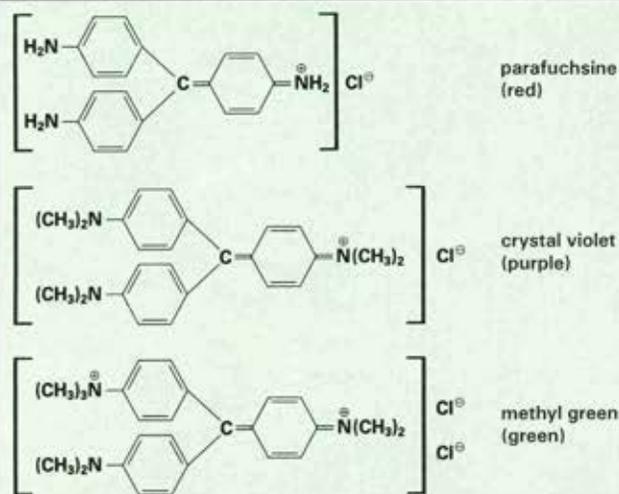
a dyestuff for wool, silk, cotton and linen but is still sold under the name of “Astrazon Green M” and used in large quantities to dye polyacrylonitrile synthetics. Above is an airtight can of the type used at the time to send dyestuffs to the tropics.



Early green dyestuffs

The green dyestuffs of the early days all belonged to the category of alkaline triphenylmethane dyes, i.e. those containing amino groups.

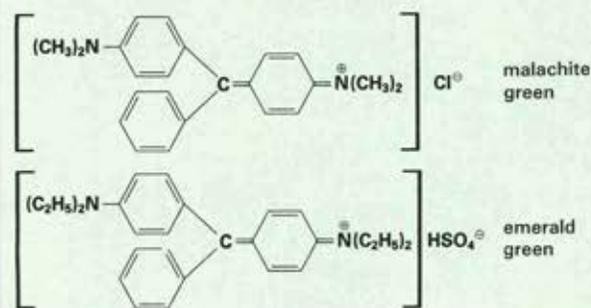
They show the extent to which the number of methyl groups attached to the amino groups influence the actual color.



The iodine green cited in the text as the first from this category has the same structure as methyl green, except that chloride ions are replaced by iodide ions.

Agfa's malachite green contains only two methylated amino groups.

Emerald green, the new competing green dyestuff developed by Bayer, was the ethyl analog of malachite green:

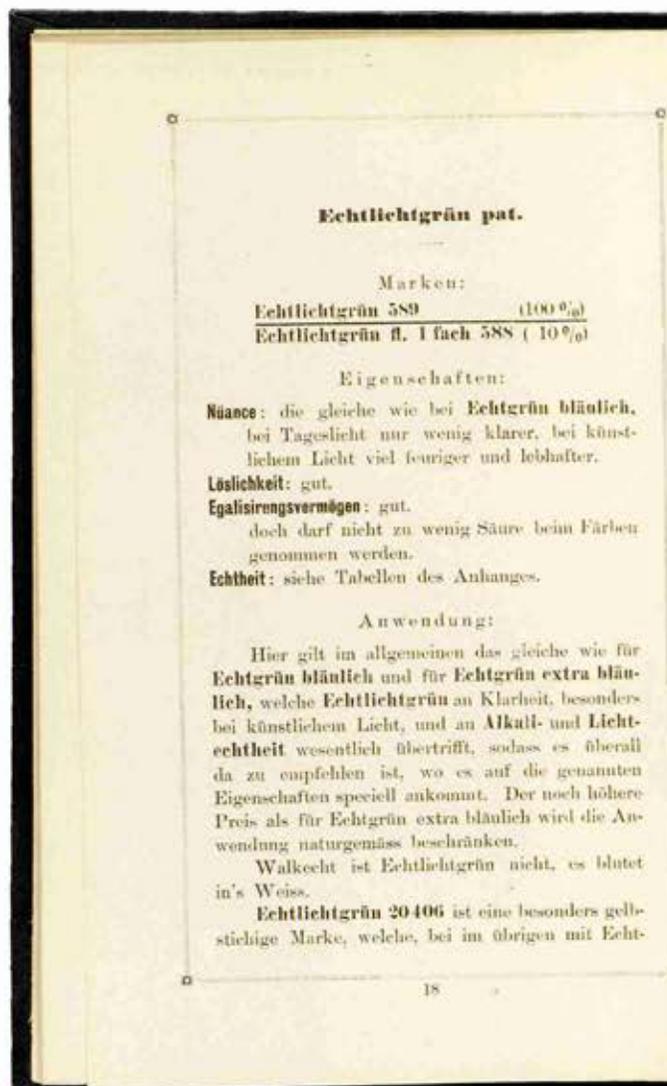


This task was entrusted to Hugo Hassencamp. He started by doing what he always did, namely, going through all available scientific publications.

In the latest edition of the "Berichte der Deutschen Chemischen Gesellschaft," he found an article about a compound consisting of benzaldehyde (oil of bitter almonds) and methyl aniline, which had the property of turning to a green color. Hassencamp fetched the benzaldehyde from the local pharmacy. When he had oxidized the compound described with chromic acid, he found the color he had been looking for. In 1878, it came out on the market as "New Green No. 1."

But it could not be patented because Hassencamp's development was based on work already published by Otto and Emil Fischer; what he had contributed in the form of research was not new in the sense of the patent law. However, since his actual process was new, Agfa had no power to block Bayer's competing product, because their malachite green patent

Customer service and applications technology were of great importance even in the very early days of Bayer. The manual on green dyestuffs pictured on the right includes both sample swatches of dyed fabric and warnings against incorrect use.



covered the process only. Serious patent disputes did not take place until later (see chapter on 1896). Whatever the case, Bayer sold its "New Green" without a patent and with success.

The green fashion trend kept up, and Bayer did not rest on its laurels. It brought out "Emerald Green" and "Fast Blue-Green" in 1880 and "Fast Light Green" in 1895. These were the fruits of the company's in-house research, which had by then become a prerequisite for progress.

The alizarin facilities dated from an era when the straightforward takeover of other people's patents was both permissible and usual. Bayer had not invented these dyestuffs, but it had improved them and despite falling prices, they remained the biggest single branch of production. Bayer was top-ranked of Germany's 12 alizarin plants in 1877, with 136 workers producing 6,000 kilograms per day. The payroll rose to 195 in the following year, 236 in 1879 and reached 300 in 1880.

Bayer chronicle 1877

On January 1, the sons of the founders—Friedrich Bayer Jr. (25) and Friedrich Weskott Jr. (26)—join the firm as partners.

Chemist Edmund ter Meer forms the company "Dr. E. ter Meer & Cie." for the production of azo dyestuffs in Uerdingen on the Rhine.

On January 17, Friedrich Bayer Sr., Carl Rumpff, August Siller, as well as Friedrich Weskott Jr. and Friedrich Bayer Jr., sign a deed of partnership "to operate a joint company whose purpose is the production and sale of aniline dyestuffs as well as related business." At the same time, a corresponding contract is signed for alizarin dyestuffs.

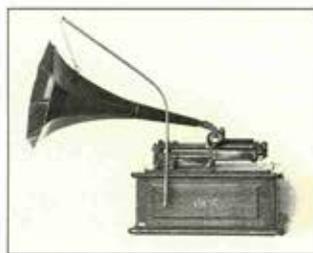
The "Factory Workers' Relief Fund of Friedrich Bayer & Co." is officially recognized as a registered relief fund.

Bayer takes out accident insurance covering all workers for 1,500 marks per person.

World events 1877

Queen Victoria is officially proclaimed Empress of India in Delhi.

American scientist Thomas Alva Edison invents the phonograph. (The photograph below shows a more advanced model of his invention dating from 1905.)



Willy Kühne coins the term "enzyme."

Julius Cohnheim proves that tuberculosis is caused by an infection.

Ernest von Bergmann introduces antiseptic tampons in treating wounds.



Robert Koch (above) is successful in photographing microorganisms.

lichtgrün gleichen Eigenschaften, speciell gegen Patentgrün O Höchst concurriren soll.

2% Echtleichtgrün.



2% Echtleichtgrün 20400.



Concurrenz-Producte:

Die gleichen wie bei Echtleichtgrün bläulich und wie bei Echtleichtgrün extra bläulich.

Echtleichtgrün erreicht die Alkaliechtheit der besseren Patentblau-Marken und übertrifft diese sowie auch Wollgrün S und Cyanol durch seine Leuchtechtheit.

Bemerkungen:

Da Echtleichtgrün beim Trocknen an Ausbeute verliert, sind flüssige Marken vortheilhafter.

Wir können hierin auf Verlangen dieselben Concentrationen herstellen wie bei Echtleichtgrün bläulich und wie bei Echtleichtgrün extra bläulich.

The race for azo dyes gathers speed

While Bayer in Elberfeld was hard at work trying to improve its green dyestuffs in order to retain the leading position in the alizarin sector, a further group of dyes had its *première*: the azo dyestuffs.

The azo dyestuffs' remarkably wide range of shades and applications soon made them the most comprehensive group of organic synthetic colors on the market. Today, they comprise more compounds than all other classes of dyestuffs taken together. Bayer had two choices: to join in or to leave the field free for the competition. There was, of course, no choice; Bayer had to take part in the development of azo dyes, or it would lose ground.

This important newcomer to the dyestuff sector can be traced back to the discovery of a new chemical reaction by Peter Griess. He described the action of nitrous acid on an aromatic amine in 1858 in the publication, "Justus Liebigs Annalen der Chemie und Pharmazie." The product of this reaction showed the gain of a nitrogen atom and was thus given the name "diazocompounds" by Griess.

A native of Hesse, Griess had studied under Hermann Kolbe in Marburg and was later assistant to Hofmann in London for three years. He was recruited in 1862 to be Henrich Böttinger's assistant. Böttinger was at the time the chief chemist of the big Burton-on-Trent brewery, Alsopp & Sons. When Böttinger returned to Germany with his family in 1866, Griess took over as his successor.

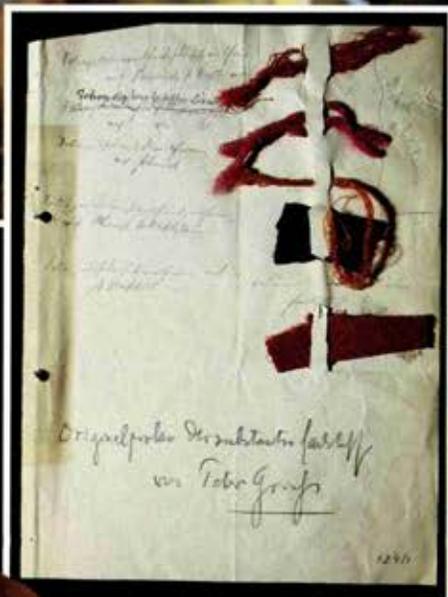
His working day was devoted to solving the brewery's chemical problems, but he concentrated his leisure time on his hobby—investigating diazocompounds and their properties—in his private laboratory at home.

His goal was purely scientific, but it proved to be of the utmost practical importance for the chemical, and more specifically, dyestuff industry. The combination of the compounds with suitable reaction substances, which is known as "azo coupling," produced azo dyes of singular beauty. Although he was to become known as the father of these dyestuffs, Griess initially collected samples of the resultant colors without any commercial application in mind.

In the mid 1870s, other companies came to realize just what a treasure he had found. The first of these

The illustration on the right shows how dyestuffs were produced in the late 19th century, here in an excellent model of an azo dyestuffs plant on display at the German Museum in Munich. Peter Griess (1829–1888), pictured below right, was August Wilhelm Hofmann's assistant at

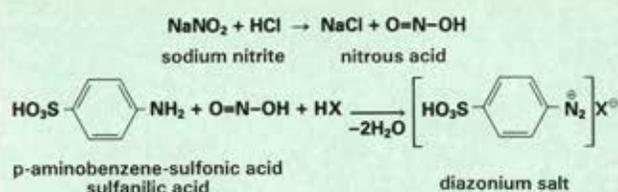
the Royal College of Chemistry in London. Griess had first produced aromatic azo, diazo and diazonium compounds in 1858. Carl Duisberg asked for dyestuff samples from Griess and wrote on the reply (right) "original samples of Peter Griess' substantive dyestuffs."



The azo dyestuffs

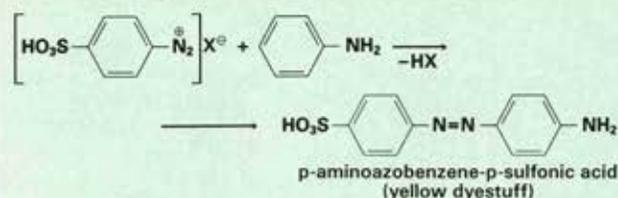
The method of producing azo dyestuffs discovered by Peter Griess is based on two reactions. In the first step, a solution of sodium nitrite is added to an ice-cooled, highly acidic solution of an

aromatic amine. This yields unstable nitrous acid which is set free in proportion to its reaction with the amine. The amine is thus converted into diazonium salt.



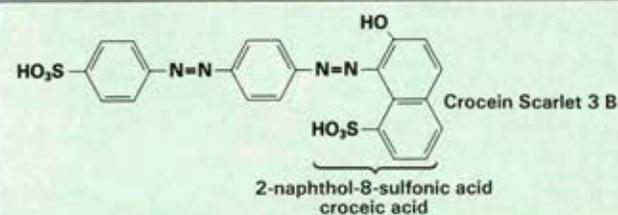
Since pure diazonium salts are very unstable, the resultant solution is directly used

for the second reaction—the coupling with phenols or amines:



The yellow dye obtained can now be diazotized once more at its free amino group. Then, for example, it can be coupled to the croceic acid synthesized by E. Frank and

P. Seidler that is mentioned in the main text. This process leads to the azo dyestuff Crocecin Scarlet 3B, the subject of Bayer's first patent.



Since diazotization and coupling are universal reactions, the use of the appropriate choice of diazo and coupling

components opened the way to an inexhaustible variety of dyestuffs.

was BASF, whose chief dye chemist Heinrich Caro developed azo yellow, azo orange and a fast red for wool. It was also BASF which took out the first German patent for an azo dyestuff in 1878.

Hoechst followed suit the same year, when the company registered patents for what it called Ponceau colors, while Kalle in Biebrich introduced azo scarlet in 1879. Bayer's first azo dye was marketed as Crocecin Orange G in 1878 and was based largely on Peter Griess' information. Fritz Rübel, a works chemist who headed the company's methyl green production, was put in charge of the manufacturing unit.

To synthesize the new dyestuffs, Bayer needed research chemists, so Eugen Frank and Paul Seidler were assigned to concentrate on azo development. In 1881, Frank succeeded in synthesizing an important intermediate. By sulfurizing beta-naphthol at a high temperature, he obtained a new sulfonic acid, croceic acid. It came to be known as "Bayer acid." This substance proved to be a valuable coupling component and was used for the manufacture of Crocecin Scarlet, the first dyestuff to be an original invention of Bayer's and to be granted a German patent (No. 18027).

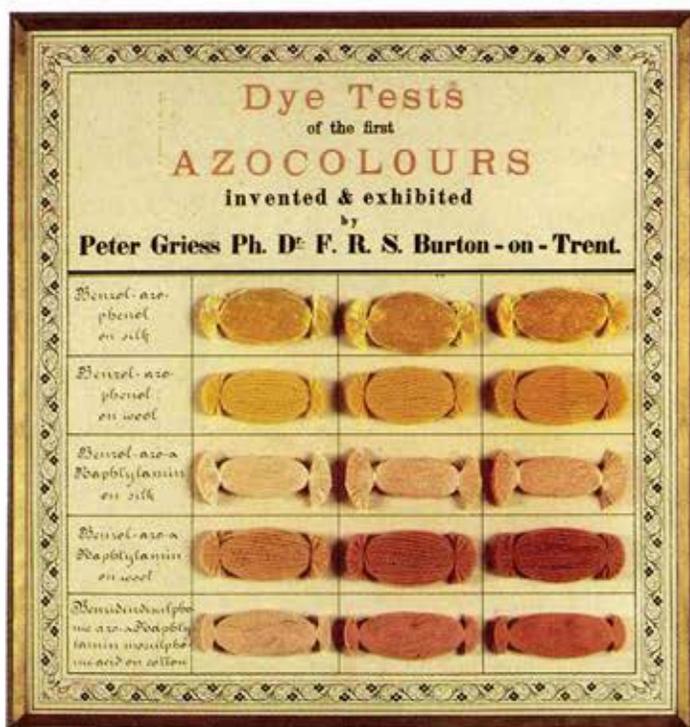
A particular advantage of Crocecin Scarlet and Crocecin Orange was that they could also be used for dyeing cotton without the use of a mordant. The only trouble was that Agfa introduced the same dyestuff in Berlin shortly afterwards. In contrast to the case of malachite green (see preceding chapter), Bayer was now the patentee. So the company brought a suit—and promptly lost it. It remained the loser when the case was taken on to the Supreme Court.

Bayer had made a mistake. The wording of the patent application was



This pretty young lady advertised Bayer dyestuffs in the Far East. On the top of this label for Crocecin Scarlet is the name of the Chinese agency.

entrusted to a Bonn scholar who was famous in the young discipline of patent law, but who got so tied up in legal intricacies that the actual chemistry behind the patent got lost along the way. As a result, Bayer had to let Agfa produce the identical dyestuff, free of charge.



In the meantime, Seidler had used beta-naphthylamine to synthesize two new dyes that offered an interesting range of shades—fast reddish-violet and fast bluish-violet.

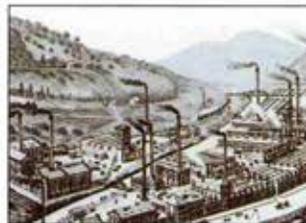
It was only with the appointment of Henry Theodor Böttinger, the son of Griess' predecessor at Alsopp's, and Carl Duisberg to the company's management that Bayer fully realized the promising future of azo dyestuffs and the potential for the company. After the initial difficulties, azo dyes were to carry Bayer into a leading position in the German dyestuff industry.

Above is a much-valued showpiece from the Bayer archives: a sample showing Peter Griess' azo dyestuffs tested on silk, wool and cotton. This display was specially prepared for the Royal Jubilee Exhibition held in Manchester in 1887 to mark the 50th anniversary

of Queen Victoria's coronation. It is not known how the exhibit came into Bayer's possession.

Bayer chronicle 1878

Headquarters of Farbenfabriken Friedr. Bayer & Co. and almost all production units are moved from Barmen to Elberfeld.



Bayer's price list now includes 100 products.

Permanent agencies are opened in the French textile center of Roubaix near Lille and in Belgium. New German agencies are set up in Thuringia, Saxony and Silesia.

Bayer chronicle 1879

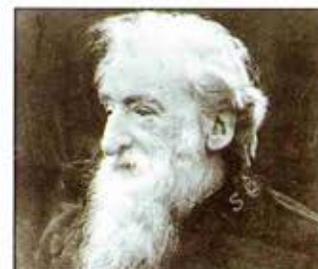
First warehouse for dyestuffs, the so-called scarlet storehouse, is set up in Elberfeld.

World events 1878

German Parliament passes Bismarck's "Socialist Law," which restricts freedom of association, assembly and publication to counter "subversive activities of the Social Democrats."

William R. Gowers is able to quantify hemoglobin in blood.

Methodist preacher William Booth (below) founds the Salvation Army.



World events 1879

The "Saltpeter War" over the ownership of the nitrate deposits in the Atacama Desert breaks out between Chile, Bolivia and Peru.

Thomas Alva Edison invents the carbon-filament light bulb. A report of the British Parliament comes to the conclusion: "Edison's ideas may be good enough for our overseas friends, but they do not deserve the attention of practical or scientific men."

Patents

A patent is a contract between the public, represented by the state, and the patentee with a technical invention. The public grants the patentee privileges over his competitors for the clearly defined time period expressed in the patent.

On the other hand, the patent offers the public a new technical idea that can be freely used after the patent has expired, and can serve as a base for the development of further technical innovation.

The Imperial Patents Office (below) was opened in Berlin on July 1, 1877, after a patents law had already been passed on May 25. German companies could now protect their inventions throughout the whole of Germany and not just abroad, as had been the case up until then.

This naturally widened the possibilities for the industrial application of research results quite substantially. A year after the Patents Office had been established, almost 6,000 patents had already been registered there.

The idea of patent protection went back much further than 1877. The word "patent" comes from the Latin term meaning "open letter" and was originally a privilege granted by the ruler to a person or group of subjects. An officer or an official was granted his "letters patent;" a landowner's property was patented; or a religious group received a patent which guaranteed its right to freedom of worship.

The idea of an inventor being granted a patent was foreign to medieval thinking. Guilds, in fact, occasionally went so far as to forbid the protection of inventions to prevent one craftsman from gaining an advantage over the others.

A change in the situation was first initiated by the expansion of the economy. Rulers tried to attract innovative craftsmen into their territory—and were prepared to grant the necessary privileges.

The first "patent law," even though it did not bear this

name, was passed in the Republic of Venice as early as 1472. Other governments followed suit. On the other hand, it was realized that patents could harbor dangers of their own. To prevent monopolies from arising as a result of long-term patents, which could negatively influence the entire economy, the British Parliament limited the duration of patents to 14 years.

It was not until the signing of the American Constitution that intellectual property was recognized as a basic human right that should be protected. This right was introduced to Europe in a French law of 1791.

In the following century, Austria and various German states followed the French example by offering legal protection for inventors. However, since each patent was valid only in the registering state, it wasn't worth much in the mosaic of little sovereignties that made up Germany. Not many inventors wanted to register their discoveries in 41 different states, some of which were of such insignificant dimensions that sales of a patented product would have rarely covered the registration fee.

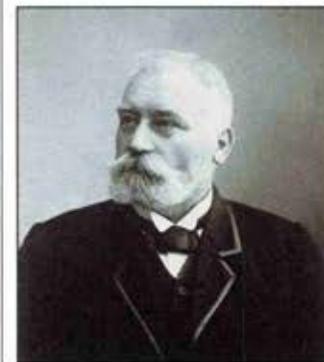
The new German Empire, however, was also a large and unified new market, and the Imperial patent meant that the fruits of what had frequently been costly research and development work would be protected over the whole country and over a considerable period of time.

The first Imperial patent for a chemical process was granted for the production of red ultramarine dye; the patentee was Johann Zeltner in Nuremberg.

The patent question was, in fact, one of the most important problems facing the chemical industry. When the "Association for the Protection of the Interests of the Chemical Industry of Germany" was established in Frankfurt on November 25, 1877, it immediately set up a special patents committee.

The official publication of the "Deutschen Chemischen Gesellschaft" (German Chemical Society), which had been in existence since 1867, did not report until 1879 that Eduard Tust of the Bayer company in Barmen had obtained a British patent. That was the first published mention of a Bayer patent.

Farbenfabriken Friedr. Bayer & Co. was granted its first Imperial German patent on March 18, 1881. Dr. Eugen Frank (below) received a patent with the number 18 027 for the synthesis of croceic acid.



A document to be proud of from Bayer's long history: the first patent, granted to the company on May 16, 1882, by the Imperial Patents Office in Berlin. The official seal is placed over cords dyed in the then national colors of black, white and red.



PATENT-URKUNDE

N^o 18022.



AUF GRUND DER ANGEHEFTETEN BESCHREIBUNG UND ZEICHNUNG IST
DURCH BESCHLUSS DES KAISERLICHEN PATENTAMTES

*Farbensabriken, vorm. Friedr. Bayer & Co
in Elberfeld*

EIN PATENT ERTHEILT WORDEN.

GEGENSTAND DES PATENTES IST:

GESETZ v. 25. MAI 1877

*Verfahren zur Darstellung des Crocein-Schar-
lachs, des Crocein-Gelb und anderer rother und
gelber Farbstoffe aus einer neuen Monosulfo-
säure des Betanaphthols*

ANFANG DES PATENTES: 18. März 1881.

DIE RECHTE UND PFLICHTEN DES PATENT-INHABERS SIND DURCH DAS PATENT-GESETZ
VOM 25. MAI 1877 (REICHSGESETZBLATT FÜR 1877 SEITE 501) BESTIMMT.

ZU URKUND DER ERTHEILUNG DES PATENTES IST DIESE AUSFERTIGUNG
ERFOLGT.

Berlin, den 16. Mai 1882.

KAISERLICHES PATENTAMT.

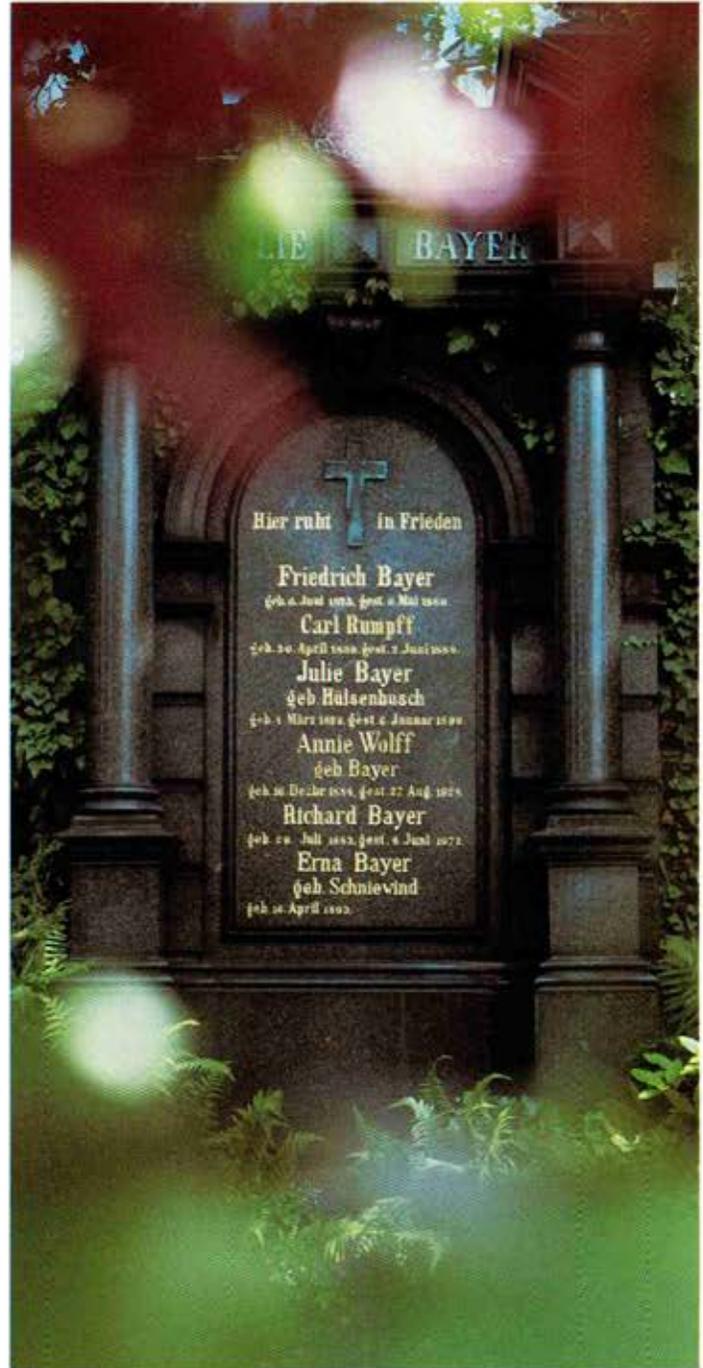
Beglaubigt durch

Schott
Sekretär des Kaiserlichen Patentamtes.

Wegen der Patentgebühr ist die zweite und letzte Seite dieser Urkunde zu beachten!

Friedrich Bayer had put his house in order

On May 6, 1880, Friedrich Bayer died at 55 of pleurisy, which he contracted while on a business trip. Friedrich Weskott had already passed away at the same age three and a half years earlier.



To this day, the tomb of the founding family Bayer is kept in good condition and well-groomed in the Protestant cemetery at Elberfeld, now part of the city of Wuppertal. Friedrich Bayer's son-in-law, Carl Rumpff, is also buried here.

With Weskott as the circumspect and skillful technician and Bayer as the far-sighted merchant and convincing salesman, the two founders had built up a substantial business within 17 years.

Before his death, Friedrich Bayer had "put his house in order." His son, Friedrich Bayer Jr., was a partner in the firm; his eldest daughter Clara had married the ambitious young man Carl Rumpff, who had valuable experience in the American market; and his second daughter Adele was the wife of Würzburg brewer Henry Theodor Böttinger, who was soon to join the Bayer management. Like Rumpff—Böttinger was soon to become a driving force in the expanding company.

In the patriarchal society of the day, the two founders had been the "fathers" of the company. In the same tradition, dynasties began to form among the corps of 400 workers.

Hermann Wüster belonged to one of these. "My father was a fuchsine man and my uncle was in the boiler room," said Wüster. Looking back on his life at Bayer, he added: "When I took my father his lunch to work as a six-year-old, I often saw the old gentleman Mr. Bayer. He was a kind, friendly man. My mother told me that Mr. Bayer often used to carry me when I was still in diapers ... When I was 14, I went to work at the factory myself. Old Mr. Bayer had already died by then, but I had paid him my last respects at my father's side."

To mark the occasion of the funeral, one worker wrote a poem. Translated into English, it reads:

*"On each one of our working days
We shall remember you,
Within our house on all our ways
Shall hold your memory true.
Though now we mourn, we see you yet
In Progress' worthy van.
So rest in peace; we owe a debt
To the scientist and the man."*

Bayer chronicle 1880

A small dyehouse manned by a master dyer and two laborers is installed. This later develops into the central dye-house and then the "Colorist Department," the forerunners of the department for application technology.

First permanent agency is set up in the Netherlands.

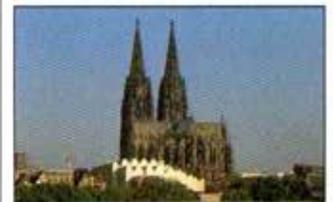
Firecrews are appointed in a first step toward establishing a works fire department.



The number of employees now reaches 298.

World events 1880

The Cologne Cathedral is completed after being under construction for 632 years. (This photograph shows the Cathedral in 1987.)



Louis Pasteur begins research in infectious diseases and possible forms of prophylaxis.

Emil du Bois-Reymond lists seven mysteries which cannot be solved:

1. The nature of energy and matter;
2. The origin of movement;
3. The origin of perception;
4. Free will;
5. The origin of life;
6. The meaning of nature;
7. The origin of thought and speech.

Average workweek is 60 hours in Germany, France, Belgium and the United States, but only 52 hours in the United Kingdom.

Incorporation — a new era begins

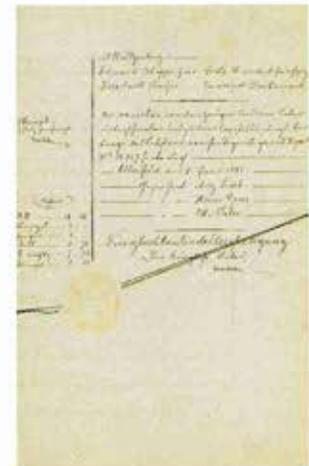
Following the death of the founders, the surviving partners decided to put the company on a broader and more solid basis. On July 1, 1881, they registered “Farbenfabriken vorm. Friedr. Bayer & Co.” as a joint-stock company with capital of 5.4 million marks.

At the time of its incorporation, “Farbenfabriken, vorm. Friedr. Bayer & Co.” consisted of one fuchsine, aniline, alizarin and azo plant each in Elberfeld and a second aniline works in Barmen.

The company employed two managing clerks in Elberfeld, two more in Hamburg and one in Moscow, as well as 14 chemists, an engineer, 15 master craftsmen, 14 staff clerks and 340 workers; 70 of them in the building department.

The founders of the joint-stock company were Friedrich Bayer’s widow Julie, his son Friedrich Jr., his son-in-law Carl Rumpff, Friedrich Weskott’s son-in-law August Siller, Friedrich Weskott Jr. and Eduard Tust, the only person with no familial relationship to either of the original partners.

Corporate law called for a supervisory board and a board of management. The latter initially consisted of the two founders’ sons, who also belonged to Bayer’s Supervisory Board until 1885, when the law was altered to separate the two functions. The supervisory board consisted of the other initiators of the corporation. The law made little difference, since there was in those days no real division of labor between the two boards.



The partnership paved the way for what was later to become an extensive public stock corporation.



Bayer's shares were first traded on the stock exchange in May 1883, two years after the joint-stock company had been formed. The various stamps on the above share show that subscription rights were exercised from June 30, 1883, right up to the period after World War I.

To the left are pictures of the first and last pages of the articles of incorporation of the joint-stock corporation Farbenfabriken vorm. Friedr. Bayer & Co. The small picture to the right shows part of today's Düsseldorf stock exchange.



Bayer shares are listed here and on many other major bourses.

The existence of the firm was now no longer dependent on the personal relations between its founders; its financing could be funded by equity in the future.

For all that, Bayer retained its family atmosphere until 1911, when Carl Duisberg was appointed chief executive officer. He was, admittedly, married to a niece of Carl Rumpff's and thus an in-law of the second generation of the founder families—but at the same time, he was very similar to entrepreneurs of today.

Bayer's corporate structure proved to be the best to handle the rapid development in the years and decades to come. Starting capital of 5.4 million marks was raised to 6.6 million by 1883 and reached 12 million by 1898. This substantial capital base allowed Bayer to expand, particularly since it was soon supplemented by borrowed funds used to finance the construction of the Leverkusen works from 1895 onwards. Between 1899 and 1909, the balance sheet total rose by an average of 10.7 percent annually, so that at the start of this century, Bayer was the third largest chemical company in terms of share capital, preceded only by "Deutsche Solvay-Werke" and BASF.

Bayer had become a joint-stock company, but was not a "Société Anonyme." The character of the firm was shaped by the personalities of Bayer himself, Weskott, Rumpff, Böttinger and Duisberg.

Expansion was not without serious problems, however. The alizarin market was a case in point. Many of the former producers had fallen by the wayside as a result of the tough competition. When the price of ten-percent alizarin paste had fallen to only two marks per kilogram, the remaining producers agreed on September 16, 1881, to form a convention. This agreement was signed by nine German firms and the "British Alizarine Company," the successor of Perkin's factory in Greenford. The ten signatories divided up the market between themselves and laid down minimum prices for all countries.

The key to the agreement was the apportioning of 52 equal shares of the market. Each individual convention member's share was based on 1881 output. Bayer profited from the fact that Rumpff had, despite unfavorable market conditions, expanded production. Like BASF and Hoechst, Bayer was thus given 10.52 shares. Six shares went to the Elberfeld-based firm Neuhaus, five to British Alizarine and three and a half to Dr. Leverkus & Söhne in Wiesdorf. The remaining seven and a half shares were split up between four other German manufacturers. The Alizarin Convention was the first time that the so-called "Big Three"—Bayer, BASF and Hoechst—appeared together in a paramount position.



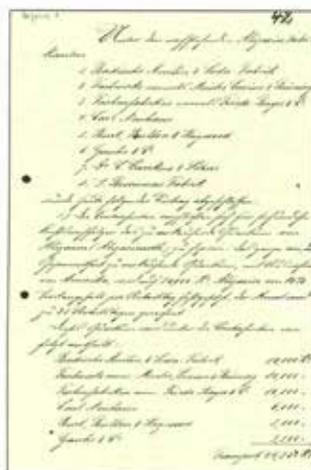
Bayer chronicle 1881

Engineer Emil Thiele is appointed head of the company's technical operations.

The company now has a total of 265 suppliers and 2,588 customers.

First general meeting for shareholders takes place on June 11. Carl Rumpff, August Siller and Eduard Tust are elected to the Supervisory Board. Friedrich Weskott Jr. and Friedrich Bayer Jr. become the first "Directors" of the company.

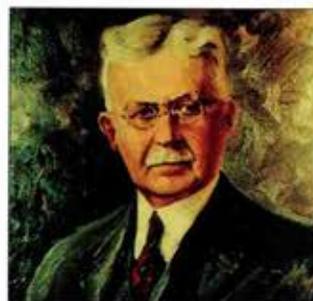
Alizarin Convention is signed on September 5. (The picture below shows a facsimile of the first page of the contract.)



Bayer chronicle 1882

The Hudson River Color Works is formed in Albany, New York, with Bayer participation.

Eye and ear specialist Franklin L. Miles (below) starts to bottle his medicine



"Nervine" in Elkhart, Indiana, and sells it to his patients and drugstores.

The Elberfeld works is linked up with the "Bergisch-Märkische-Eisenbahn" railroad.

Shanghai firm Meyrinck & Co. takes over permanent representation of Farbenfabriken Bayer in China.

World events 1881

On March 13, Czar Alexander II of Russia is the victim of a bombing. His successor, Alexander III, forms the "Three Emperors' League" with the German Empire and Austria-Hungary. The alliance pledges neutrality in the case of attack by a fourth power.

Romania becomes a kingdom under Carl I of Hohenzollern-Sigmaringen.

Africa's explorer Henry Morton Stanley finds Leopoldville (today's Kinshasa) as the capital of what is to become the Congo Free State under the rule of King Leopold II of Belgium.

Theodor Billroth performs the first successful stomach removal operation.

Edouard Grimaux and an assistant synthesize citric acid.

Father Sebastian Kneipp sets up a water cure spa at Wörishofen, Bavaria.

Albert Landerer administers the first saline infusion.

World events 1882

The German Empire, Austria-Hungary and Italy conclude the so-called Triple Alliance on May 20.

Charles R. Darwin dies on April 19. His greatest masterpiece was undoubtedly "The Origin of the Species."

Immigration into the United States reaches a peak of 789,000 people. (The wood engraving below dating from 1875 depicts immigrants at the outset of their journey to North America.)



John D. Rockefeller merges 40 oil companies into the Standard Oil Trust.

The "Handbook of Organic Chemistry" by Friedrich Beilstein appears in two volumes, listing 20,294 organic compounds. Bayer takes part in the financing of the project.

Robert Koch discovers tuberculosis bacillus.

Hamburg pharmacist Paul Beiersdorf is granted a patent for a "sticking dressing" for wounds and founds his own company.

Producers of alizarin dyestuffs were not able to enjoy their success for long. Cutthroat competition pushed prices down so far that many of them had to give up. To stop things from getting worse, the ten "survivors" signed the first Alizarin Convention in September 1881.

A young man named Duisberg

On September 29, 1883, a young chemist at Bayer named Carl Duisberg was given a research assignment. It was his 22nd birthday. He would later be described as the “founder and leader of the large-scale chemical industry in Germany,” by Heinrich Wieland, the 1927 Nobel laureate for chemistry.

Some 52 years after this 22nd birthday, one of Britain's foremost chemical engineering teachers, Henry E. Armstrong, wrote in a London “Times” obituary on Duisberg: *“His country loses a man who, all things considered, I believe may be regarded as the greatest industrialist the world has yet had.”*

Carl Duisberg was a child of the “Bergisches Land” region of western Germany, where his family could be traced back to the 16th century. The first recorded



Young Carl Duisberg (right) decided at an early age what he wanted to be when he grew up. After his first chemistry lesson at secondary school, he knew he wanted to be a chemist. He not only realized this ambition but was later to be termed “the founder and leader of large-

scale chemical production in Germany.” The self-confidence which was characteristic of Duisberg shows up clearly in the portrait of the 22-year-old above.

Duisberg in the dynasty was a teacher, pastor and reformer in the parish of Hückeswagen on the upper reaches of the Wupper, some 18 miles from the then nonexistent town of Leverkusen.

A number of Duisberg generations are recorded as having been local merchants, farmers, and frequently mayors in the small town. Finally, two Duisbergs, one a baker, the other a ribbonmaker, moved to Barmen in 1795.

At the time, the ribbon industry was concentrated in the Wupper valley. Merchants from the cities supplied the ribbonmakers with silk and cotton, which were then woven on home looms into ribbon, braid and cord.

Wages depended on the quantity produced, which meant both hard work and skill. Carl Duisberg's grandfather had plenty of both, as did his father, who was able to set up a second loom and employ a journeyman. Apart from making ribbon, he farmed a small holding. Duisberg's mother looked after three cows and sold their milk in town.

Carl Duisberg was born on September 29, 1861, at 58 Heckinghauser Street in Barmen. His father naturally assumed that his son would eventually take over the family ribbon business, but Carl's mother Wilhelmine, née Weskott, had grander plans for her only son. She survived her husband by 24 years and became the central figure in Duisberg's life. In the local dialect, she used to tell her relatives, *"you just leave me be, (Carl's future) is my business. There's a lot in that lad. I know that better than anybody."*

Carl Duisberg started grade school at five-and-a-half. He attended the secondary school in Barmen-Wuppertal, where chemistry was taught from the fourth year onwards. After the first class, the youngster decided what he wanted to be when he grew up. That day, he went home and told his mother, *"I want to be a chemist."*

But what exactly was a chemist? His mother had a vague idea that it was a sort of pharmacist, and young Carl wasn't able to explain the profession well, either. All that changed when Carl bought

with his own pocket money Justus von Liebig's "Chemische Briefe," the book that had already introduced generations of young people to chemistry.

These "Chemical Letters" begin with the words: *"In this first letter, I hope to convey the conviction that as an independent science, chemistry offers itself as one of the mightiest means to elevate the culture of the intellect and that its study is valuable, not only in promoting the material interests of mankind, but also in granting an insight into the wonders of Creation that immediately surround us, and that are closely allied to our being, our existence and our development..."*

The enthusiastic lad undoubtedly read this passage in Liebig's epochal work to his mother. That should have been enough to convince Wilhelmine Duisberg that there could be no better career for the young hopeful. She may not have understood every word he quoted, but she realized her son's early commitment. From then on, she launched a patient and diplomatic campaign to convince her husband. Slowly but surely she got her way.

In his father's eyes, Carl's schooling had already lasted much too long. But when it was time for him to do his military service (because he was a secondary school graduate, he only had to do one year), his mother persuaded Duisberg Sr. to allow Carl to finish a full high school program.

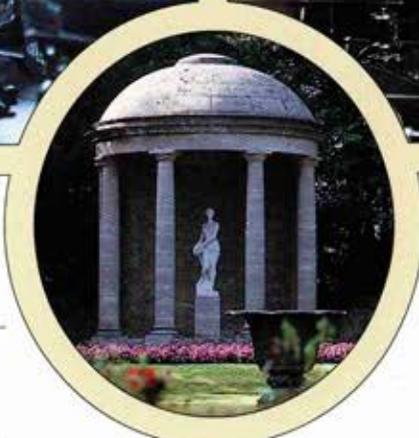
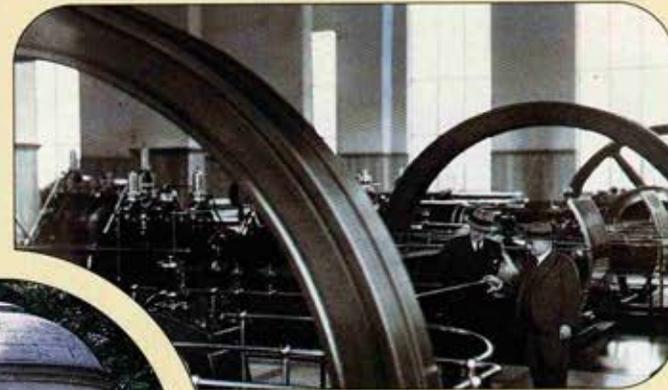
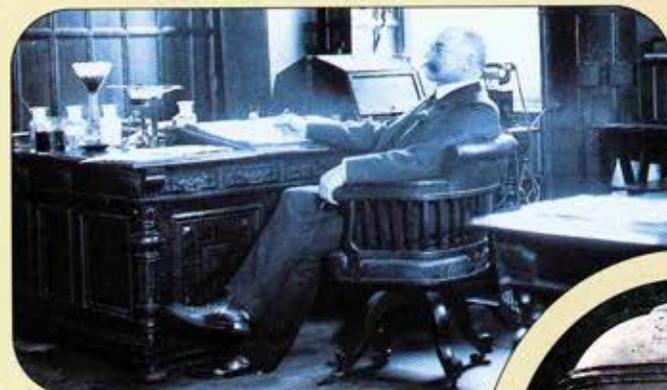
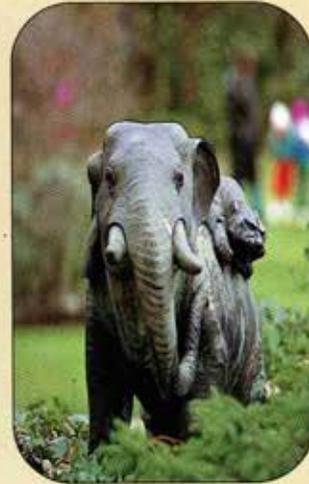
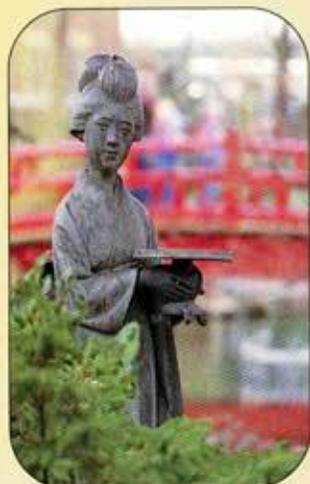
When he graduated from high school on August 17, 1878, he wanted to study chemistry. But his father demanded that Carl spend a year in the chemical course at Elberfeld's technical college: he felt that Carl was too young for university life.

Duisberg went through the Elberfeld chemistry course in only eight months instead of a year. This qualified him to carry out practical work in a chemical laboratory (today, one would call him a lab technician). In the end, this experience was enough to convince his father that he was ripe for the university—and to give him an allowance of 100 marks per month.

Duisberg chose to attend the university in Göttingen, mainly because an older friend of his let him



“I want to be a chemist!”



Despite his youthful determination to become a chemist, the adult Duisberg had anything but a one-track mind. Seen in the top picture with wife Johanna and son Carl Ludwig, he was enthusiastic about all aspects of technology. As an early automobile fan, he owned one of the region's first horseless carriages—but was just as fascinated by the steam and generating equipment in the company power station.

Nor was it easy for him to stay glued to a desk: he could not keep from paying visits to the laboratories. Duisberg was an avid foreign traveler and returned not only with new ideas and a host of memories but also with numerous works of art for his Leverkusen home. He found his last resting place in the park named after him next to the Leverkusen works. Fritz Klimsch's "temple to flora" adds a classic touch to the gardens.

have his room. He started off in the Analytical Laboratory, where he handled everything so easily that during the next term he was permitted to move to the Organics Department and study under Professor Hans Hübner.

But because of a rule of the Prussian government that said that graduates of nonclassical secondary schools could receive their doctor's degree only after passing a Latin examination, he moved to the university in Jena.

At the new university, Duisberg got to know Rudolf Eucken, the first philosopher ever to be awarded the Nobel Prize (1908). Eucken attempted to keep alive the idealistic tradition established in Jena by Johann Gottlieb Fichte.

At the same time, however, there was philosophical opposition between the university faculties. Zoologist Ernst Haeckel taught a comprehensive ideology that covered matter and spirit, the worldly and the divine, all on the basis of Darwin's teachings. His "monon principle" presented the world as an integrated whole: *"Everything is nature, there is nothing outside, above or beyond nature."* His book, "Natural Genesis," was published in 1868 and went through ten editions in 12 languages; his later work, "Riddle of the Universe," sold no fewer than 300,000 copies in 15 languages.

No matter which department a Jena student attended, he had to choose between Eucken and Haeckel. Duisberg opted for Haeckel.

In chemistry, his teacher was Professor Anton Geuther, whose laboratory was equipped so simply that Duisberg described it as an "alchemist's workshop." Water came from a rain barrel, and although there was a gas connection, the students experimented with the coal-burning unit known as Wöhler's wind-furnace. Geuther worked on the principle that the less equipment there was, the more the student learned.

Geuther soon gave Duisberg a major assignment. In 1864, the professor had discovered a compound that he called acetoacetic ester. A formula existed for this, but Geuther thought it was incorrect.

Duisberg was told to find a better one. He was able to show that Geuther's formula was in fact possible. At the same time, he himself discovered a compound that he and Geuther named oxytetrolic ethyl ether. Duisberg based his doctoral thesis on the compound, "Contributions to the Knowledge of Acetoacetic Ester."

Postgraduates studying for a doctorate were required to take two minors. Duisberg decided to take geology and economics. That was unusual, since most chemistry majors normally studied physics as a minor. Duisberg, however, had instinctively realized the future significance of the then barely heeded study of economics. But it is also said that he did not much like the physics professor of the day. His economics professor, Julius Pierstorff, was a so-called "academic socialist." In the discussions between professor and student, Duisberg sharpened his skills in reasoning.

On June 14, 1882, Carl Duisberg passed his doctoral examination. The party afterwards ended in a noisy parade through the little university town, which in the eyes of the local police constituted a disturbance of the peace. As a Ph.D., Duisberg had to pay a ten-mark fine—it would have been less had he still been a student.

Duisberg was now a qualified but unemployed chemist. He answered every advertisement for a job he could find and received only a single acceptance—as assistant in the Food Inspection Office in the town of Krefeld. Geuther strongly advised against taking the job and gave Carl a post as his own private assistant. This, however, carried the less-than-spectacular salary of 80 marks per month: certainly not enough to live on. For the time being, Duisberg remained dependent on aid from his father, who naturally saw his misgivings confirmed that Carl had not gone into a "proper profession."

When Duisberg did receive an answer to job applications, it generally included a question as to his military status. So he joined the First Bavarian Regiment in Munich as a one-year volunteer.

Geuther was very upset at his assistant's arbitrary decision to leave and the man parted on bad terms.

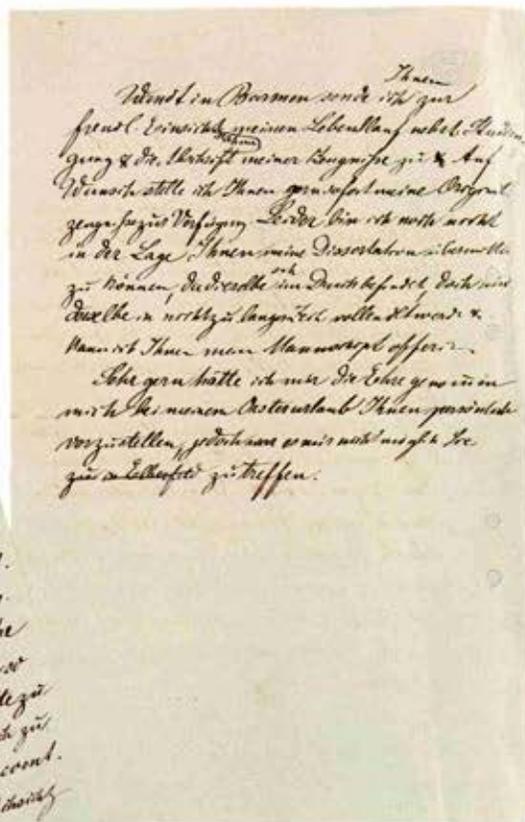
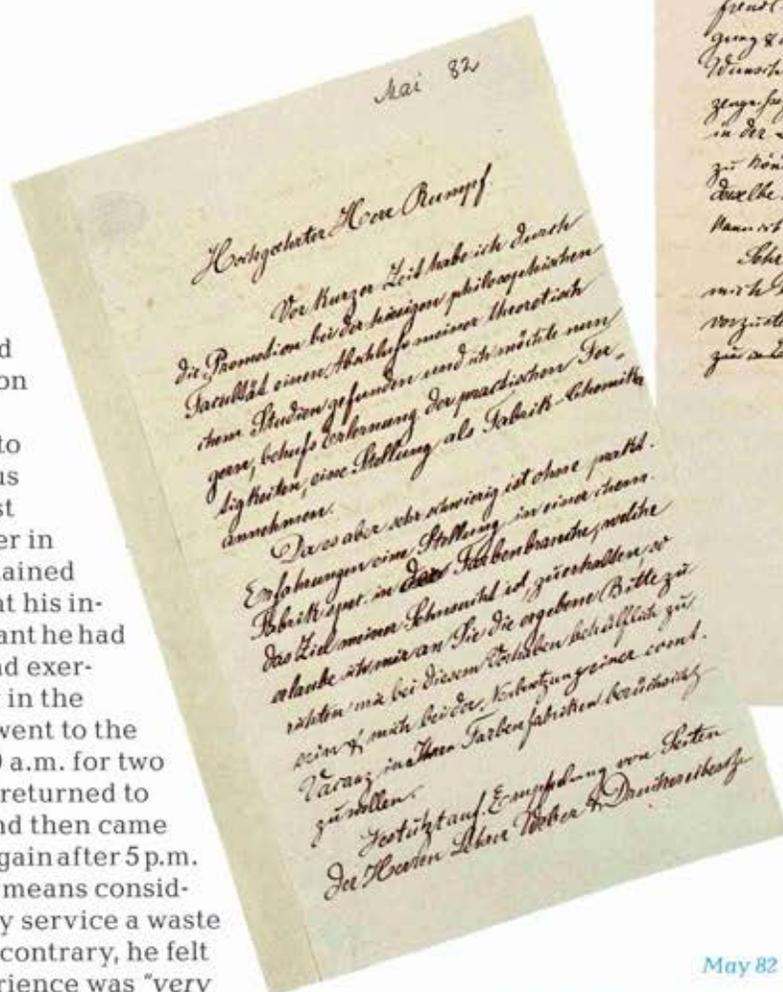
Duisberg got to know the famous German chemist Adolf von Baeyer in Munich and obtained a part-time job at his institute. This meant he had military drill and exercises first thing in the morning, then went to the laboratory at 10 a.m. for two or three hours, returned to the barracks, and then came back to the lab again after 5 p.m. Duisberg by no means considered his military service a waste of time. On the contrary, he felt that army experience was "very valuable for the head of a chemical works, the profession I want to follow."

But for all that, he left Munich and went home without a job or visible prospects.

In 1882, immediately after he obtained his doctorate, Duisberg applied directly to Bayer Supervisory Board Chairman Carl Rumpff for a post as a works chemist so that he could "learn practical skills." Unfortunately, Bayer had no vacancies at the time.

Although there were no vacancies in 1883 either, Carl Rumpff had already come to realize that Bayer needed able chemists whose sole purpose would be to make new discoveries. The other directors and managers thought this would cost too much. Like the time he bought the Elberfeld site out of his own pocket, he once again took matters into his own hands. He himself hired and paid three young chemists who were in time to become known as

In May 1882, Duisberg sent this letter to Carl Rumpff, Chairman of the Supervisory Board, in which he applied for a job at Bayer. He was turned down, but it did not take long before Rumpff contacted him again.



May 82

Dear Mr. Rumpff:

A short while ago I obtained my doctor's degree in chemistry from the local university. Now that I have finished the theoretical side of my studies, I would like to find employment as a works chemist in order to acquire practical experience in my chosen field.

Unfortunately, it is extremely difficult to be hired for a position as works chemist if one does not already have some professional experience. Since it is my greatest desire to work in a chemical company, and more specifically in the dyestuff industry, I would like to take the liberty of asking you for your kind support in achieving this goal. I shall be most indebted to you, if you would think of me the next time it is necessary to fill a post in your Farbenfabriken.

At the recommendation of my teacher, Mr. Weber, and of the owner of a printing house in Barmen, Mr. Wandt, I am sending you for your perusal my curriculum vitae and a copy of my certificates. If necessary, I shall be happy to provide the originals.

I regret that I cannot as yet forward my dissertation to you

because it is still in the process of being printed. It should, however, be available within the near future, so that I can then send you the manuscript.

I would have considered it a great honor to introduce myself to you personally during my last Easter vacation, but it was unfortunately not possible to make your acquaintance.

the "three mountains" of the company landscape: Martin Herzberg, Carl Hinsberg and Carl Duisberg, all of whose names ended in "berg," which means "mountain" in German. Rumpff came to Duisberg's home personally to hold the first interview, and then asked Carl the next day to visit him at Aprath Castle, his house near Elberfeld.

The meeting at Rumpff's house was to prove fateful for Duisberg in more than one respect. Apart from launching his working career, it also brought him together with Rumpff's niece, Johanna Seebohm, who later became his wife.

Duisberg was given a research job at Bayer. For the first half of a one-year period, he was to work at Strasbourg University, since Bayer as yet had no research laboratory of its own. He received a monthly salary of 150 marks. Rumpff explained his assignment to him: "*We have bought Dr. Paul J. Meyer's Patent No. 25 135 to be able to make isatin. It will be your task to ascertain whether it is possible to obtain indigo from isatin at a reasonable price.*"

That was like reaching for the stars. Young Duisberg was supposed to succeed in something that all other dyestuffs chemists had failed to do and that Adolf von Baeyer himself had only attained theoretically. Duisberg did not succeed either. But there was a positive side to his failure—he was able to prove that this was not a way to synthesize indigo.

Duisberg's stay in Strasbourg was extended for a second term. His task this time was to try to find how to make a blue azo dye that would break the monopoly of natural indigo. His work was interrupted by a call-up order for reservist maneuvers. When he came back on September 29, 1884, his 23rd birthday, Rumpff gave him a permanent job.

Bayer chronicle 1883

Bayer's younger generation moves into top management when Theodor Henry Böttinger (35), the second son-in-law of Friedrich Bayer Sr., and Hermann König (35) are made "Directors." Managing clerk positions are given to Hermann Matthis (44), August Wilhelms (35) and Carl Hülsenbusch (29).

The number of employees rises to 521.

Bayer chronicle 1884

Carl Duisberg (23) signs a three-year contract, with a salary of 2,100 marks in the first year, 2,400 marks in the second and 2,700 marks in the third. If he has not been given notice by then, the contract is to be automatically extended by a further three years and the annual salary raised to 3,000 marks. Just two months after he joins the firm, Farbenfabriken Bayer registers the first patent under Duisberg's name.

The "Dr. Miles Medical Company" is formed in Elkhart, Indiana.

A permanent agency is set up in Barcelona, Spain.

World events 1883

On August 26, the Krakatau volcano in the Sunda Strait erupts, and the island sinks into the sea. Some 35,000 people lose their lives.

German Parliament passes the Health Insurance Act, the first of Bismarck's "social security laws."

Orient Express makes its first trip from Paris to Constantinople on June 5.

Robert Koch isolates the pathogenic agent responsible for cholera.

World events 1884

German Empire becomes a colonial power, setting up protectorates in South West Africa (today's Namibia), in East Africa (now part of Tanzania), the Cameroons, Togo and New Guinea in the Pacific.

German-American Ottmar Mergenthaler invents the linotype machine, which enables mechanical typesetting and thus paves the way for large-circulation newspapers.

Count Hilaire Bernigaud de Chardonnet in France and Joseph W. Swan in England simultaneously and independently invent "artificial silk."

Benzopurpurine 4B: Bayer's life-saver

For the first time since incorporation, Bayer could not pay a dividend in 1885. And for the first time since the firm was set up 22 years ago, the number of workers had to be reduced.

On November 18, 1885, the Berlin stock exchange paper, "Allgemeine Börsenzeitung," wrote the following: *"Those who wish to protect themselves from major losses should sell their (Bayer) shares, since neither the state of the alizarin and aniline markets, nor the ability of this company's management, point to an improvement in the situation. It seems more than doubtful that any dividend can be paid over the next few years—assuming the company can last that long."*

Times were hard—and not only for Bayer. Some dyeworks had to give up; many were unable to pay a dividend. There were exceptions, notably the Aktien-Gesellschaft für Anilinfabrikation (Agfa) in Berlin, whose Congo red had come on the market in 1884. With the help of Congo red, Agfa was raking in the profits.

The history of this dyestuff, which reads like a thriller, began with Bayer. During a visit to England in 1883, Böttiger had visited his birthplace Burton-on-Trent and met with his old friend Peter Griess. Griess had shown him his collection of dyed cotton hanks and explained how he had colored them without prior mordant treatment. This meant that he was using direct coloring dyes.

Böttiger may have not been an expert in dye-stuffs, but the blue that Griess showed him looked so convincing that he took a few samples home to Elberfeld. As a result, Paul Seidler was sent to England to buy up Griess' invention on behalf of Bayer. But it soon proved that production of the important intermediate benzidine-sulfone-disulfonic acid posed unanticipated difficulties. It could be produced in the laboratory, but not on a technical scale that would have been economically justifiable.

It can no longer be proved whether Griess discussed the use of benzidine instead of benzidine-sulfone-disulfonic acid with Seidler; he certainly did not mention this in any of his publications. Benzidine presented no difficulties in production and yielded a brilliant red.

Paul Böttiger, a friend of Seidler and not to be confused with Bayer's son-in-law Henry Böttiger,

The journalist's opinion in the newspaper on the right were most certainly not appreciated in Leverkusen. The front page article in the Berlin-based "Allgemeine Börsen-Zeitung" recommended investors to sell their Bayer stock.

In the same year, however, the company got a new boost with the introduction of the successful product "Benzopurpurine 4B." This breakthrough also led to the promotion of 25-year-old Carl Duisberg to technical manager of the new factory.

Börsen-Zeitung

für Privat-Capitalisten und Rentiers

No. 91.

Berlin, Mittwoch, den 18. November 1885.

13. Jahrgang.

Zur gefälligen Beachtung! Alle Correspondenzen etc. sind an die Adresse „Allgemeine Börsen-Zeitung, Berlin SW., Friedrichstr. 214“ zu richten.

Farben-Fabriken vorm. Friedr. Bayer u. Co. in Elberfeld.

Bereits in Nr. 89 dieser Zeitung brachten wir die Bilanz obiger Gesellschaft zum Abdruck und verwiesen in einer Notiz auf eine demnächstige Besprechung derselben, da uns aus dem Leserkreis unseres Blattes Anfragen zugegangen waren, ob es rathsam sei, die Aktien dieses Unternehmens zu verkaufen oder zu behalten. Ein kurzer Rückblick auf die historische Entstehung der Gesellschaft scheint uns insofern erforderlich, als dieser Umstand dazu beitragen dürfte, unsere Raththeilung an die Actionaire zu begründen.

Die Gesellschaft wurde im Juni 1881 durch Uebernahme der Fabrikanlagen der Firma Friedr. Bayer u. Co. gegründet und zwar mit einem Actien-Capital von 7,500,000 M., davon 5,400,000 M. in 1080 Actien à 5000 M. und 2,100,000 M. in 2100 Actien à 1000 M.

nur 278,132 Mark zur Verfügung, das „etwas“ befristet sich also auf 443,680 M. Aber auch dieser geringe Ueberschuß von 278,132 M., welcher ca. 3% pEt. Dividende gestatten würde, soll den Actionairen nicht zu Gute kommen. Denn trotz der Convention der Alizarin-fabriken und wenigstens die Gesellschaft durch Gewinnung eines Patentprocesses und daraus resultirendem größerem Absatzgebiet nach Amerika nach allen Seiten gesichert war, so war es dennoch dem Scharfblick der Direction entgangen, daß in dem Artikel „Alizarin“ Ueberproduction in optima forma herrsche. Die Folge davon war, daß die Gesellschaft ihre Production nicht nur nicht einschränkte, sondern noch vergrößerte, indem sie seit der Begründung für Gebäude, die sie neu errichtet 532,428 Mark ausgiebt und dazu für 122,331 M. Grundstücke ankaufte.

Wir möchten wohl, Angesichts solcher Handlungsweise den Vorbesitzern und gegenwärtigen Directoren die Frage vorlegen, ob sie aus ihrem eigenen Geldbeutel so unverantwortlich erwirtschaftet haben würden, wie sie es als Actionaire geschehen? — Wenn man sich an die Bilanz von 1884/85 erinnert, im Jahre 1886 drohenden Verlusten von 1,200,000 M., die eine gewisse proportion unverkennbar hat die Direction schon früher in dieser Situation zu verfallen.

Ausgaben		
General-Unkosten	375,873	355,097
Dubiose	26,498	36,058
Abreibungen	248,220	286,878
Patentproceffe	—	90,256
Kosten der Convention	—	85,821
Reservefond	70,477	—
Spezial-Reserve Proibrom	5,000	—
Verlust-Reserve	—	278,132
Vortrag	72,482	—
Reingewinn	721,812	336,882
Dividende	527,600	—
in Procenten	8	0

Wir kommen zum Schluß und resumiren uns, mit Bezug auf die diversen Anfragen aus dem Leserkreis unserer Zeitung, dahin: Wer sich vor größeren Verlusten schützen will, verkaufe seine Aktien, da sowohl die Lage des Alizarin- und Anilin-Geschäfts einerseits, wie auch im vorliegenden Falle die Befähigung der leitenden Kräfte dieser Gesellschaft andererseits, keine Chancen für Besserung des Courses in Aussicht stellen, die Vertheilung einer Dividende aber auf Jahre hinaus mehr, wie zweifelhaft erscheint, vorausgesetzt, daß die Gesellschaft sich überhaupt noch Jahre lang, zu halten, im Stande ist.

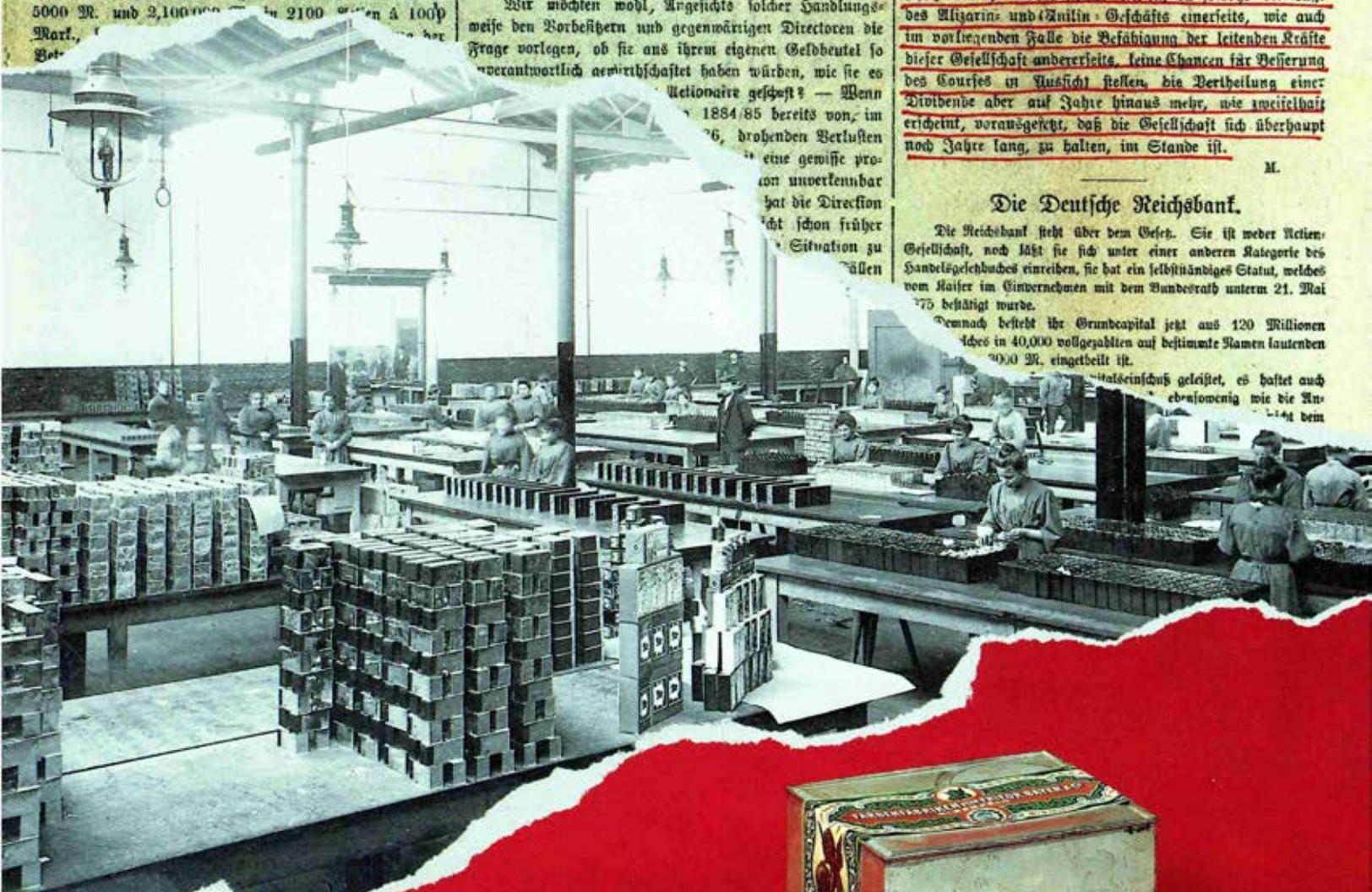
M.

Die Deutsche Reichsbank.

Die Reichsbank steht über dem Geset. Sie ist weder Actien-Gesellschaft, noch läßt sie sich unter einer anderen Kategorie des Handelsgesetzbuches einreihen, sie hat ein selbständiges Statut, welches vom Kaiser im Einkommen mit dem Bundesrath unterm 21. Mai 1875 bestätigt wurde.

Demnach besteht ihr Grundcapital jetzt aus 120 Millionen Mark, wovon 40,000 vollgezahlten auf bestimmte Namen lautenden 2000 M. eingetbeilt ist.

Das Geschäft der Reichsbank ist einseitig gelöst, es haftet auch ebensolowenig wie die An- dem

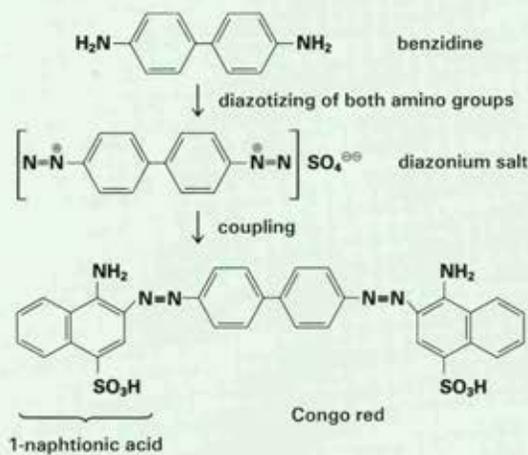


The cotton fabric in which this old can of Benzopurpurine 4B is standing was dyed specially for this book with the original dyestuff. In its archives, Bayer has samples of all the dyestuffs it has ever developed together with their production recipes.

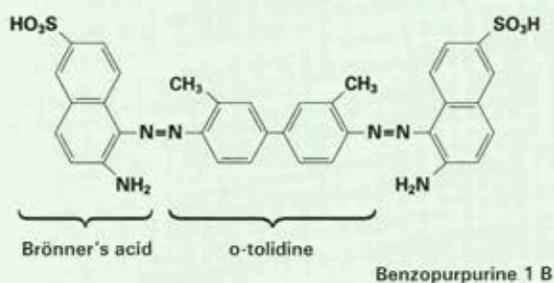


Congo red and benzopurpurine

The Congo red introduced by Agfa in 1884 is produced from benzidine by a double diazotization process and subsequent coupling on 1-naphthionic acid (1-naphthylamine-4-sulfonic acid):



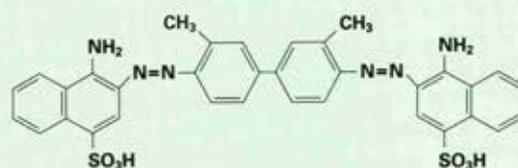
Bayer tried to develop a competing product by choosing starting materials not mentioned in the patent. The replacement of benzidine by o-tolidine and the use of "Brönner's acid" (2-naphthylamine-6-sulfonic acid) instead of 1-naphthionic acid led to benzopurpurine 1 B:



The so-called color sample cards were prepared so that sales representatives and "traveling technicians" could show customers the firm's dyestuffs. This one shows benzopurpurine, the "hit" of the day.

This dyestuff did not make the grade in competition with Congo red. Success came

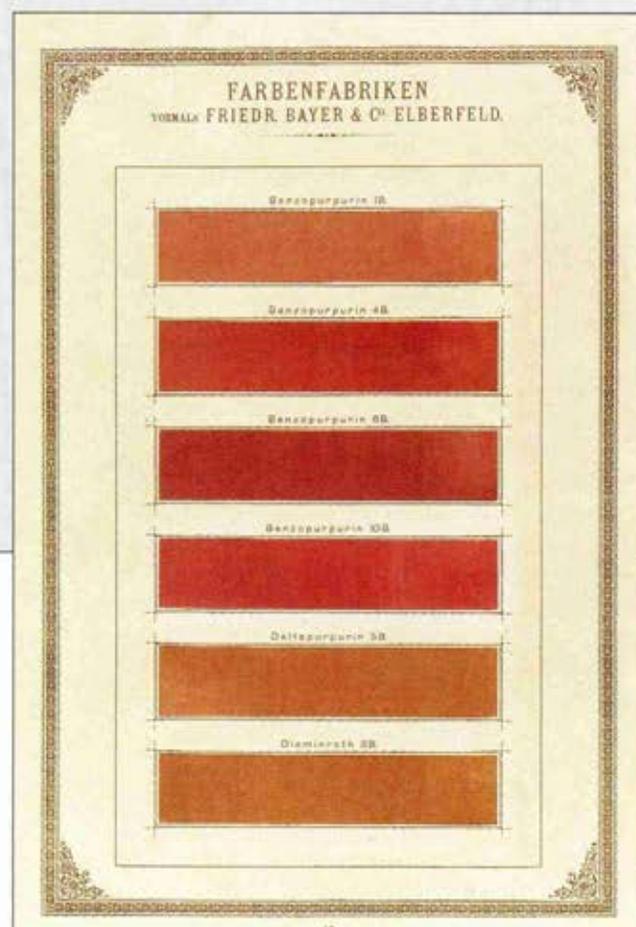
only when the Bayer chemists went back to 1-naphthionic acid.



Benzopurpurine 4 B

Benzopurpurine 4B had better dyeing qualities than Congo red. It was also, thanks to the influence of the two methyl groups on the central nuclei, not as sensitive to acid as Congo red. This particular

dyestuff is used in analytical chemistry as an acid indicator due to its characteristic color change in the presence of acid.



was working in Elberfeld at the time. He left in 1884 and went to work for a dyer in Lodz. Soon afterwards, he registered a patent application for a red azo dye in his own name.

No one knows whether Böttiger had carried out the preparatory experiments for this new dyestuff in Elberfeld, but nevertheless he did first offer use of his patent to Bayer as it appears he did not want to risk being sued. It may be that Bayer had its sights set on a new blue as a possibility to compete against natural indigo, though it seems more likely that the firm was simply dissatisfied with the properties of the azo dye—the brilliant reds that this produced changed into the deepest of blue-blacks when exposed to acids. Whatever the case, Bayer turned it down.

Paul Böttiger drew a blank with BASF and Hoechst, too. Agfa wasn't interested in the "fake stuff" either, but then a master dyer advised the Berlin firm to buy the patent because he felt that the brilliant colors would go down well with the customers, regardless of the fact if it was fast to acids or not. He was right.

In his historical work on the German chemical industry, "Aufbruch ins heute," Reinhard Woller writes about the year 1884: "Paul Böttiger synthesized Congo red, the first substantive dyestuff with which the direct dyeing of cotton is possible." Peter Griess, quietly going about his hobby in England, seemed forgotten.

As stated in the preceding chapter, Carl Duisberg had joined Bayer in 1883. After being appointed to the permanent staff the following year, he went to work for Eugen Frank, head of the azo department.

Behind Frank's laboratory was a bathroom, and behind this was a small room with only one window but equipped with a lead-covered table and a connection to water and gas mains. This was Duisberg's domain, where he could go about his work without being interrupted.

To save money, he still lived with his parents in Barmen in a tiny attic room. It was an hour-long com-

mute by horse-driven streetcar to Elberfeld, which meant he had to leave at 6:45 a.m. every morning and return at 7 o'clock in the evening.

Eugen Frank, who had invented Crocein scarlet as Bayer's first dyestuff three years earlier, was very anxious to find something new to set against Agfa's Congo red. In 1884, he discovered Chrysamine G, Bayer's first direct dyestuff. It was now Duisberg's task to improve the yield in the production of croceic acid. He did not succeed in this assignment, but found instead a yellow-green dyestuff, which formed the subject of the first patent in his name on November 20, 1884. This dyestuff proved, however, to have unsatisfactory fastness. It never went into production.

The second Duisberg patent was more promising—a process for the production of benzidine sulfone as a base for the azo-dye intermediate benzidine-sulfone-sulfonic acid. The patent was registered in Germany and he also applied for one abroad.

"In my mind's eye, I could already see our goal within reach," Duisberg later admitted. But this youthful optimism was premature. Every red, violet and yellow dyestuff that he formulated turned out to be much too sensitive to light. There was still nothing like the Congo red among them.

Duisberg kept on experimenting with new coupling components. Among the chemicals in his little laboratory was a bottle containing 2-naphthionic acid, known at the time as Brönner's acid after its Frankfurt-based manufacturer. After coupling with doubly diazotized tolidine, this base produced a light red precipitate. After filtering off the substance and finishing the dyed cotton in a soap bath, a fine, bright red was produced. Unlike Congo red, it remained unaffected by acetic acid.

The trouble was that Brönner's company had been one of the victims of the alizarin crisis, and its patents had been bought up by Agfa. On the other hand, Duisberg had chosen tolidine instead of benzidine, a substance not mentioned in the Agfa patents. He also discovered that Farbenfabriken Bayer had

found a different way to obtain 2-naphthionic acid before Brønner had patented its process. Bayer saw its chance and registered a patent for tolidine dyestuffs on March 17, 1885.

Then another difficulty appeared unexpectedly. According to Duisberg's process, the 2-naphthionic acid could be produced only in autoclaves approved to withstand a pressure of 40 atmospheres. Bayer had no such units and would have had to buy them

in the middle of the crisis.

With a great deal of publicity, the new product with the name benzopurpurine (subsequently benzopurpurine 1B) was finally in-

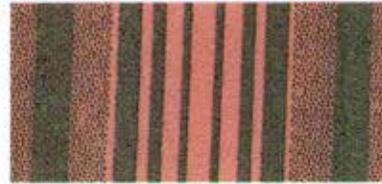
troduced to the market in the fall of 1885. But it was not a success. Although it was faster to light and acid than Congo red, it had a dull, brick-red tone and lacked Congo red's coloring power.

Coincidence brought success where hard work and conscientious research had failed. At the end of every week, Duisberg and his assistant used to clean up his laboratory. In the process, all beakers were emptied and carefully washed. When Duisberg was about to pour out the contents of a beaker that had been standing around unstirred for several days, he noticed that the originally brown dyestuff had turned red.

At first, neither Duisberg nor his assistant could remember which dyestuff it was. Only after tedious investigations did it turn out that the beaker had been used in one of the many attempts to couple the 2-naphthionic acid, also an ingredient in Congo red, with tolidine.

Further tests proved that this coupling took place in two stages. The first stage resulted

in the dull brick-red color; the second, which took place when the mixture had been allowed to stand in the cold for three days, led to a brilliant red dyestuff that was even brighter than Congo red.



A chemistry book from 1775 includes the sentence: "That which is sought after is rarely found, or then with difficulty, while that which had not been reckoned with is given into the hands of the seeker. It is thus that the best inventions are found." Or to quote the Prussian General Helmut von Moltke, "Luck is a talent, too."

The new product was the last-minute breakthrough that saved the firm. It was sold as benzopurpurine 4B, and became one of the most successful items in the azo dyestuffs range. Carl Rumpff immediately had a new plant built and fitted it out with new machinery and equipment. Carl Duisberg, whose contract still included the obligation stating he was allowed to "enter only those factory areas where he is instructed to work," became manager of the new plant at the age of 25.

Perhaps it would have been too much of a good



thing if the recovery after the crisis had continued without further obstacles.

In fact, however, Agfa filed opposition

against the benzopurpurine patent because the two red dyestuffs were allegedly too similar in their chemistry. The sole difference, Agfa claimed, lay in the diazo-compound, which was benzidine in the case of Congo red and tolidine in the case of benzopurpurine. The court ruled that benzopurpurine was not patentable.

In the meantime, Duisberg had developed into something of a patent expert. Eduard Tust no longer passed on patent matters to a Berlin lawyer. Instead, Duisberg worked out the texts and corresponded with the Patent Office himself. He advised strongly against appealing the judgment of Agfa. Instead, executives of Agfa and Bayer got together and decided to cooperate. In the future, both firms were to produce both products, while the benzopurpurine patent was transferred to Agfa as an adjunct to the Congo red patent.



The color and print samples on wool and half-silk (a combination of silk and cotton) shown on this page demonstrate the scope of early dyestuff applications. The samples came with detailed instructions on the various dyeing and discharging techniques for customers.

The cooperation also extended to other products and research projects.

Duisberg's contract was extended for a further four years and his salary was raised from 2,700 to 6,000 marks per year. In addition, he was promised a two-and-a-half percent share of the net income from his inventions. His first share totaled 9,000 marks. With that money, he bought shares of *Farbenfabriken vorm. Friedr. Bayer & Co. AG*. Because of



the crisis, they were to be had for 80 percent of nominal value. "I felt like a partner—even like an owner—and acted accordingly," he wrote in his memoirs. At the age of 26, he was already

in charge of nine chemists. With his commitment as a "joint owner," he made two decisions that would play a decisive role in the company's future. One proposal was to concentrate scientific research in one central laboratory. The other suggestion was to subject patents, including those from competitors, to systematic evaluation. In 1883 alone, the Imperial Patent Office had granted 3,062 patents in the field of chemical technology. Some 1,791 were of interest to Bayer.

Readers of the *Börsenzeitung* who took the newspaper's advice and sold their Bayer shares would be sorry. The dividend rose from zero in 1885 to four percent in 1886 and then to seven percent the following year; it jumped to 12 percent in 1888, 15 percent in 1889, 17 percent in 1890 and 18 percent in 1891.

Bayer chronicle 1885

The Supervisory Board decides that all wage-earning and salaried employees of the company should become members of the newly formed professional association of the chemical industry.

Bayer "Relief Fund" becomes a corporate health insurance fund.

A sodium carbonate factory is constructed in Elberfeld.



A printing shop and book binding shop (above) are set up in Elberfeld to produce sample cards, advertising material and labels.

An agency is opened in Milan.

The intermediate benzidine-sulfone-disulfonic acid is discovered. It is the basic material of the so-called benzidine dyestuffs used for the direct coloring of cotton.

On August 9, the Alizarin Convention is dissolved.

World events 1885

Robert Salisbury begins his first term as British Prime Minister.

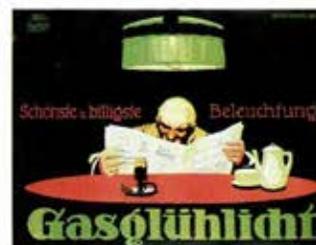
Three scientists (August Weismann, Eduard Strasburger and Albert von Kölliker) discover simultaneously and independently that the contents of the nucleus of a cell is the bearer of genetic properties. In 1888, Wilhelm Waldeyer names them chromosomes.

Physician Reinhart van den Velden proves that stomach ulcers are almost invariably the result of excessive acidity.

A Prussian decree of February 2 lays down that experiments with living animals at universities must be "performed in a reasonable and acceptable way."

Mannesmann develops seamless pipes.

Heribert Brauer of Pforzheim invents the snap for clothing.



Carl Auer von Welsbach invents incandescent gas light. The first electrical street lighting is installed in Berlin. (Poster by Ernst Lübbert.)

“Faster than indigo” — but only in winter

For all his perseverance, Duisberg could not come up with a usable blue dyestuff. But then he tried coupling Nevile acid (1-naphthol-4-sulfonic acid) with doubly diazotized tolidine. This did result in a blue dyestuff—admittedly rather dull, but promising. Bayer bought the license to produce Nevile acid from patentee O.N. Witt and was then able to introduce the first direct blue azo dyestuff to the market under the name of “Azo Blue.” It was still not up to the mark, though.

100 Kilo	Thionyl	1.50	150.00
100	Salpeters. 400	32	352.60
120	Kalide	2.10	3.20
55	Ortho Nitrophenol	2.90	
50	Tara Nitrophenol	1.00	
100 Kilo	Ortho Nitrophenol		2.90
55	Kalide	51.50	28.30
70	Ortho Nitrophenol	3.	120
100	Spermin	36.40	109.50
100	Nahouf	10.25	10.25
150	Zinkstent	26.	39.00
20	Salpeters. Natron	51.40	10.25
100	Salpeters. Natron	4.50	4.50
30	Alpha Naphthol	6.	180.00
10	Hydro	11.25	11.25

A light-fast and acid-proof red had finally been discovered. Shouldn't the same be possible for blue? The goal was still to beat indigo. Duisberg, who was in no way resting on his laurels, invented Benzoazurine G—but first only in his dreams.

Friedrich Bayer Jr. and Carl Duisberg spent half the night on the calculations for an economical production process for the new “Benzoazurine G.” Bayer Jr. kept the handwritten notes on the meeting in his cigarette case for 17 years.

Duisberg found the solution in a way that is not at all uncommon in the annals of research chemistry. He described what happened in his memoirs: *"One day I had a visit in Elberfeld from my friend Dr. Ewald Herzog who joined me for lunch in my room. After the meal we lay down for a rest. When I woke up, I told my friend that I hoped I had discovered the long sought-after, direct-dyeing greenish-blue in a dream. Instead of the two methyl groups in the tolidine, two methoxy groups should be...incorporated in the molecule that would shift the shade of Azo Blue from the ugly red-blue to the fine green-blue I was looking for."*

The inspiration that came to him in the dream was correct. The only problem was that the necessary base, benzidine with the two methoxy groups, did not yet exist. Duisberg saw a way to synthesize the compound from ortho-nitrophenol. This substance could be supplied by his friend Herzog. The trouble here was that during its manufacture about the same quantity of para-nitrophenol was produced and the ortho-nitrophenol had to be carefully separated off.

Since the other compound had no use at the time, this production method would pose a considerable technical problem. Nevertheless, Duisberg was able to obtain his benzidine with the two methoxy groups, which he was later to call dianisidine, and to diazotize the two amino groups and couple it with Nevile acid.

The blue which resulted was so impressive *"that my immediate announcement to the management put everyone in a great state of excitement,"* Duisberg said.

Friedrich Bayer Jr. came into Duisberg's laboratory and they spent half the night working out how a technical solution at a reasonable cost could be found for the complicated synthesis. This day, November 16, 1885, marked the beginning of a close friendship between the two men. Bayer kept the note on which the final calculation was written for 17 years in his cigar case.

Cotton hanks dyed with the new product Benzoazurine G were hung up on a line beside the Wupper to brave the elements. They were left there for three

months. They passed the test, and production was ready to begin.

Rumpff immediately planned the building of a new "blue" factory, which was to have a daily output of 10,000 kilograms. As foreseen, the economics of the project were strained because of the large amount of para-nitrophenol produced as a by-product. The para-nitrophenol had to be stored in large vats in the courtyard. Two years passed before a use was found for this substance (see chapter on 1888).

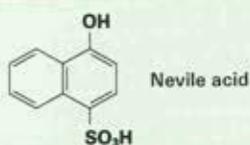


Dyestuffs have to stand up to sun, wind and weather. At a special light-exposure and weathering unit at Engerfeld in the Bergischen Land, dyed fabrics are tested under different weather conditions.

"Faster than indigo" –
but only in winter

Benzoazurine G

An important chemical referred to in the text is Neville acid, or 1-naphthol-4-sulfonic acid.

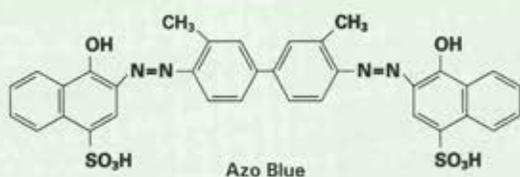


Together with croceic, naphthionic and Brønner's acids, this belongs to the group of dyestuffs intermediates developed in the early days of azo dyes and used as coupling components for diazonium salt solutions. Up to this day, they are

generally known by their "popular" names, most of which are derived from the family name of their inventor, rather than by the official chemical term.

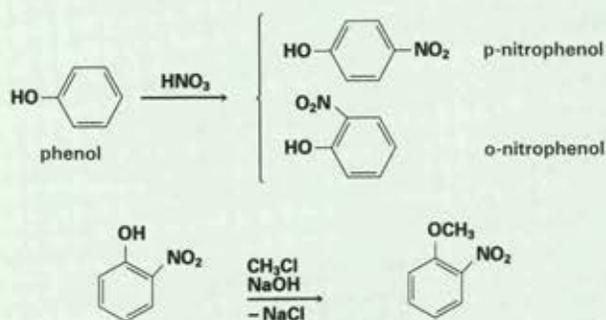
As azo dyestuffs gained in significance, the supply of the various diazo and coupling components became so important that the dyestuffs manufacturers decided to set up their own production units.

At first, the *o*-tolidine, which became known in the development of benzopurpurine, was coupled with Neville acid to produce azo blue.



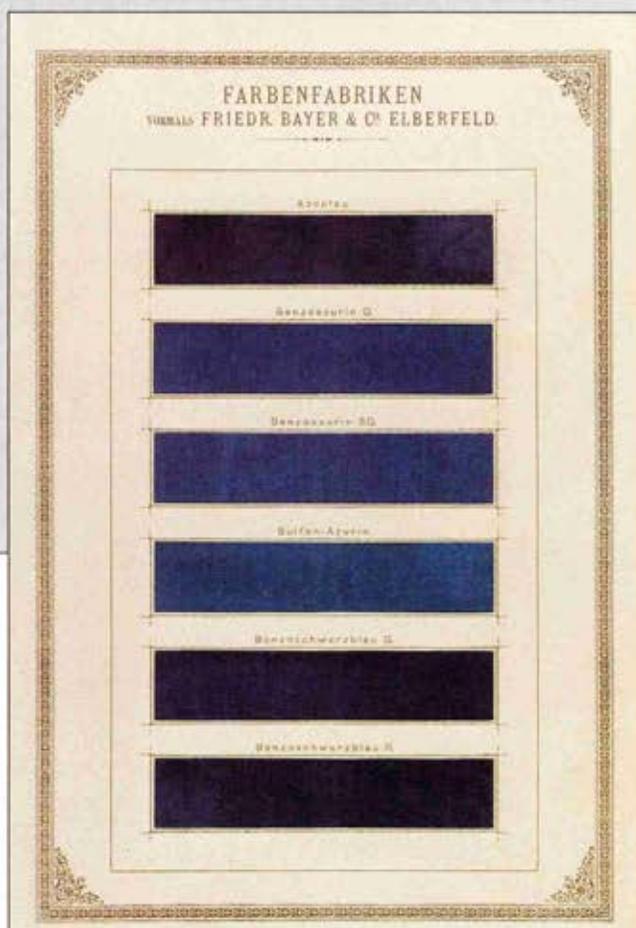
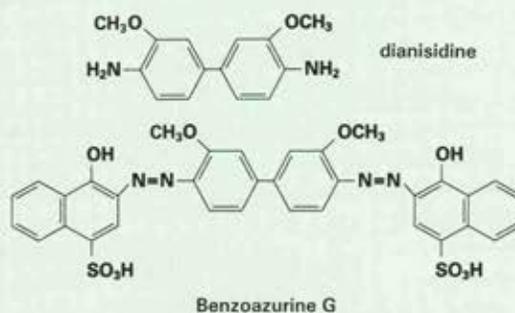
The benzidine with two methoxy groups required for benzoazurine production was obtained by the process developed by Duisberg.

The phenol is first nitrated, and then the *o*-nitrophenol is distilled out of the mixture and subsequently methylated:



The nitro group can be reduced to an amino group in which case *o*-methoxyaniline (also known as *o*-anisidine) would be obtained. It is possible, however, to carry out a process in which two molecules combine back-to-

back to produce dianisidine (the so-called "benzidine rearrangement"). When this is subjected to double diazotization and coupling with Neville acid, benzoazurine G is the result:



This color sample sheet shows a range of blues selected from the first azo dyestuffs. Among them is "Benzoazurine G." This product, which Carl Duisberg had spent so much time developing, was to remain market leader among synthetic indigos for a long time.

Benzoazurine G was brought on the market in the summer of 1886, "with a fanfare of trumpets," Duisberg recalled. The advertising promised a blue "faster than indigo."

Unfortunately, the dyers did not agree. Within a few days they were sending faded and unsightly cotton samples back to Elberfeld. Behind glass and exposed to bright sunlight, the blue took on a reddish tinge within a day, or even within hours. Bayer had, it is true, tested Benzoazurine G in wind and weather and in sunlight for three long months. The catch was that the cotton had been exposed outdoors from November to January, and had been damp for most of the exposure time. While the customers subjected the material to treatment that was admittedly rather extreme, Bayer took their complaints seriously.

Rumpff stopped his ambitious plans. The factory was not built after all, and daily production was only 150 kilograms, not 10,000. But the dye had been improved enough to make it sell.

"I wouldn't go through that bother again for thousands of marks," Duisberg wrote to a friend. And as the output of benzoazurine gradually climbed to more than a thousand kilograms per day and put his invention at the top of the list of the blues similar to indigo for many years to come, Duisberg began to lay down rules for a thorough testing of all new dyestuffs.

Bayer chronicle 1886

Systematic evaluation of patents begins.

Electric light comes to the factory yard in Elberfeld.

Company engineer Emil Thiele sets up a drafting office.

An independent Intermediate Department (ZW) is set up (below a view of the "Intermediates Department II")



The Intermediates Department is split off from the Dyestuffs Division because it has to be considerably expanded to accommodate new products.

Bayer signs an accident insurance policy for its salaried staff.

World events 1886

Working independently, both Carl Benz in Mannheim and Gottlieb Daimler



in Stuttgart build the first "motor carriages."

On June 10, King Ludwig II of Bavaria is deposed because of alleged mental illness and taken to Berg Castle. Three days later he and his psychiatrist drown in Lake Starnberg under what to this day have remained unexplained circumstances.

Heinrich Hertz discovers electromagnetic waves.

Atanta drugstore owner John S. Pemberton starts selling a concoction against headaches, fatigue and women's complaints and calls it Coca-Cola.

Americans Hannibal W. Goodwin and Reichenbach invent cellulose film.

Dyers, colorists and application technologists

The term “application technology” is missing from most encyclopedias and dictionaries. Carl Duisberg is hardly likely to have used it—or even heard of it—yet he was the one to introduce application technology to Bayer when he created the “Colorist Department.”

There was some surprise in the industry when Bayer recruited the master dyer Paul Linke in 1880. At first, Linke operated a small dyehouse with two laborers. As the product range grew, this developed into a central dyeing facility.

After the slip-up with Benzoazurine G, the firm followed Duisberg’s advice and added a dye-testing unit in 1887. It was the job of the “colorists” (no connection to the painters of the same name) to test the dyestuffs as they would be used by the consumer. Duisberg himself worked out detailed instructions for testing procedures.

The colorists soon found that their job took them outside the testing unit. They went to the customers, the dyers, textiles industry and trading companies, where they explained the properties and advantages of Bayer dyestuffs and recommended the most appropriate dyeing process. Sometimes experienced “oldtimers” had to be talked out of long-established working methods.

Apart from this consultant work, it became increasingly more important for the traveling colorists to learn the problems and expectations of the customers. Manufacturers and merchants in Europe and North America, for example, had quite different needs compared to small traders in the countries of China or India.

Getting to know the market, and especially the end-user of dyed goods, was even more essential. Ladies of high society in Paris or London had a taste quite unlike that of Russian peasants or Levantine bazaar customers. The colorists, both as technical advisors and as market researchers, became indispensable middlemen in preparing the ground for the actual sales staff.

Nor was traveling their only duty. Customers had to be supplied with advertising and special publications reporting on the advantages of Bayer’s products. In addition, it was sometimes beneficial to invite important customers to Elberfeld to see what the firm’s own dyers could achieve with Bayer products.

Colorists were having to become more versatile from year to year. As a chemist with commercial



The flash of the photographer's camera has caught the "colorists" of the main dyehouse in a slightly stilted pose. Their job is to put together the dyestuff samples for the "traveling technicians." The above dye tests have been performed on

flocks (upper right-hand corner), hanks (bottom left) and even feathers (right).

skills and a knowledge of human nature, he had to understand enough of everything to create a permanent connection between the factory and the client that transcended the individual order.

The "job description," as we would call it today, was changing all the time. Qualified staff, who spoke one or several foreign languages, were not prepared to be classified as simple colorists. Nor could they be expected to report to a single department; the sales division, for example, demanded them for work as so-called "traveling technicians."

In 1892, there were six of them. Two years later, there were 16. Their comprehensive abilities and growing experience gave them greater chances for advancement than someone who stayed at the Elberfeld headquarters.

Take Christian Hess, for example, who joined Bayer at the age of 35 after having taught at the Royal Technical College in Krefeld. He spent a number of years as a traveling technician and then took over the responsibility for the North American region in the sales department. Finally he joined corporate management and became head of dyestuff sales. Some colorists developed sales branches in Germany and abroad, or set up agencies of their own.

Whether dyers, colorists, traveling technicians or salesmen—it was often hard to determine who was what—they all were working for Bayer's "application technology" operations, even though the name was not yet in use. Even top management was prepared to go to the "front" to promote Elberfeld products to international customers.

In November 1888, Henry Theodor Böttinger went on a long journey to the Far East. In India he was able to establish contacts with the dyers' school set up by the Prince of Baroda. Böttinger agreed to put an Elberfeld technician at the school's disposal, while in return, graduates of the Baroda school began selling products in the state of Gujarat, the center of a growing textile industry. One of the teachers was put in charge of coordinating the activities.



From India, Böttinger continued on to China. In Canton, Hong Kong and Shanghai, he and his party went into the dyers' huts to show them how to use Bayer dyestuffs. Another manager, Carl Hülsenbusch, went to the Middle East in the same year and set up the first agencies there.

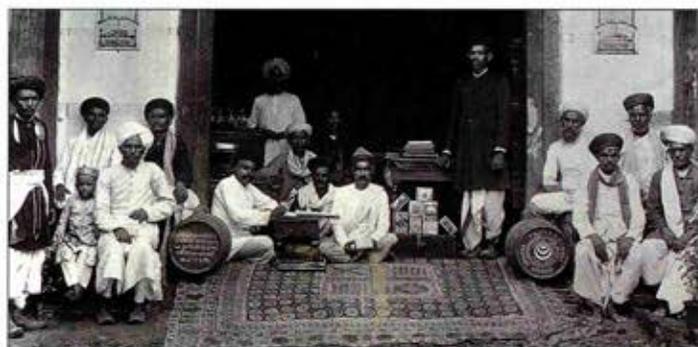
In 1923, all Bayer dyeing units were combined in the "Colorist Department." This name survived even after the company had become a diversified chemicals group with major synthetic rubber, coatings, plastics and fiber capacities.

A central synthetic rubber laboratory and a testing unit for the development of coatings and plastics were opened in the 1930s in Leverkusen. Later on, the increasing production of synthetic fibers necessitated the installation of corresponding experimental and testing facilities as a service to customers.

All of these functions could hardly continue to sail under the title "Colorist Department." The organization and its name were finally changed in 1956, when the "Application Technology Department" (ATEA) was established in Leverkusen. It soon employed a total of 2,200 people, including 160 university graduates. Similar departments were set up for the product groups in Dormagen and Uerdingen.

The new departments had a broad range of responsibilities. In addition to supervising quality control of current production, these departments were primarily aimed at discovering new applications for plastics, synthetic rubber, raw materials for coatings, textile fibers and other products. They also were concerned with determining any "gaps" in the product program. The corresponding information was then passed on to the researchers.

It was soon realized that Bayer products could be put to best use only on the basis of regular and reliable counseling of customer firms. Based on mutual trust, this service also brought advantages because Bayer had an early-warning system with regard to new developments and trends, which enabled corresponding research to be launched in good time.



This group photograph taken in 1901 shows the employees of Bayer's supply depot in Ahmadabad, India, some 300 miles north of Bombay. In the background dyestuff cans from Elberfeld can be seen under the table.

The picture on the left is from 1901 and shows staff and employees of Tientsin-based Wm. Meyerink & Co., which represented Bayer in China. Doubtless at the request of the photographer, the man with the fan was supposed to liven up the otherwise somber picture.

Small experimental laboratories were soon no longer able to handle the growing volume of work expected of them. Application technology came to need not only more staff but also more room to accommodate the additional, and newer, equipment and machinery in order to be able to test a rapidly expanding range of products according to the latest possible methods.

With the burgeoning world trade volumes of the Federal Republic of Germany as well as other European countries, Bayer had to keep adjusting to new conditions. The ATEA of 1956 was only an intermediary stage in the reorganization of the entire corporate structure.



In the bottom half of the picture above, an apprentice looks closely to see how a master dyer determines a specific color. A hundred years later (above), color samples are tested by sophisticated colorimetry and computer technology.

In 1970, when the firm carried out its first major restructuring program after the war, the individual fields of application technology were attached to the new product divisions. This new organization led to a closer link between product-oriented research, production, application technology and marketing. Coordination was improved as a result, and it gave the company an even better awareness of the trends of the market.

The 19th-century dyers could hardly have imagined how things would work in the "Colorimetry Department," created in 1965. If a customer, for example, asks for a dyeing process for a particular color on a particular fabric, he presents a sample, which is then examined by a colorimeter to determine a breakdown of the desired shade into its spectral colors. A computer takes the data and works out a number of alternative "recipes." The computer readout also states how the respective colors would look in daylight, in electric light and in fluorescent lighting in comparison with the sample.

In the next step, the dyer chooses the most suitable dyestuff combination on the basis of all this information. He then puts a sample through the colorimeter to determine whether it corresponds to the original sample, or whether the new recipe needs adjusting.

Each of today's application technology departments has a pilot plant where new developments and processes can be tested in conditions as close as possible to those of the customer.

The pilot unit for synthetic rubber, for example, allows for the production of automobile tires under the same conditions as those in a full-scale tire plant, so they can be subjected to maximum stress. This is the only way that a vulcanizing agent can be realistically tested.

In some cases, the success of new product groups has been possible only after Bayer developed a new processing method using machinery that is employed in the industry. Polyurethane raw materials would hardly have been marketable if Bayer had not joined up with "Maschinenfabrik Karl Hennecke"

of Birlinghoven in the Sieg river region in the 1950s. They set about the task of developing new technology to exploit the potential uses of this new category of engineering materials. A number of similar examples can be found in Bayer's history.

In the beginning, application technology was a question of quality control and exploring new applications for both existing and newly developed products. In the meantime, the priority has shifted, and the central questions today are concerned with what the various national markets need, what they possibly may need in the next ten years, and what products are best designed to meet their needs. Only when these criteria are clarified can the research department come up with a new product. This approach is the same for all sectors and business groups, be it pharmaceuticals or polymers; dyestuffs or agrochemicals; inorganics, polyurethanes or coating raw materials.

With the second corporate reorganization in 1984, application technology operations remained attached to the product groups. Each one now has an application technology department of its own. Of the parent company's 64,500 employees, more than 3,300 are engaged in this work.



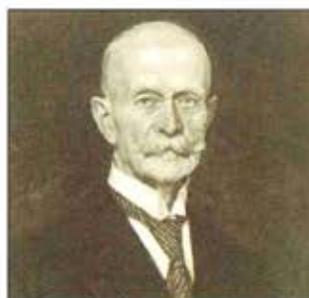
This collage shows only a fraction of the scope of activities performed in Bayer's departments for application technology, here in the fields of agrochemicals, polyurethanes and dyestuffs. The motto of the applications expert is that to stand still is to move backwards.

They are constantly searching for new ways to use the company's products.



Bayer chronicle 1887

Chemist Momme Andreesen (photo), of the "Aktiengesellschaft für Anilinfabrikation" (Agfa) in Berlin, begins work on the testing and production of photographic developer substances.



Bayer joins the local organization "Bergischer Verein für Gemeinwohl," which builds houses for workers.

Ludwig Girtler is hired to work at Elberfeld as an engineer and starts setting up an Engineering Department.

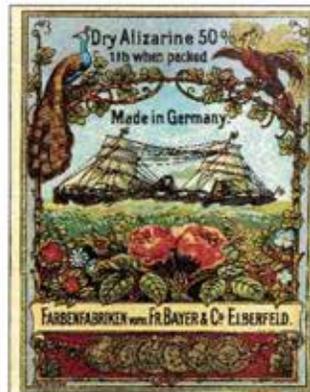
Robert E. Schmidt, who later will develop the algal dyes, joins the company.

World events 1887

The United Kingdom, Austria-Hungary and Italy sign a special alliance to guarantee the independence of the Ottoman Empire in the face of Russian expansionism. German Chancellor Bismarck signs a pact with Russia, in which the country pledges neutrality.

Gold diggers establish the settlement of Johannesburg in South Africa.

To protect Britain from foreign competition, the government introduces the Merchandise Marks Act. All goods imported from



Germany must now be marked "Made in Germany."

Emil Berliner in Washington develops the gramophone as an improvement on Edison's phonograph, and a German company, known as "Deutsche Grammophon Gesellschaft," introduces it to the market at a later date.

Phenacetin — the first pharmaceutical product

“Waste is raw material in the wrong place,” according to today’s recycling experts. This thought could have been inspired from the invention of phenacetin, which was produced from a substance that at first nobody wanted. And no one in 1888 could have imagined that the name Bayer would soon be known throughout the world for its pharmaceutical products.

The era of synthetic pharmaceuticals had not yet arrived. Pharmacists and apothecaries made their medicines from vegetable, animal or mineral materials obtained from nature. There were only a few chemically synthesized products used in medicine. Chloroform was used as an anaesthetic, chloral hydrate was used as a soporific, iodoform was used as an antiseptic and salicylic acid was known to help in treatment of rheumatic complaints.

Until 1883, the only specific agent against fever was quinine, a natural product obtained from cinchona bark. Ludwig Knorr, studying for his doctorate under Emil Fischer, discovered the first artificial antipyretic in that year. Hoechst introduced it to the market as Antipyrine.

Chance played a large role in the next pharmaceutical advancement. Strasbourg interns Kahn and Hepp had read that naphthalene was believed to have antipyretic properties. Although it had not been proved, it was supposed to bring down fevers. They were treating a dog suffering from distemper, and had a chance to see whether this theory worked in practice. They sent a messenger to Kopp’s pharmacy for a packet of the white powder. It worked—the dog’s temperature fell to normal.

Hepp sent his brother, a chemist at Kalle & Co. in Biebrich, a sample of the “miraculous” powder for examination. The chemist found out that the powder was not naphthalene at all. It was acetanilide. The pharmacist later admitted he had confused the two similar, colorless powders.

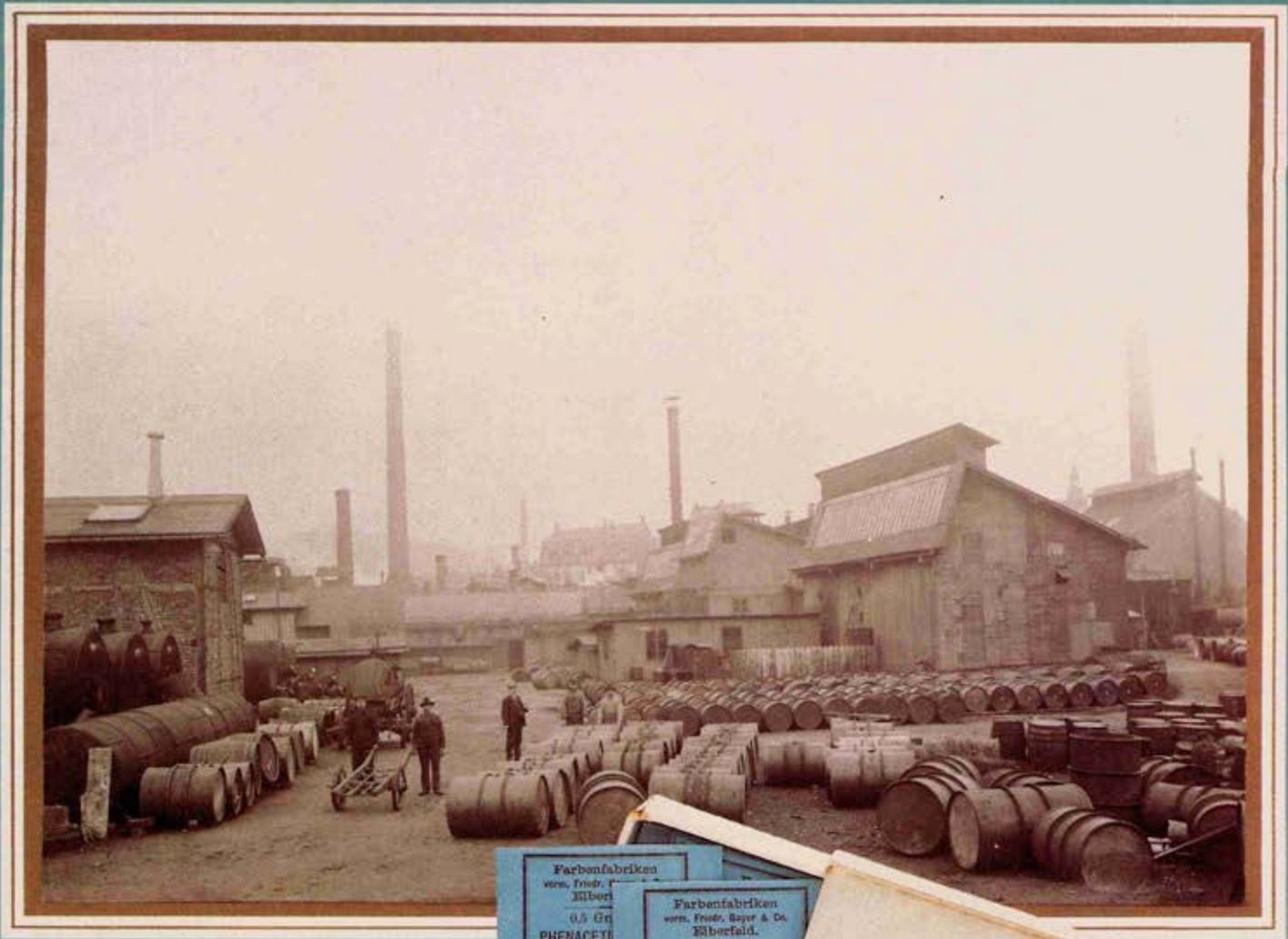
Acetanilide was subjected to animal and clinical tests. There was no doubt—it consistently reduced temperatures. Despite certain unpleasant side effects, Kalle & Co. introduced the substance to the market as an antifebrile drug.

At this time, some 30,000 kilograms of para-nitrophenol were stored in the yard of the benzoazurine plant in Elberfeld. It was the unwanted by-product of benzoazurine G. Since it was of no use to anyone, it had been stored in vats since 1886.

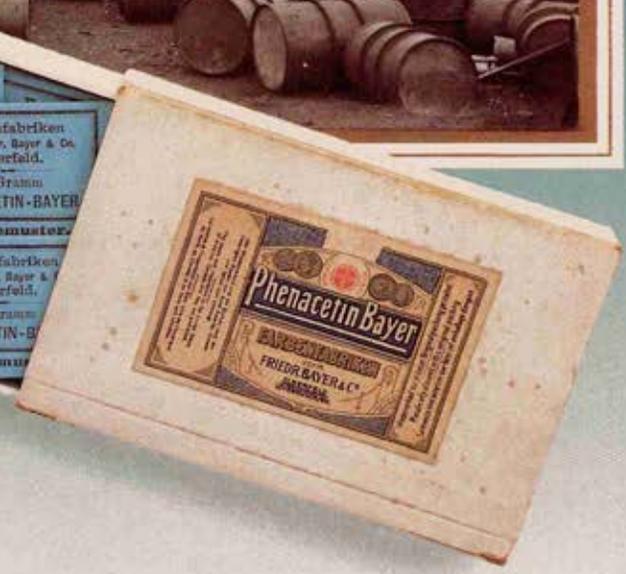
Duisberg came to the conclusion that if acetanilide could be obtained by acetylation of aniline,

Some 30,000 kilograms of para-nitrophenol were stored in barrels in the Elberfeld factory yard. Oskar Hinsberg experimented with this useless by-product from dyestuff production, and his work led to the development of acetophenetidine. Sold under the trade

name of Phenacetin, the white powder was marketed to fight against fever. The package shown here dating from 1904 contained samples for doctors. After the introduction of Phenacetin, the monopoly position of quinine appeared to be broken.

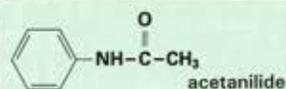


Farbenfabriken
von Friedr. Bayer & Co.
Elberfeld.
0,5 Gramm
PHENACETIN
Aerzten
Farbenfabriken
von Friedr. Bayer & Co.
Elberfeld.
0,5 Gramm
PHENACETIN
Aerzten
Farbenfabriken
von Friedr. Bayer & Co.
Elberfeld.
0,5 Gramm
PHENACETIN
Aerzten
Farbenfabriken
von Friedr. Bayer & Co.
Elberfeld.
0,5 Gramm
PHENACETIN
Aerzten



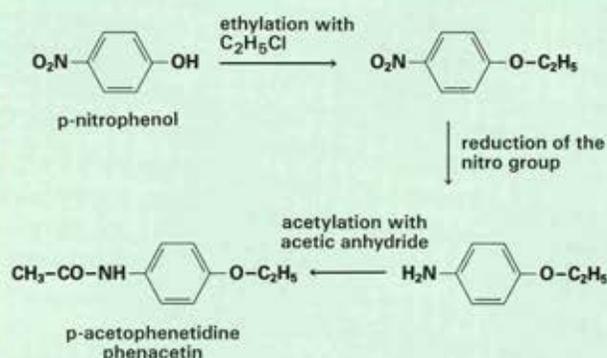
Phenacetin and Sulfonal

Kalle & Co.'s Antifebrin was pure acetanilide, a reaction product of aniline and acetic acid:



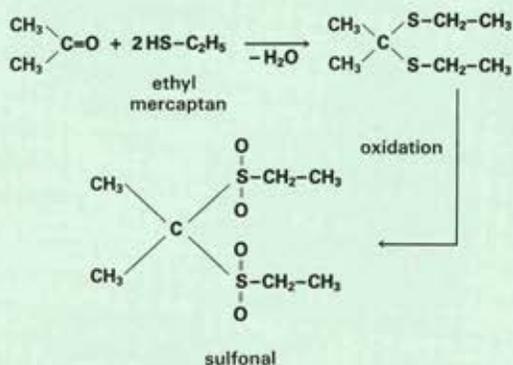
Duisberg and Hinsberg recognized that by reducing the nitro group of the waste

product para-nitrophenol, they could obtain an amine that might in acetylated form lead to a similar antipyretic.



Sulfonal is obtainable from acetone and ethyl mercaptan and subsequent oxidation.

In the case of Trional, one of the two methyl groups is replaced by ethyl, $-C_2H_5$.



a "product X" with comparable properties might perhaps be obtained from para-nitrophenol via aminophenol, a substance which is related to aniline.

Oskar Hinsberg, one of the three "Bergs" who had been recruited by Rumpff in 1883, was working for Bayer in the laboratory of Freiburg University. During the 1886 vacation, he was supposed to get some practice at the plant, but there was no vacancy for him at the time. Duisberg let Hinsberg use his own laboratory bench and instructed him to develop the "product X" idea. And he did that very thing by producing acetophenetidine.

Hinsberg took the substance back to Freiburg with him. There, it was subjected to pharmacological tests by Professor Alfred Kast. The result was that acetophenetidine worked better than Kalle's antifebrin and had fewer side effects.

Elberfeld chemists volunteered to act as guinea pigs for the new product, which subsequently was made available for clinical testing. On February 19, 1888, the board approved manufacture of the product under the trade name Phenacetin.

Decades later, Hinsberg came up with a different version of the story. According to him, he had come back from Freiburg with the idea of making "product X" from the waste nitrophenol. Duisberg denied this, but in the end the two old gentlemen agreed that their memory was no longer very reliable and that either one of them could be right. After all, the only thing that mattered was the result.

Phenacetin could hardly have arrived at a better time. In the period from 1889 to 1892, an influenza epidemic went around the world, particularly affecting America. In the United States, the product had been patented in Hinsberg's name. Phenacetin benefited countless patients.

It took 65 years before two Swiss researchers proved in 1953 that pharmaceuticals containing phenacetin could cause kidney damage if taken regularly in large quantities over a long period of time. But as Paracelsus (1493–1541) had said, "whether a substance is harmful or not depends on the dose."

The discovery that dyestuffs could be obtained from coal tar had led to the establishment of synthetic dye plants 25 years earlier. The discovery that pharmaceuticals could be produced from the same raw material now meant that the German dyestuff manufacturers were able to turn to a new and very promising branch of the still-young chemical industry.

The pharmaceutical sector grew so rapidly that improvisation was the order of the day. The first batches of para-nitrophenol were alkylated in beer bottles wrapped in damp towels to prevent breakage and placed in boiling water.

Adolf Buchloh, the head of the sample-card unit, was chosen by Böttinger to organize the packaging and shipment of the first Phenacetin samples. He was given a glass container with five kilograms of the new drug. He borrowed a gold balance from Duisberg's laboratory and weighed out 5,000 one-gram portions. Ten portions were put in little boxes and dispatched to doctors and hospitals. This packaging method proved so successful that Phenacetin was soon distributed in glass bottles containing 50, 100 and 250 grams. When the flu broke out, the plant had to work overtime, even over the Christmas and New Years holidays.

Phenacetin was sold with a red ribbon around the bottle neck. In 1888, Bayer started producing another pharmaceutical, Sulfonal. These bottles were packaged with a blue ribbon.

Hinsberg's teacher in Freiburg, Professor Eugen Baumann, had developed the soporific Sulfonal from diethylmercaptodimethylmethane. Unfortunately, this compound could not be patented, since he had published the details of his discovery two years earlier. He went on to improve Sulfonal to obtain Trional, which remained one of the most effective and well-tolerated sleeping drugs until Veronal was introduced 15 years later.

Both Trional and Sulfonal needed the sulfur compound mercaptan, a raw material with an appalling smell, which,

strangely enough, is even worse when diluted than when in its concentrated form. The inhabitants of the Heckinghausen section of Barmen, where the sleeping pills were made, complained bitterly about the "cat smell" that emanated from the plant. They collected signatures and finally forced the police to close the plant down.

Bayer moved production to the less populated Haan, some six miles away. Here, too, the locals protested against the "stink shop," and accused the chemists working there of being "stink doctors." At that, the firm moved once more, this time to a farm at Schleploh, in the near-wilderness of Luneburg Heath.

Bayer's pharmaceutical program was soon extended beyond Phenacetin, Sulfonal and Trional. Heinrich Vollmann, one of the first chemists to be engaged in pilot production of drugs with the company, later reported the conditions under which experiments were carried out on piperazine.

Duisberg had instructed Vollmann to produce an experimental quantity of 25 kilograms of piperazine. When Vollman asked about a location and equipment for the experiment, he was told to "make it in the yard."

Vollmann reminisced about this experience in his memoirs: *"I stood an old 6,000-liter vat in front of the laboratory, stowed a cylinder of sulfurous acid under the steps beside the storeroom basement, and put three acid carboys beside it to catch the overflow. When Bree, the works' fire chief, complained that everything was in the way, I simply said that I had*

Mr. Duisberg's permission. The old man just shook his head and murmured, 'Well, maybe, but it ain't at all right.'"

Bayer soon became better known as a drug manufacturer than as a supplier of any other product. Around the turn of the century, the word "Bayer" was already being used as a synonym for "medicine" in parts of the Far East.



Demand for the antipyretic drug Phenacetin was so great that the company soon decided to introduce larger packages for hospitals, wholesalers and other major customers. The product was consequently made available in 50-, 100-, 250- and even 500 gram glass bottles.

The Shipping Office serves 10,000 customers

Some of them wanted whole shipments of goods, others only a few kilograms. Each production unit stored, packaged and shipped goods on behalf of its own clients. This meant that several separate deliveries might be made in a single day to a single customer, each of them with a separate bill and, if necessary, customs declaration. This was hardly economical.



By 1888, the main office in Elberfeld was serving some 10,000 customers, not only in Europe, but as far away as Bombay and Madras; Yokohama and Shanghai; Rio de Janeiro and Vera Cruz.

The management called on Rudolf Mann to set up a "Shipping Office." On March 4, 1888, he moved into a little attic in the aniline warehouse. Mann commented about the beginnings: *"The aniline stock was in the same building as the raw materials warehouse, the latter being on the ground floor and the former a story above it. The two were joined by a long iron stairway. From the aniline storehouse, the path led over a series of iron plates to the scarlet warehouse that was also the location for a set of crushing rollers for grinding the dianisidine. Above this unit was a tiny room where there was just enough room for a high desk for my four assistants to stand at, and a desk where I could sit.*

"Our work was accompanied by the thumping of the crushers, which made the whole place shake. When the dianisidine was being ground, we often had to escape into the open air, because the fine dust brought about coughing fits.

"It was here that we started to take the necessary measures to secure for the company the advantages of a proper department, which could work out tariffs and determine the best connections to foreign—particularly to non-European—destinations."

While these five employees were investigating the best ways to get products out of the plant, there

The company is celebrating three important jubilees in 1988: Bayer is not only observing its 125th anniversary, but also the 100th birthday of its pharmaceutical operations. The above postage stamp marks the 100th anniversary of the company's shipping office on March 4, 1888.

were still problems with transporting goods inside the plant itself. In the collection of workers' letters and reports, "Nicht ohne uns," edited by Hilla Peetz (Ullstein, 1981), one quotation in particular illustrates the conditions: "No outsider can imagine what goes on in a factory of this kind. Railroad wagons used to be pulled in the plant from the sidings by particularly strong horses. In the frost and snow of winter, not even two or three of the most powerful carthorses were enough to get the 10- or 15-ton freight cars to start rolling. When it got very bad, a dozen laborers were called in to help.

"Dyestuffs and raw materials that had to be moved from one unit to another had to be pulled on a wooden litter or rolled in vats. The coal was emptied from freight cars into horse-drawn carts, which then dumped it at various points around the site. It had to be taken by wheelbarrow to where it was

finally needed... There was no sidewalk in front of the factory. At that time, most of the König Street was not even paved. When chemist Arnold Fischer came to work at the plant, the first thing he did was buy a pair of knee boots."

Those boots weren't exactly the right purchase. Another employee of the day explained: "It soon became clear that the best footwear for salaried staff, as well as for workers in the plant, was the humble clog. To realize this, you only needed a couple of pairs of good leather shoes to disintegrate after exposure to the harmless-looking but treacherous

puddles scattered around the place. When it was snowing or raining, the workers' footsteps could be seen in blue, yellow, violet or green, leading right up to the middle of town."

Describing his workplace, Rudolf Mann continued: "And with the rapid development of the firm, the time had come when the shipping office became too cramped. By the time the first move took place, six men were working there."

The relocation of the shipping office to Leverkusen took place on November 1, 1903. Rudolf Mann was elated. "The present conditions are really ideal for a shipping office. A railroad connection permits the direct loading from the warehouses, while the location on the Rhine allows shipments overseas to take place completely by water...The office has links to all corners of the world through its agents in Hamburg, Bremen, Antwerp, Rotterdam and London.



Low freight rates are guaranteed by annual contracts with shipping companies that regularly handle large quantities of our products...Arrangements with the Post Office also work very well, such as express and parcel post between Elberfeld and Leverkusen..."

Duisberg had designed the Leverkusen plant (see chapter on 1895) so that there would be no further need for horse-drawn traffic. But this took time to accomplish. A letter from around the turn of the century tells why: "The transport problem in Leverkusen was holding back development. Before the building of the narrow-gauge railroad, all traffic was

What looks like a corral in the wild West was the teamsters' yard at the old Elberfeld plant, where the horse-drawn cart played a central role. Before the turn of the century most of Bayer's transportation was by means of one or two horse-power.

by horse and cart, with up to 150 teams working daily. All horse owners and farmers had a hand in this. Freight transport was between the plant and the Manfort and Küppersteg stations. The unpaved Düsseldorf Street got in such a state that man, horse and cart often ended up stuck in the mud."

Admittedly, the Rhine ran past the Leverkusen plant, but there were still no quays or cranes to unload cargo. This meant that pyrites from Spain, for example, had to be unloaded from the barges into large baskets and carried to the bank on laborers' backs.

These reports may not have anything to do with the story of the shipping system directly, but they do prove that it was not only up to the shipping office to plan shipments, draw up contracts and process the necessary paperwork. There had to be a plan for taking the products to the customer. They also had to make sure products reached the customers on schedule.

In view of the growing importance of freight traffic, a Transport Department soon grew out of the original shipping office. This new department first employed 19 salaried staff and four assistants. By 1913, a total of 870,000 metric tons of goods were being moved—600,000 metric tons arriving at the plant and 270,000 leaving. This volume had reached 1.3 million metric tons by 1933, 3.5 million by 1953 and almost 16 million—9,000 tons of which were airfreighted—in 1986.

The technical side of this service called for an infrastructure of its own, independent of commercial interests. This meant that the operation of warehouse, works railroads, vehicle pools, loading bays, barges, and later car and truck facilities and workshops, had to be kept separate. With this in mind, the "Engineering Department V: Transport Services" was set up in Leverkusen in 1931 with the responsibility for all technical transportation duties.

§ 1.

Jeder Arbeiter empfängt bei seinem Eintritt ein Exemplar dieser Fabrik-Ordnung und hat sich durch seine Namensunterschrift zu verpflichten, sich nach den Vorschriften derselben genau zu richten.

§ 3.

Die Arbeitszeit dauert 10 $\frac{1}{2}$ Stunden für die Tagesschicht, von Morgens 6 Uhr bis Abends 6 Uhr, mit einer Pause von $\frac{1}{2}$ Stunde von 8—8 $\frac{1}{2}$, und einer von 1 Stunde von 12—1 Uhr.

Für die Nachtschicht dauert die Arbeitszeit 10 $\frac{1}{2}$ Stunden, von 6 Uhr Abends bis 6 Uhr Morgens, mit einer Pause von $\frac{1}{2}$ Stunde von 8—8 $\frac{1}{2}$ und einer solchen von 1 Stunde von 12—1 Uhr.

Das Signal zum Beginn und Schluß der Arbeit wird durch die in der Fabrik befindlichen Glocken gegeben.

§ 8.

Der Arbeiter, der während der Arbeitszeit schlafend betroffen wird, oder nicht auf seinem Platze ist, soll mit einer Strafe von \mathcal{M} 1.— belegt werden.

§ 9.

Heizer, die nicht genügend Wasser im Kessel haben, sind mit \mathcal{M} 1— $\frac{1}{2}$ Strafe zu belegen; für Unreinlichkeiten an der Maschine zahlt der Betreffende eine Strafe von \mathcal{M} 1.—.

Beim Nachsehen und Reinigen von Kesseln jeder Art dürfen keine anderen Lampen als die vorgeschriebenen Sicherheitslampen verwendet werden. Die Nichtachtung dieser Vorschrift wird in jedem einzelnen Falle mit 50 \mathcal{G} Strafe geahndet.

§ 11.

Es ist ohne besondere Erlaubnis untersagt, Mahlzeiten innerhalb der Fabrikräumlichkeiten einzunehmen, sowie Kleider und Schwaaaren in denselben aufzubewahren. Für jeden Arbeiter befindet sich in dem Esszimmer ein Schränkchen, sowie ein Haken, und dürfen Kleider und Schwaaaren nur hier aufbewahrt werden. Uebertretungen werden mit 50 \mathcal{G} — $\frac{1}{2}$ \mathcal{M} geahndet.

§ 18.

Sämtliche Arbeiter haben vor dem Nachhausegehen ihre Kleider ordentlich hinzuhängen und sind gehalten, sich vor dem Verlassen der Fabrik gründlich zu waschen und zu reinigen. Uebertreter zahlen \mathcal{M} 1.— bis \mathcal{M} 1.50.

Bayer chronicle 1888

The "Farbenfabriken vorm. Friedr. Bayer et Co." celebrates its Silver Jubilee. Its logo had already been redesigned two years ago.



Duisberg forms a "reading circle." The first members take turns in presenting a weekly lecture on their own profession "with the exclusion of any discussion on matters concerning the works."

Voluntary payments for public holidays are introduced.

Volunteer fire department takes on professional status.

Bayer chronicle 1889

Construction of the Main Scientific Laboratory begins.

A medical polyclinic is established in Elberfeld.

The first strike by Bayer workers begins on March 30. The laborers demand 21 marks weekly wage.

Carl Rumpff dies in Berlin on June 2.

Bayer chronicle 1890

Robert Emanuel Schmidt invents Alizarin Bordeaux (Red) and Alizarin Blue.

Two funds—one for wage earners and the other for salaried staff—are set up to support employees in emergencies. Each has a starting capital of 50,000 marks.



Lieven Gevaert (photo) sets up a factory for photographic paper in Antwerp, which becomes a joint-stock company called Gevaert-Photo-Producten NV in 1920.

World events 1888

This is the so-called "Year of Three Kaisers." After the death of Wilhelm I at the age of 91 on March 9, his successor Friedrich III reigns for only 99 days. On June 15, Wilhelm II becomes German Emperor.

The convention of Constantinople declares the Suez Canal international waters.

Louis Pasteur is given an institute of his own in Paris to study microbiology, immunology and infectious diseases.

World events 1889

Main attraction at the Paris World Exposition is the 980-foot-tall iron tower erected by Gustave Eiffel.

At the Paris World Exposition, Hilaire de Chardonnet unveils the first machine for spinning artificial silk, along with samples of his "nitrosilk."

Socialist parties from 20 countries meet in London to establish the Second International Workingmen's Association.

World events 1890

Chancellor Otto von Bismarck is dismissed after a disagreement with Wilhelm II.

Second International of the socialists designates May 1 (May Day) as a labor holiday.

German Workers' Protection Act limits the workday of young people under sixteen to ten hours and that of women to eleven.

Hermann Hollerith develops a punch-card tabulation machine, which is used in the United States' eleventh census.



Angelo Mosso determines that muscle fatigue can be transmitted by the blood of a fatigued animal.

Emil von Behring develops an antitoxin as the first method of passive immunization to treat diphtheria. In cooperation with Shibasaburo Kitasato, he introduces passive immunization against tetanus in the same year.

Swedish pediatrician Oskar Medin recognizes the epidemic nature of infantile paralysis (polio).

Using what would be considered authoritarian language according to today's standards, the factory rules regulated even the smallest details of day-to-day operations and safety regulations. The version shown in excerpts to the left was approved by the regional authorities in

Düsseldorf on August 2, 1888, and still prescribed the ten-and-a-half-hour day. The working day was subsequently reduced to nine hours in 1905 and eight hours in 1918.

The Main Scientific Laboratory— the heart of research

“If it were a question of setting up a scientific institute in London, we could not do any better than to take these plans and realize them in all their detail. We could then be proud of having the world’s best chemical institute for our own.”

This was how well-known English inventor and technologist Henry E. Armstrong summarized his impression of the newly built Main Scientific Laboratory in Elberfeld in a report in the magazine “Nature.”

The working conditions of the early chemical pioneers are enough to boggle the mind today. Justus von Liebig’s laboratory in Giessen was almost impossible to heat. In winter, his assistants had to wear felt slippers. He himself complained that the water used in his experiments sometimes turned to ice. Robert Bunsen worked in the refectory of an old convent in Heidelberg, storing his chemicals in an adjacent chapel.

The laboratory of the famous August Kekulé consisted of a room with a single window. He conducted his experiments in the neighboring kitchen where the chimney did not function properly. On one occasion, his assistant at the time, Adolf Baeyer, found Kekulé lying unconscious on the floor.

A total of 54 chemists were working for Bayer by 1889; 40 of them in Elberfeld, 10 at other plants and four at universities. There was no difficulty in finding chemists—but it was not easy to find room for them to work at the company.

The old “main laboratory” was a workplace made up of three small, adjoining rooms for six chemists and their assistants. Three of the chemists worked in the first room, which had a door leading to the yard. One complete wall of the second room was taken up by two large cabinets, in which Duisberg kept his dyestuffs collection. The narrow third room was shared by Duisberg, two other chemists and a “lab boy.” This was actually not even a proper room, but a covered passage to the factory. Close to the door to the yard was a further opening, leading into a narrow corridor where the glass and porcelain vessels were washed out. It was lit only by gas flames.

Shortly after his entry into the firm, Duisberg realized that the company’s successful development would depend on the establishment of a central laboratory for basic research, where a group of

A century lies between the top and bottom picture on the right. Both photographs exemplify research at Bayer. The one below shows the main scientific laboratory in Elberfeld, which Carl Duisberg designed as a series of compartments in a large open-plan

room. Each of the compartments was a separate laboratory, comprising gas, water, vacuum and compressed-air connections, a flue and 180 reagents. The principle has remained the same but equipment and methods have been adjusted to modern technology.



chemists could work on innovations undisturbed by day-to-day operational problems.

As early as 1885, he suggested building a "Main Scientific Laboratory." It took until 1889 before the young man had enough clout within the firm to be able to tell Fritz Bayer and Henry T. Böttinger that it would *"certainly cost more than half-a-million (marks)."* For those days, that was an enormous sum of money. But, as Duisberg added, *"I am convinced not only that this capital will be amortized in a very short time, but also that it will prove to be a very fruitful venture."*

The old main laboratory was pulled down and construction of the new unit started the same year. Responsibility for the building rested jointly with Duisberg and the local Elberfeld architect.

Duisberg planned all details of the new laboratory—the distribution of rooms, the position of pipes, the installation of lab benches, the shape of the cabinets and shelves; he even planned the shape and labeling of reagent flasks. There was not a single faucet, drain, vent, appliance or lamp in the lab that Duisberg hadn't carefully considered.

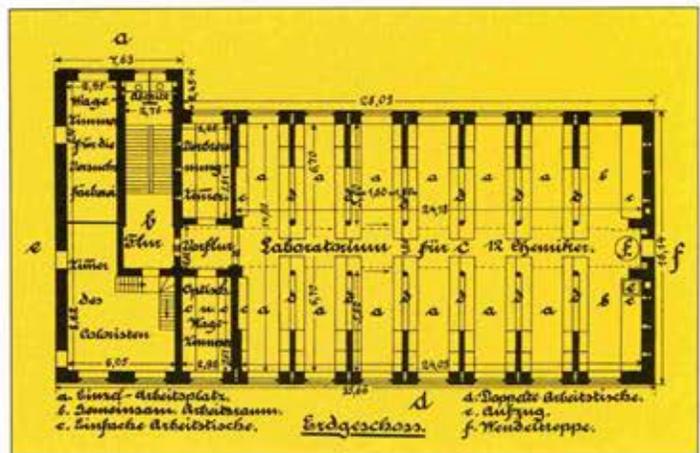
In those days, it was the common practice for each chemist to work in a separate room of his own with his lab assistant. The cramped conditions in Elberfeld had the advantage of showing Duisberg the benefits of working together and exchanging opinions. *"In order to give the chemist the opportunity of being alone with his work, while still having access to all necessary equipment, I chose the cubicle system."*

The two ground-floor rooms, each of which were approximately 78 by 52 feet in size, were thus divided into 12 cubicles. Each of these was a mini-laboratory in its own right, with 180 reagents and equipped with fittings for water, gas, vacuum and compressed air. The cubicles were separated from one another by upright shelf units. In each of the two rooms there were also two "common areas" for major experiments. These areas were fitted with connecting faucets for the supply of oxygen, carbon dioxide, chlorine, sulfur dioxide and other important gases from tanks in the cellar. Duisberg

paid particular attention to ventilation and fume outlets at the individual workplaces where gas was used. Emergency water showers were also installed in case of accidents.

On both floors there were weighing stations, combustion areas and a so-called "stink-gallery" for work involving hydrogen sulfide. A room was also available for pilot plant experiments. Another room was available for optical tests, while a special working area was reserved for electrochemical investigations.

This design was not only remarkable in itself, it was unique for its time. All details were based on the fundamental principle of "corporate invention"—or what we today would call teamwork. Duisberg had realized that the day of the solitary thinker in the ivory tower would soon pass. With some exceptions, inventions would in the future be the result of a group effort.



As a team leader, Duisberg had little time for experiments of his own. He said later of this period, *"I simply pushed my ideas like cuckoos' eggs underneath the others to hatch."*

As head of the laboratory, he introduced the principle that inventors had a contractual right to a three percent royalty. *"This is how it came about that some of our inventors have an annual income of up to 50,000 marks,"* he later said. There were times

Yesterday's laboratory: the above diagram shows Duisberg's plan for the ground floor of the Main Scientific Laboratory, with clear distinctions between the self-sufficient lab compartments.

Today's laboratory: CAD (Computer Aided Design) is the magic word for this program that incorporates all possible elements and is able to be adjusted according to the individual wishes of each research worker.

when three patents in a single day were applied for as the fruits of research in the Main Scientific Laboratory.

As ambitious as the planning and building of the Main Scientific Laboratory undoubtedly were, it was soon insufficient to keep up with the growth of the company. A larger unit was built in Leverkusen in 1913. It was replaced by a new building in 1953, which was again expanded a decade later. The Uerdingen plant was given a main scientific laboratory of its own.

There had been no difficulty in the beginning differentiating between university and industry research strategies. The universities carried out basic research, while industry focused on product research. There had always been cooperation between the two.

In 1963, Otto Bayer, head of the Main Scientific Laboratory from 1934 to 1951, member of the Bayer Board of Management for many years and one of the "Grand Old Men" of the chemical industry, spoke of this relationship in an address at the company's centennial celebrations: *"The borders between basic and applied research are, in most cases, no longer clear-cut. Experience has shown time and again that most problems, as theoretical as they may seem at first, lead to an extension of knowledge that have directly or indirectly, sooner or later, found a practical application..."*

"The main difference between university and industrial research is no longer in the level of the work involved, but rather in the fact that academic researchers, unlike those in industry, are completely free in the choice of their subjects because business aspects do not have to be taken into consideration. Whatever the case, the greatest satisfaction a research worker can have is the same: treading on new scientific ground..."

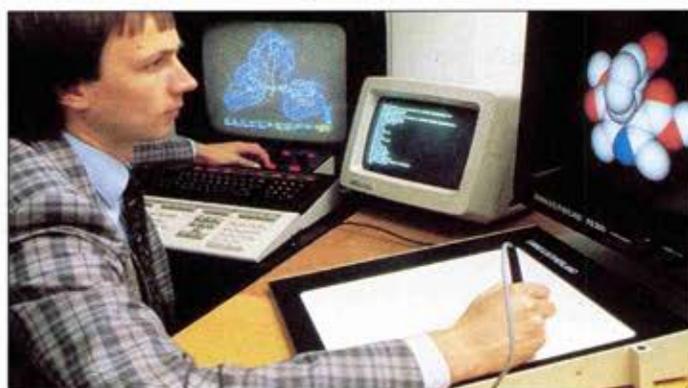
Within corporate research itself, there was a growing need to separate short-term, specifically aimed and market-oriented research from long-term, technology-oriented "central" research. Today, the individual business groups of the Bayer

organization function as profit centers. This means that they have to develop and market their own products. As a result, each business group needs its own research and development facilities that—by keeping a close eye on the market—are able to expand the product range and improve existing products.

In addition, a large number of scientists work in "Central Research and Development." This Service Division has the task of opening up completely new product areas, not only with the help of chemistry, but also using biology, physics and technical disciplines. These broad-based research efforts are particularly important, because experience has shown that real progress today is achieved in an interplay between disciplines.

Central Research and Development can only be effective if it is able to offer Bayer's Business Groups solutions to problems that they cannot work out themselves. The idea here of the company is that business groups should not have to turn to universities and research institutes outside the company in order to get the top quality research assistance they need.

Today, Bayer's Central Research and Development is divided into three areas of responsibility: chemical research, technical development, and research and development (R&D) services. The six main departments of chemical research are involved in basic research; investigating active agents; and research



The computer has also become an important tool in the search for new, custom-made pharmaceuticals. "Drug design" is an accepted part of research and development today. The screen not only conjures up space-filling atom models like the one shown above, but also permits

the superimposition of the structures of various substances for purposes of comparison and alteration.

in intermediates, polycondensation, auxiliary products, fibers and polymers. It is also concerned with biotechnology.

Technical development deals with process and engineering technology. Research and development services include central analytics, scientific information and documentation, as well as a department for logistics. Altogether about 2,400 people are employed in Central Research and Development today.

In 1968, Bayer spent about 300 million marks on research. One could hardly have imagined in those days that by 1978 expenditures would reach one billion marks, or that they would hit the two billion notch by 1986.

On the other hand, who could have predicted that the chemical industry would venture into such scientific fields as genetic engineering, or that 7.5 percent of all Bayer staff would be employed in research by the 1980s? They work in the research facilities of the business groups and of the Central Research and Development Service Division, as well as in those of the domestic and foreign subsidiaries and affiliated companies. Not even with his foresight would Duisberg have envisioned the diversity and tempo of modern development.

Our times are characterized by growing demands that have to be met within a tight framework of regulations. It has become more and more difficult to introduce new and successful specialties. The development of a new product, particularly in the health care and agrochemical sectors, now takes an average of 10—sometimes even 15—years.

Who can tell at the start of a research project how the world will look and what it will need—or no longer need—in 15 years' time? With this in mind, it is even more impressive that a share of some 40 percent of Bayer sales is contributed by products that were developed by the company itself. These are the fruits of Bayer's modern research.

Bayer chronicle 1891

Bayer buys the alizarin red factory of "Ultramarin-Fabrik Dr. Carl Leverkus & Söhne," plus additional land on the right bank of the Rhine near Wiesdorf, the site of modern-day Leverkusen. (The picture shows a view of Dr. Carl Leverkus' plant in 1880).



Bayer enters a new field by starting production and marketing of photographic chemicals.

The "reading circle" is upgraded to a "Chemists' Conference," where chemists report every four weeks on innovations in their own fields.

Bayer chronicle 1892

Antinonin is put on the market as the first synthetic insecticide. It is used against the nun moth caterpillar.

Statistics Office is established. It was originally a subsection of the Bookkeeping Department that was first set up in 1886.

World events 1891

The Republic of Brazil, which came into existence in 1889, passes a Federal Constitution and now consists of 20 states.

Pope Leo XIII issues the first of the "social" encyclical letters.

On March 18, the first telephone connection is installed between London and Paris via a Channel cable.

Otto Lilienthal flies over 80 feet with a glider of his own construction (illustration below).



Eduard Pflüger determines that the physiological basis of obesity is due to an excessive intake of fat and carbohydrates, which are subsequently retained in the body.

World events 1892

Agreement is reached in Geneva on nomenclature rules for chemical terms, whereby the structure of a compound can be determined from its name.

Two typewriters — for management use only

Robert Leyendecker had joined Bayer at the age of 14 as an unskilled worker. Thanks to his good handwriting, he was promoted to the central office by the time he was 27.

He later reported what his life was like as a 19th-century clerk:

"Work began at 8 a.m. and ended at 8 p.m., with a two-hour break for lunch. The offices were lighted by oil lamps. The main office employed some 12 correspondence clerks, six to eight invoice clerks and five to six office boys to serve them and do odd jobs. We had three managers and four head clerks, but only two typewriters, which were for the use of management only.

"All letters and bills had to be written by hand in copying ink. Obviously, importance was placed on fine, clear handwriting. All documents had to go into a copying-bath or pass through a copying-press in the form of loose sheets; we had six such presses.

"It frequently happened that a letter or bill was spoiled and had to be rewritten because the copying-rag had been too wet or not uniformly moist.

"In the office, we had a fireproof safe where all main ledgers, account books, copying-books and the like were deposited. They had to be taken out every morning and returned every evening.

"All in all, we were a harmonious team, a fact promoted by the possibility of enjoying a drop of beer from time to time. The reason for this was that one of the top executives was on the board of two breweries. Since he believed in increasing their sales, a canteen was set up here. Profits went into the company's sick fund.

"So as not to disturb the employees at their work, everything was made as easy as possible. Every employee was issued a beer stein. The works security guard at the entrance of the plant was in charge of 'beer coupons' worth ten pfennigs each, which entitled the holder to a beer or a snack consisting of a slice of gray bread with a piece of sausage or liverwurst.

At a given time every morning and afternoon, the security guard sent his lad into the office with a wire basket to walk along the desks calling, 'Who wants a beer?'"

There were only two typewriters in Bayer's main office in 1893; both of them were reserved for management use. The bulk of letters, bills and reminders to pay were handwritten with copying ink at writing stands, put through a copying press and then filed in "copybooks."

Most of the young people on the inset picture were doubtless very pleased about the advantages resulting from the advent of the typewriter (here the keyboard of an old-time Underwood).



Bayer chronicle

1893

World events

1893

The heads of the branch offices and the "traveling technicians" are invited to annual "Christmas Conferences" in Elberfeld. According to Wilhelm Kramer of the Shipping Office, "They were all there—Reinhard Muurling from New York, Max Stempel from Shanghai, Werner Otto from Vienna, Jean Kahrés from Paris, Otto Akermann from Norrköping, Artur Silbernagel from Basel, Anton Keuter and Dr. Wilhelm Löw from Moscow, Prochaska from Prague, Boeckelmann from Aachen, Max Petzold from Zittau, Mackensen from Düsseldorf, Otto Zwirschky from Reichenbach, Dr. Eugen Setzer from Stuttgart, Georg Oelsner and August Oppertshäuser from Lodz, and many more."

Topics of the Chemists' Conference are extended to include electrochemistry.

Haarmann & Reimer of Holzminden, to be taken over by Bayer in 1953, introduces an artificial violet fragrance to the market.

Standard time is introduced in the German Republic on April 1. It is based on solar time at the 15th degree of longitude east of Greenwich.

Corinth Canal in Greece opens on August 6. It is almost four miles long and over 70 feet wide. With a depth of over 26 feet, it cuts through a hill which at its highest point is more than 260 feet tall.

German chemical industry is represented at the Chicago World Fair with a joint exhibit of 73 companies.

Carl Wehmer discovers that certain microorganisms have the ability to transform sugar into citric acid. His discovery forms the basis for the subsequent industrial production of citric acid.

In Springfield, Massachusetts, on September 22, Charles Dureya is the first American to drive a car. In Detroit, Michigan, Henry Ford is working on his first engine.

Heidelberg astronomer Max Wolf photographs 52,000 stars with a one-hour exposure. He increases this to 108,000 stars in three and 197,000 in 13 hours.

Venturing into inorganic chemistry has its price

Sulfuric acid was—and still is—one of the staples of the chemical industry. Bayer had been buying this important raw material before management decided to set up an Inorganic Chemicals Department of its own in Leverkusen. It was to produce not only sulfuric but also nitric and hydrochloric acid. Production did not turn out to be easy.

Bayer had been obtaining its sulfuric acid from the Rhineland-Westphalia Sulfuric Acid Syndicate under a contract that expired in 1892. It would have been easy to simply extend this, but Bayer felt that the volumes it bought over the years had risen in price to such an extent that they could demand a rebate. The syndicate, which had a monopoly position, thought differently and refused.

Opinions were divided in Elberfeld as to how the company should react. Friedrich Bayer and Carl Duisberg were in favor of independence from an outside supplier, while Henry T. Böttinger and Hermann König warned that this would cost more. The decision came out in favor of presenting the syndicate with the ultimatum: a price cut or else termination of the contract.

Much to the surprise of the Bayer managers, the syndicate did not give in to the threat from Elberfeld. Nothing remained for Bayer to do but make the sulfuric acid in house—as BASF and Hoechst were already doing.

In the narrow Wupper Valley, it would have been hard to find available room for facilities of this size. However, land directly on the Rhine had been bought by Bayer. The previous owner, Dr. Carl Leverkus, had called the factory site "Leverkusen." To make things easier, Bayer decided to keep the same name.

The site on the banks of the Rhine offered a great advantage to the plant. For one thing, such raw materials as the pyrites coming from Spain, Portugal, Greece, Norway or Cyprus via Rotterdam in the Netherlands could be delivered directly to the plant by river barges.

Word soon got around of Bayer's plans to manufacture sulfuric acid. Belgian specialist Gustav Delplace from Namur offered to build the unit, asking for a share in the expected earnings. Bayer's Supervisory Board and top executives turned this offer down and appointed an expert from Saxony.

The acid factory was built in no time; it started work on December 3, 1894. Since the decision had been made to manufacture other inorganic base

chemicals as well, hydrochloric and nitric acid units were added, which started production the following year.

The sulfuric acid plant worked according to the lead chamber process, which had been in use since 1794. This production method may have proved itself over the hundred intervening years, but it was not without its snags.

The trouble was that Bayer had no foremen or workers with any experience in the sulfuric acid field, nor did the responsible executives know how to deal with it.

Duisberg was very aware of this, particularly as he had strongly supported the company's entrance into the heavy chemicals sector. He admitted later: *"We understood nothing about buying pyrites or selling roasted ore. There was one breakdown after another. Even the so-called 'vessel' of the lead chambers occasionally collapsed ... All these setbacks meant that the Inorganics Department, which had to supply other parts of the company with its products at syndicate prices, ran at a loss in the first five years."*

The firm called on Professor George Lunge of Zurich, a specialist in this field, for a report. The professor's comments were scathing: nothing short of a complete reconstruction would help.

With their hats in their hands, the Bayer executives went back to the Belgian they had initially turned down. Delplace stayed with the lead chamber process, but totally redesigned—and in part rebuilt—the plant.

In the 1870s, Professor Clemens Winkler of the Freiberg Mining Academy in Saxony had succeeded in developing the catalytic process using platinum

as a catalyst for the production of sulfuric acid. BASF had bought the rights to this process and had Rudolf Knietsch convert it into an industrial

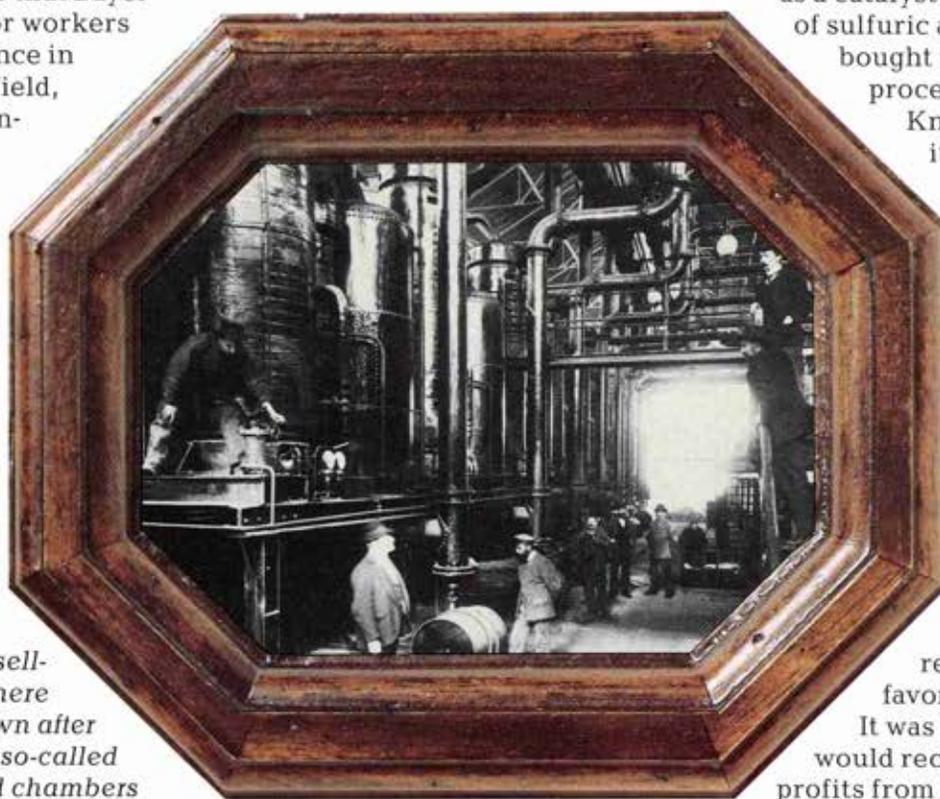
scale project. Both Bayer and Hoechst tried to obtain a license from BASF, but the latter demanded the sum of 4.5 million marks—exorbitant by 1897 standards.

After long negotiations, the companies reached more favorable conditions.

It was agreed that BASF would receive part of the profits from the sale of oleum (also known as fuming sulfuric

acid), plus regular licensing fees. The first installment of half a million marks was paid that year.

A new factory went up beside the old one, and the two units started working parallel to one another. Bit by bit, the firm got over the difficulties. The plant started to make money as additional types of and applications for sulfuric acid were found. New factories were built in 1908 in Uerdingen and in 1917 in Dormagen.



In Leverkusen, as elsewhere, sulfuric acid was first produced in the lead-chamber process. This method was difficult, however, and breakdowns occurred frequently. At the Leverkusen, Dormagen and Uerdingen plants of today, sulfuric acid is made

by the so-called double-contact process, which has decisive advantages from an ecological point of view.

The most important acids

Sulfuric acid, hydrochloric acid and nitric acid are among the first compounds to be mentioned in school chemistry lessons. There are, of course, many other acids, such as phosphoric acid, acetic acid or benzoic acid, to name only three.

By far the most important acid for the chemical industry is sulfuric acid, which is consequently produced all over the world in huge quantities.

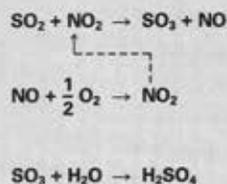
Production is based on sulfur dioxide, SO_2 . This is itself obtained in the initial process by the roasting of a highly sulfurous iron ore such as pyrites, FeS_2 , in large rotary kilns or fluidized beds, whereby the sulfur is separated off as SO_2 . The remaining ferrous oxide can then be smelted.

The modern process, however, obtains SO_2 by the burning of elementary sulfur:



Sulfur dioxide is a gas with an extremely penetrating odor in which sulfur is present in quadrivalent form due to its combination with two bivalent oxygen atoms.

For the production of sulfuric acid it has to be further oxidized to SO_3 with hexavalent sulfur. In the first processes, this took place solely by the so-called lead chamber process, lead being resistant against sulfuric acid corrosion. In the presence of water, nitrogen dioxide and air, SO_2 converts into SO_3 :



The nitrogen dioxide acts here as an oxygen carrier. The separation, purification and concentration of the resultant sulfuric acid necessary in this process are relatively troublesome and not ideal from an ecological point of view.

Today the industry has gone over, almost without exception, to the more elegant contact process, in which the SO_2 is oxidized under the influence of a vanadium pentoxide-based catalyst. Here too, it was some time before a satisfactory answer could be found for the removal of residual SO_2 from waste gases.

This problem was not solved until the introduction of Bayer's double-contact process in 1964, which made modern sulfuric acid ecologically unobjectionable.

In its pure form, sulfuric acid is a heavy, oily liquid with a boiling point of 338° Celsius. It can absorb large quantities of surplus SO_3 , in which case it becomes "fuming sulfuric acid," or "oleum." In organic chemistry, it is used primarily for the introduction of sulfonic acid groups into aromatic systems.

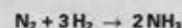
Hydrochloric acid plays a much less significant role in industry. It can be obtained simply from salt (sodium chloride) and sulfuric acid:



Today, the hydrochloric acid used in the company is almost exclusively gained as a by-product from chlorination and other processes. The only kind that is specifically produced is the chemically pure acid that is attained by burning hydrogen and chlorine.

Nitric acid, HNO_3 , has a strong oxidizing effect in

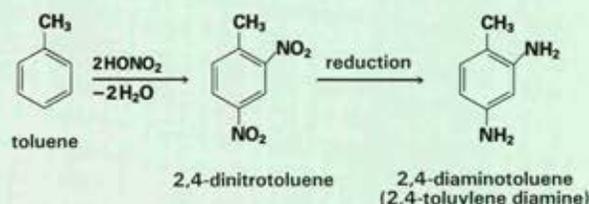
addition to its properties as an acid. In former days, it was obtained from Chile saltpeter, NaNO_3 ; or potassium nitrate, KNO_3 , and sulfuric acid. Today, industrial scale production is usually via ammonia, which, when produced by the Haber-Bosch process, is made from nitrogen and hydrogen under pressure with the aid of efficient catalysts:



In a second stage of the process, the ammonia—in the presence of air and also with the aid of catalysts—is burned into nitrogen oxides, which are themselves then converted into nitric acid.

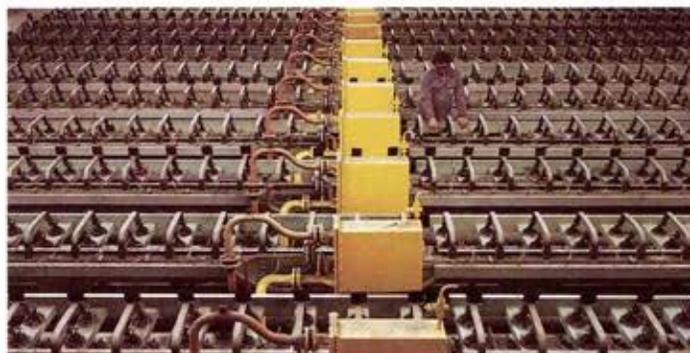
In organic chemistry, nitric acid is used mainly for the introduction of nitro-groups into aromatic systems, which are then reduced to aminogroups in subsequent reactions.

Example:



Derived from the group of halogens, chlorine is of particular importance for the chemical industry. It is made in Leverkusen electrolytically, i.e. by splitting salt that has been dissolved in water into chlorine and sodium hydroxide.

The latter product is used in a whole range of processes in the chemical industry.



By the time I.G. Farben was set up in 1925, Bayer had become the biggest sulfuric acid producer on the Continent. And by the early 1960s, Bayer was turning out almost a million tons of H_2SO_4 per year, one-third of the total production in the Federal Republic of Germany. Bayer was responsible for two percent of the entire world's output.

Despite often unpromising prospects at the beginning, Bayer had become not only one of the biggest producers, but also one of the most innovative.

Its work in the sulfuric acid field was crowned by the development of the "double-contact" process with its decisive ecological advantages (see chapter on 1964).

In the early days, the two other acid factories also ran into difficulties. The hydrochloric acid plant did not work trouble-free until 1898.

Fifty years later, chlorination processes and the production of isocyanate were yielding more hydrochloric acid than needed. In order to make use of the surplus, 30-percent acid was broken down by electrolysis into chlorine and hydrogen, both of which were required elsewhere. Bayer was the first producer in the world to build a large-scale facility of this kind. Its existing acid plant was then closed down.

Nitric acid production was scrapped as early as 1918, after BASF's Haber-Bosch process had shown a totally new way to obtain ammonia in large quantities from atmospheric nitrogen and subsequently oxidize it to nitric acid.

Initially, Leverkusen was of interest only in that it provided space for facilities to be moved out of the now-crowded Elberfeld site. The first plant to relocate was the anthracene purification unit; the second was the anthraquinone facility. The first dyestuff to be produced in Leverkusen was diamond black.

There was certainly no lack of space; a production unit could be built anywhere, with as yet no thought as to what the site would look like afterward. But that upset Duisberg's sense of order and organization. As early as 1894, he was working on a memorandum aimed at a methodical and long-term design of the works.

Bayer chronicle 1894

After becoming head of research, Duisberg now introduces Engineers' Conferences in addition to those meetings for colorists and chemists.

Pharmaceutical Department introduces a new product that is effective against diarrhea. The tanniferous "Tannigen" does not upset the stomach because it first takes effect only after reaching the intestine.



The first dyestuff production plant—for Diamond Black—is transferred from Elberfeld to Leverkusen.

World events 1894

China and Japan go to war over Korea. Japan wins and acquires Formosa and the Pescadores.

In Paris, Jewish officer Alfred Dreyfus is banished for life for alleged espionage in a scandalous case based on forged documents.

The United States experiences its first economic crisis. Some 15,000 firms go bankrupt, three million people are unemployed, and 750,000 are on strike.

London's Tower Bridge is opened to traffic after an eight-year construction period.

Baron Pierre de Coubertin founds the International Olympic Committee in Paris to revive the Olympic Games of classical Greece.

Japanese bacteriologist Shibasaburo Kitasato and Swiss specialist for tropical diseases Alexandre Yersin, working independently and simultaneously, both discover the pathogenic agents responsible for the plague. Waldemar Haffkine performs the first cholera inoculation.

First car race takes place between Paris and Rouen. Winners are two French cars with Daimler engines. Top speed: 10.5 mph.

The brilliant plan for a chemical complex

“A separate site is to be reserved for each plant, so that it is not necessary to move a production unit or to set up a similar one for the next fifty years...”

This is an excerpt from Carl Duisberg's "Memorandum on the Establishment and Organization of the Farbenfabriken Works in Leverkusen," of January 1895. He goes on to say, "All buildings are to be laid out so that they can easily be extended in one or preferably two directions."

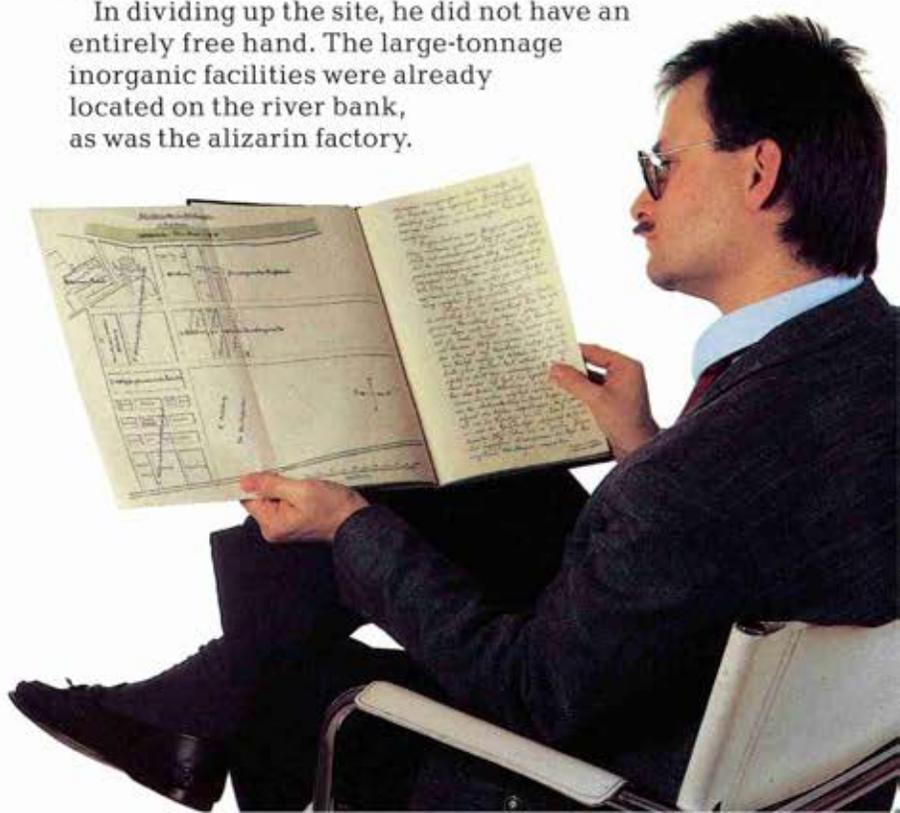
Virtually everything connected with the creation of Leverkusen is linked with the name of Duisberg. His remarkable contribution to the project formed the basis for what was to become a legend. Duisberg's biographer Hans-Joachim Flechtner wrote:

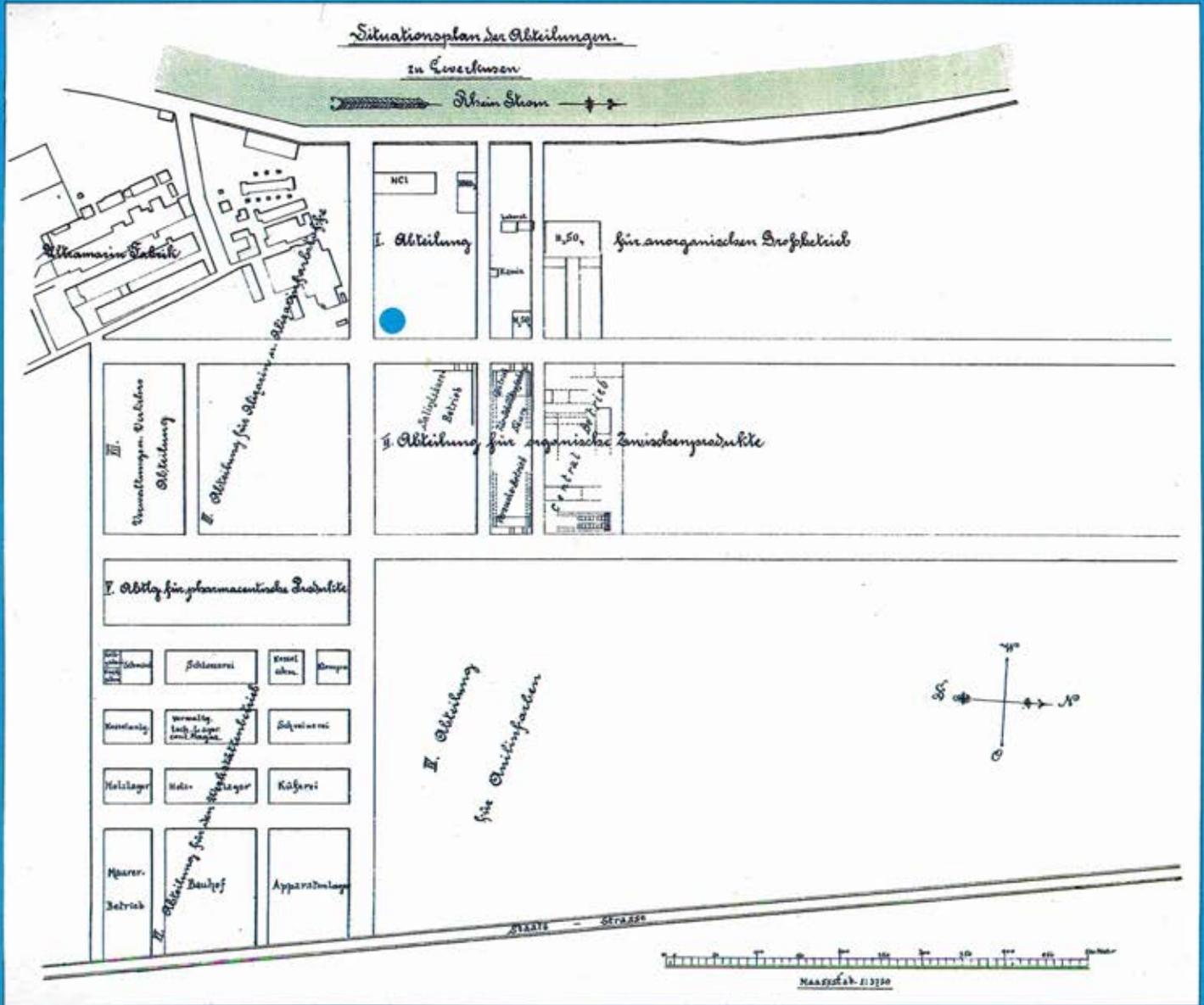
"The first impression of Carl Duisberg's life and work is one of abundance—or even overabundance! The scope of his activities is so broad, the amount of work that came his way, and which he constantly and voluntarily added to, is so alarming that it is hard to believe that this much could fit into a single existence. Only somebody who lived life to the fullest and spurned exhaustion could take on this sort of workload and not just manage, but excel, stamping every solution with his own personality."

Duisberg found the time to write his historic Leverkusen memorandum thanks to a coincidence. That Christmas, there was deep snow in Elberfeld. Duisberg's five year-old son Carl Ludwig wanted to go sledding. The older Duisberg joined in the fun and sprained his ankle so badly that he had to take time off work. So he sat down at home and worked on what could be called a "memorial."

With 24 pages written in the course of only a few weeks, Duisberg laid down a simple and convincing concept for a chemical plant that was to hold good for decades.

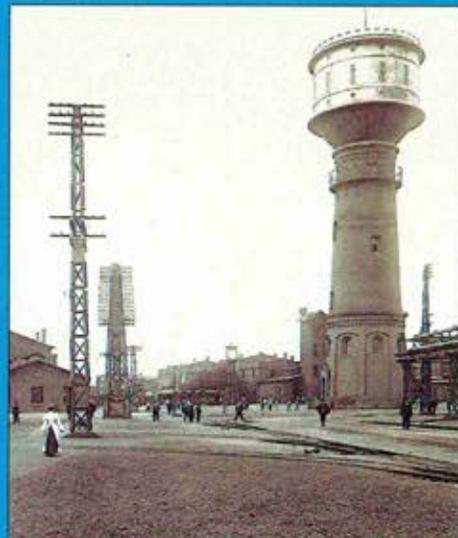
In dividing up the site, he did not have an entirely free hand. The large-tonnage inorganic facilities were already located on the river bank, as was the alizarin factory.



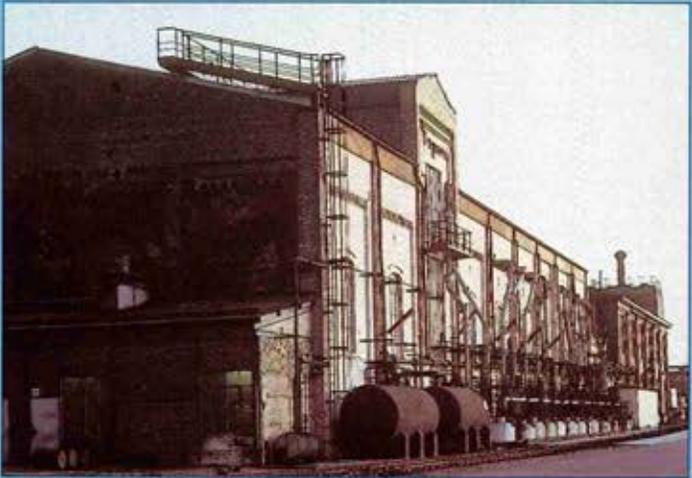
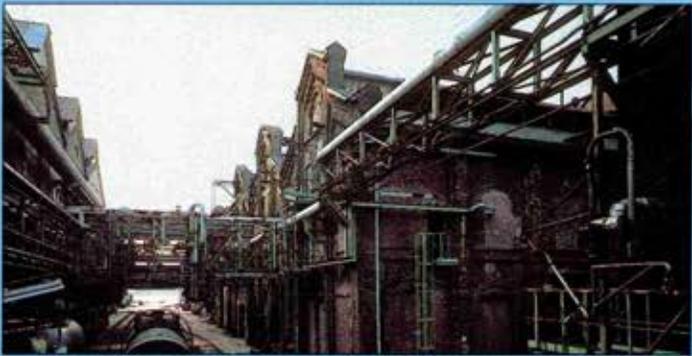


Nothing was left to chance when the new plant was being built on the banks of the Rhine. While laid up with a sprained ankle, Duisberg had drawn up a "memorial" laying down all the salient points. On the opposite page a member of the staff of Bayer's archives is shown

with the historic document. The photograph of the water tower seen on the right dates from the turn of the century. Its position is marked on Duisberg's plan with a blue spot. Still in use today, the tower is a reminder of days past (see above).



The brilliant plan
for a chemical complex



This was not a drawback in his eyes, because the raw materials for the acid plants were delivered by water. Left to himself, he would have positioned these units exactly where they were.

He split up the remaining area into blocks, working inland in keeping with the production process. His guiding principle here was that production-related products should be situated in adjacent units. Each department was thus apportioned a block of its own. The lots were split up by straight service roads, the main thoroughfares 30 meters and the subsidiary roads 15 meters across.

The roads had to be so broad—the equivalent of almost 100 and 50 feet, respectively—that they could handle an ever-increasing volume of traffic. At the same time, this breadth would allow railroad cars to run along the main roads on standard-gauge tracks. A narrow-gauge network was to be laid on the subsidiary roads for use as an on-site railroad able to maneuver curves and run from one factory to another.

Special freight wagons were to be constructed to permit transfer from one gauge to the other without operational difficulties. Cargo was to be packed into crates, which could be handled by cranes. The crates could also serve as storage units to obviate unnecessary reloading. The rule laid down in the memorandum was that wherever possible, machinery was to be used to save on human labor.

Duisberg also gave detailed instructions with regard to size, shape and construction of the buildings. He even went so far as to specify the thickness of walls and the installation of platforms.

If the factory buildings looked like a collection of basilicas, complete with gables and high, glazed roofs, this was only in keeping with his instructions: *"The buildings are to be in good taste but without external ornamentation."* The height of the gables was needed for the equipment and the skylights for adequate illumination.

In his demands for overall standardization, Duisberg was far ahead of his time. He called on the engineers and architects to *"enter into discussions*

before precious time is lost to determine how to institute standard sizes and measurements applicable for all equipment used throughout the works. We should definitely and as soon as possible introduce standards for all pipes, faucets, valves, threads, screws, boilers, vats, tanks, etc."

In another strike of genius, he decided that all equipment and machinery should be installed in such a way that they could be approached from all sides. In case of repairs, it would thus not be necessary to move them.

At the same time, all units intended to serve the whole complex, such as the ice plant, the steam boiler installations and the repairs shops, were to be centralized. This did not, however, apply to the generators, because of the varying power requirements of the individual production units and the loss of power by transmissions running idle over long distances.

"Arrangements should facilitate the introduction of new production units and enable the manufacture of products stemming from identical or similar processes, and requiring identical or similar apparatus, to take place on the same premises without major rebuilding," Duisberg wrote. He was already able to visualize what these products would be. He listed 100 different intermediates, plus 40 "prospective" products for the inorganics department.

The memorandum earmarked seven major departments for Leverkusen. The transfer of two of them was not considered urgent: the Pharmaceuticals Department, should this be moved to Leverkusen, would only need a little space, he assumed, while the administration could remain in Elberfeld until the Leverkusen plant was completed, *"in at least 15 to 20 years"* (this estimate was quite good; the administration finally relocated to Leverkusen 17 years later in 1912).

The individual departments were to be self-contained units not only in respect to their buildings, but also in their organization. *"The management of the separate departments depends on adequate departmental centralization offsetting the decentralization*

Even today individual facades, buildings and interiors bear witness to the early days of the Leverkusen plant. Among these are the sulfuric acid plant (top of left page) and part of the oldest power station (bottom right). The large picture shows Leverkusen as a building site, and

below it the first building to be constructed after the property had been purchased from Carl Leverkus. Today, this building houses, among other things, a plant for the purification of raw anthracene, an important starting material for dyestuff intermediates.

inherent in the division of the departments into individual sub-departments and units."

This statement, one of the few complicated sentences in the memorandum, was later echoed in Duisberg's concept of what he called "decentralized centralization." Every main department was in his view to operate as a separate factory and to be "led by an energetic departmental head fully conversant with the entire scientific and technical spectrum."

The head of the engineering section, Ludwig Girtler, was put in charge of the plant's construction though Duisberg could say with some justification, "I will personally manage the building of Leverkusen, where no stone is placed upon another without my approval."

This personal approval occasionally meant that Duisberg was prepared to diverge from the guidelines laid down in his own "memorial." Thus, the main thoroughfares were built 35 meters, not 30 meters wide. They were also paved, although at first Duisberg had considered this unnecessary. He foresaw that horse-and-cart traffic in the plant would cease. This, in fact, took time.

On the other hand, it turned out that standard-gauge rail tracks were laid along only a few of the main roads after all, because most transport within the complex was by the narrow-gauge system. To make up for all this, however, the works put wagon carrier trucks to use, i.e. rolling platforms with standard-gauge fittings mounted on narrow-gauge chassis that permitted freight cars of the national railroad to be taken into the works without reloading.

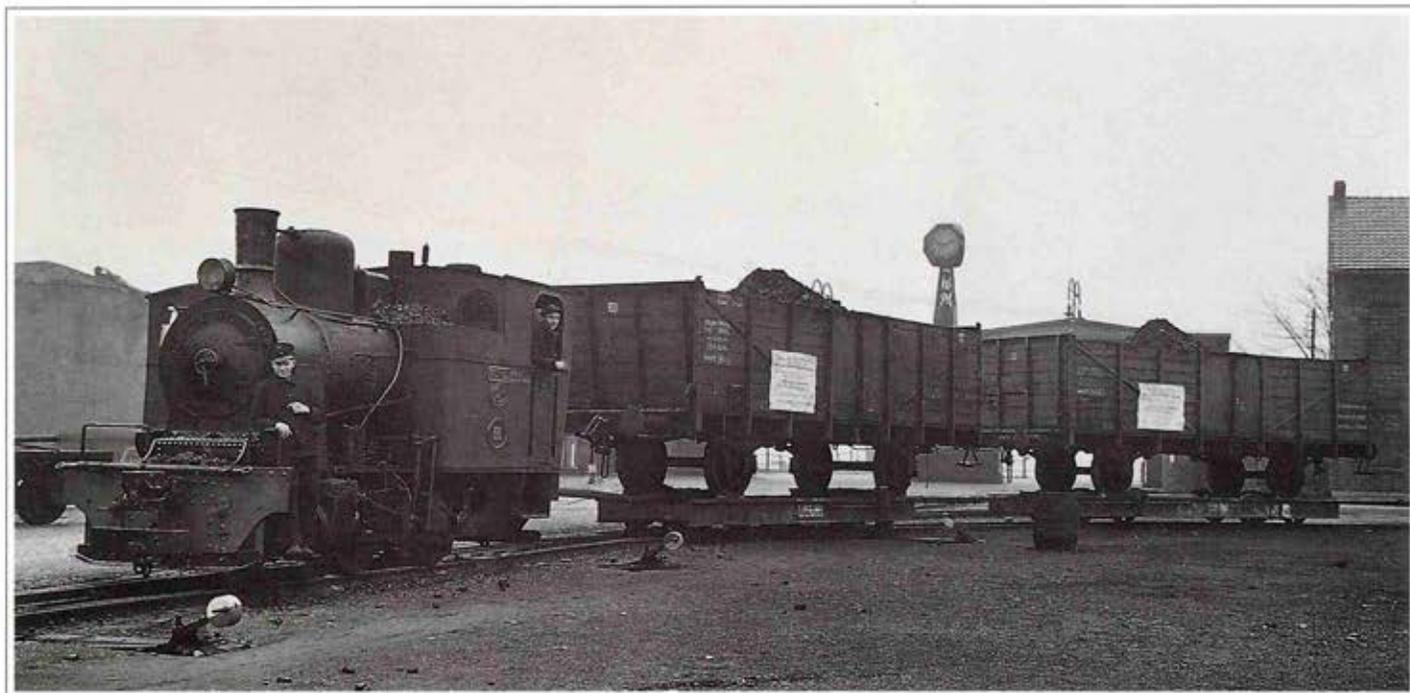
In 1895, a good deal of Duisberg's memorandum was a vision of the distant future. What did, in fact, the site look like? After all, a chemical complex was to be built according to his ideal of placing "scientific certainty" above "fortuituous success."

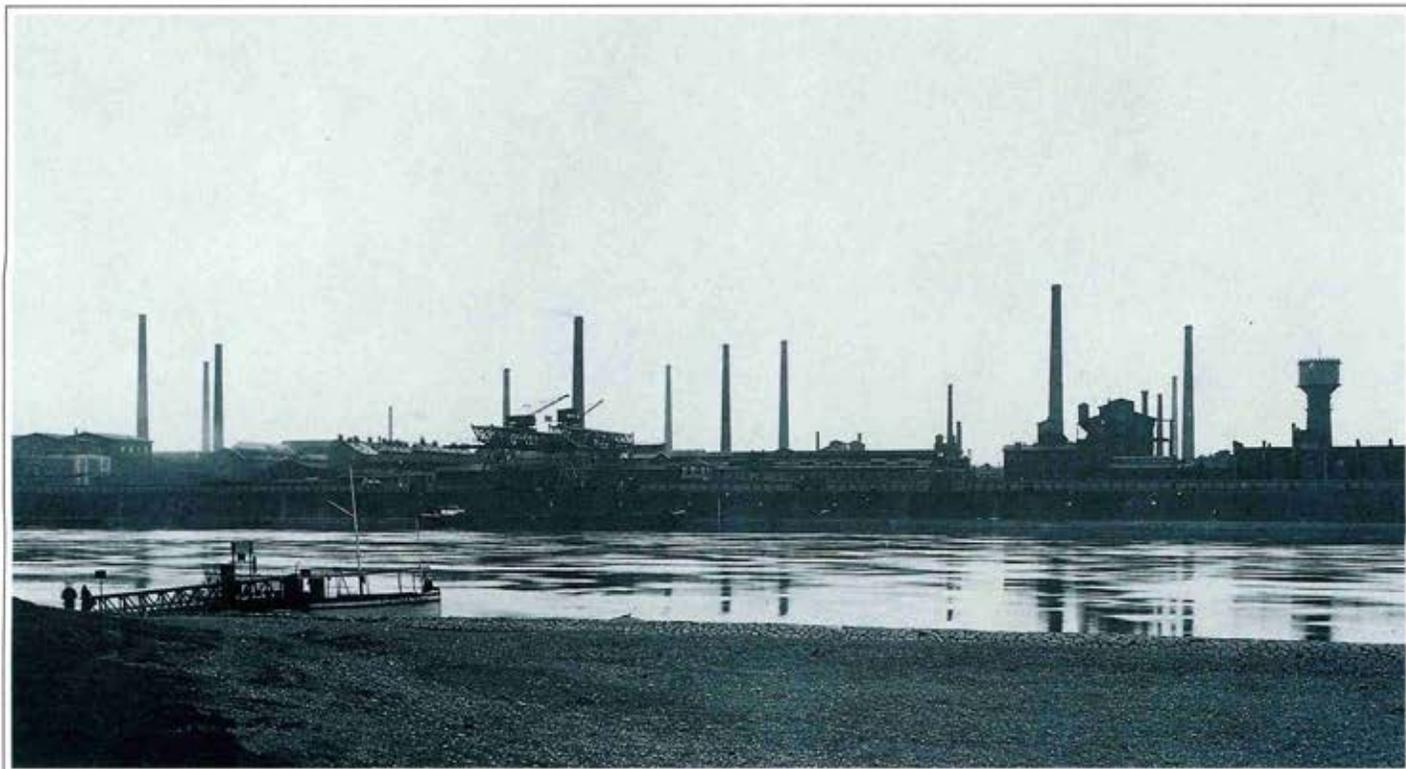
The land bought from Leverkus & Söhne accommodated an alizarin red factory, two staff villas and a makeshift canteen. That was all. Between the plant and the fishing and farming village of Wiesdorf, located more than a mile away, there was only empty meadowland.

In fact, Bayer had bought part of this property adjoining the Leverkus estate, but it was still not enough for Duisberg to realize his grand design. When the Wiesdorfers saw that the "Elberfeld people" urgently needed more space, they raised their prices. In the end, Bayer managed to purchase a total of almost 380 acres. That was enough to start with, although today's Leverkusen plant is more than twice that size.

This may have solved the space problem, but it proved much more difficult to find an answer to the manpower question—labor for the building of the works and for its subsequent operation.

The neighboring villages of Wiesdorf and Bürriig, which belonged to the township of Küppersteg, had a total of 3,396 inhabitants. They were linked to "Leverkusen" by only a footpath. Workers coming from the north bank of the Wupper had to take a ferry, or when the river was at high water, make a long detour over the railroad bridge.





The journey from the left bank of the Rhine was even more arduous. Five large ferries were employed every morning and evening. Large storm lanterns at the landings illuminated the crossings, which generally took place in the dark. In fog, ships' bells guided the ferries across. In floods or freezes, there was no way to get to work at all. Workers on the left bank had to leave home at 4 a.m., since work began at 6 a.m., and they didn't return home until late in the evening. Things did not improve until 1904, when Bayer signed a contract with the Mülheim steamboat company for the transportation of employees from Langel, Rheindorf, Hitdorf and Merkenich to Leverkusen.

The next sizable community near the plant was Mülheim, on the right bank of the Rhine, but this was a long distance to walk until a narrow-gauge rail service was started between Mülheim and Leverkusen in 1898.

The "migrants" were a special group of workers. They never stayed anywhere for very long. Their route ran down the Rhine through the chemical works at Ludwigshafen, Höchst, Griesheim, Hönnigen and Kalk to Leverkusen and Uerdingen—and then back again. They were only employed in emergency situations, because what the plant really wanted was a permanent labor force.

To encourage a permanent labor force, Bayer introduced recruiting premiums. New employees earned their "recruiters" 10 marks if they stayed

a week, and a further 30 marks for six months. As early as 1897, the company introduced seniority bonuses, which increased according to a scale from one year's service to retirement.

But this wasn't enough. Bayer hired recruiters in Hesse, in the Siegerland area and even as far away as East Prussia. Municipal employment agencies were applied to and advertisements were placed in newspapers all over the country.

The trouble was that nobody really wanted to go to Leverkusen because there wasn't anything there—no shops, no entertainment, not even a place to live.

The clerical and technical staff relocated there from Elberfeld stayed "in the sticks" in makeshift quarters during the week, and returned home to their families on the weekend with a sigh of relief. At a company party in 1896, they sang to Duisberg:

*People that he cannot stand
Go to Leverkusen-land.
Exiles they whom he doth send
To the world's own bitter end.*

This could not go on. If the chemical plant was indeed at the "end of the world," a town must be created around the plant. In September 1895, the first series of 10 semi-detached houses with workers' apartments was built, as well as a bachelors' hostel and a block of flats for salaried staff.

For many decades the strange train seen on the left was a common sight at the works. Railroad cars were loaded piggyback-fashion onto undercarriages for transportation to their final on-site destination via the plant's narrow-gauge track. The size

of the early works can be seen in the above picture taken from the opposite bank of the Rhine.

The brilliant plan
for a chemical complex



By the spring of 1899, there were 40 houses for workers and 10 for staff. A further 19 workers' houses were added in the fall. Building continued at this tempo.

It was not enough to provide accommodation alone. Duisberg wanted the houses to be attractive and here, as elsewhere, paid attention to the details. A model apartment with furniture of his own choosing was on view to all new tenants. The houses' external walls were covered with ivy and clematis.

The streets of the so-called "colonies" were planted with shade trees. Friedrich Krupp had already seen the same thing done in Essen. Bayer's competitors were amused: *"Pa Duisberg is laying out avenues—every Saturday the workers paint the leaves with malachite green."*

A retail cooperative was set up in 1895 and was the forerunner of the subsequent Bayer department store. Over the years, a large number of other facilities were added with the intent of improving the relationship between the workforce, the plant and the town.

In 1898, the Leverkusen plant already employed some 1,000 workers, a figure that more than doubled by 1900 and rose to 3,000 by 1903 and to over 4,000 in 1906. But even then nobody could foresee that Leverkusen would one day have 165,000 inhabitants and a plant with 600 buildings and 36,500 employees.

To finance all of this, money had to be raised. The share of borrowed funds on the balance sheet increased as a result between 1895 and 1899 from 31 to 46 percent and did not drop until 1904 and 1905, when it went down to 29 and 24 percent, respectively.

But the expense had been worth it. When the Nobel Prize winner Emil Fischer visited Leverkusen in 1907, he simply said: *"It is without a doubt the finest chemical works I have ever seen."*

At the end of the 19th century, a transfer from Elberfeld to Leverkusen was considered less than attractive. To put it mildly, Leverkusen was "in the sticks." The site had little to offer before the company began to build houses for its employees. Examples of the architecture

of those times can still be detected in the city of Leverkusen today.

Bayer chronicle 1895

Corporate trademark is redesigned to symbolize the



self-confidence and the cosmopolitan character of Bayer's presence on world markets.

For the first time ever, commercial staff exceeds the total of chemists and technicians. Agencies are expanded into sales branches; one of the first of them is the Farbenfabriken of Elberfeld Company in New York City.

There are now 10,376 factories in the chemical industry in Germany, with a total of 115,231 employees. Only seven chemical firms have over a thousand employees, among them Bayer with 2,660.

World events 1895

Kaiser Wilhelm Canal (today's Kiel Canal) is opened on June 21.

Alfred Nobel, the inventor of dynamite, institutes the Nobel Prize.

German physicist Wilhelm Röntgen discovers X-rays. The picture below shows the X-rayed bones of Röntgen's hand, which he himself photographed on December 22, 1895.



Sigmund Freud publishes "Studies in Hysteria" in cooperation with Josef Breuer.

Brothers Max and Emil Skladanowsky display "moving pictures" in the Berlin Wintergarden on November 1. Paris has its first one-minute film show in the "Grand Café" on December 28.

Carl Linde develops a process for the liquefaction of air.

The Patent Department— keeper of the company's intellectual property

“I have never been so happy as this evening,” wrote Carl Duisberg to Carl Rumpff, Supervisory Board Chairman and uncle by marriage. On what evening? Was it a family event? A great invention? A new idea?

No, he had just won a patent suit. The Imperial Patents Act had been passed in 1877. Since 1885, Duisberg had personally been in charge of all patent affairs for the company. He introduced the systematic evaluation of all in-house and outside patents the following year and won the decisive Congo red case before the Supreme Court in 1889. In 1896, he went on to set up a special Patent Department. This department's importance has been proven: since the establishment of the original Farbenfabriken, the company has been granted no fewer than 144,000 patents. Of these, 29,000 are still valid, some 27,000 of them outside the Federal Republic.

If Carl Duisberg had been asked at the end of his life what he considered his most significant achievement, he probably would not have named his success as a researcher, an organizer, an entrepreneur, or a business leader—not even the creation of Leverkusen. Establishing the patents system would appear to have been his choice. Apparently the *“happiest evening in my life”* was in 1889, when he left the Supreme Court in Leipzig as the winner.

The cooperation between Farbenfabriken Bayer and Agfa (see chapter on 1885) proved very satisfactory. Both firms benefited from the production of Congo red and benzopurpurin. But the competitors were not idle. The patents law prohibited the use by third parties of patented processes—but not attempts to make the same product by different processes. The Berlin company Ewer & Pick was successful in this. Agfa and Bayer sued under the Patents Act. Ewer & Pick pleaded nullity on the grounds that the manufacturing process for Congo red and benzopurpurin were not patentable in the first place. The suit went to the Supreme Court, and as patentee, Agfa had to defend itself. Acting on its behalf were the lawyer Wilhelm Reuling as counsel and Gustav Schulz, the head of the company's scientific laboratory, as chemical expert. Duisberg had gone to Leipzig only as an observer.

The opposing attorney went straight into the offensive and was successful in a bid to exclude anyone from participating in the proceedings who lacked proper legitimation as a representative.

Bayer was far from being the only company that was searching for new dyestuffs and pharmaceuticals. Tough competition not infrequently led to patent disputes. Armed with a thick file, Duisberg took one of these patent cases to the German

Imperial Court in 1889—and won. This success was one of the triumphs of his career.

1. Benzidin + α -Naphthyl-amin



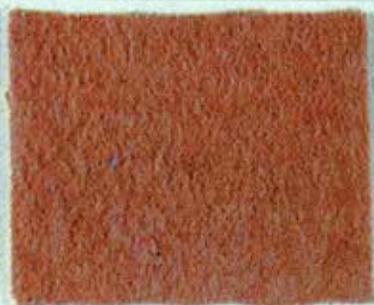
2. Benzidin + β -Naphthylamin



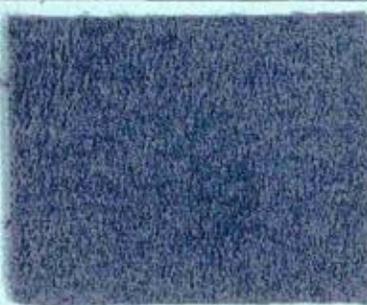
3. Benzidin + α -Naphthylamin sulfuriert.



4. Benzidin + β -Naphthylamin sulfuriert



5. Benzidin + α -Naphthylamin sulfuriert, dann mit α -Naphthol- α -sulfosäure kombiniert



6. Benzidin + α -Naphthylamin sulfuriert, dann mit α -Naphthol- α -sulfosäure kombiniert.



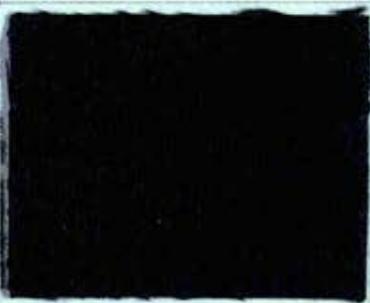
7. Benzidin + α -Naphthylamin sulfuriert, dann mit α -Naphthol- α -sulfosäure kombiniert



8. Benzidin + α -Naphthylamin sulfuriert, dann mit α -Naphthol- α -sulfosäure kombiniert.



9. Benzidin + α -Naphthylamin sulfuriert, dann mit α -Naphthol- α -sulfosäure kombiniert.



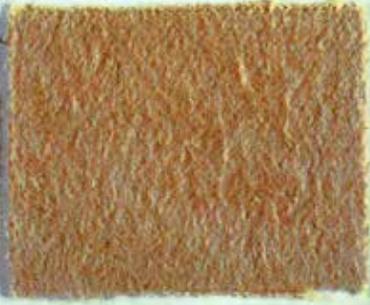
10. Benzidin + α -Naphthylamin sulfuriert, dann mit α -Naphthol- α -sulfosäure kombiniert.



11. Benzidin + α -Naphthylamin sulfuriert, dann mit α -Naphthol- α -sulfosäure kombiniert.



12. Benzidin + Amidol-
R. Laure.



18 - A 110111

This ruled out Dr. Schultz, who was just an Agfa employee. Duisberg, who held power of attorney on behalf of Bayer, was considered to be a legitimate participant—but only as an observer.

Things got off to a bad start in other respects, too. Leading chemists were called as witnesses for the plaintiff. Professor Johannes Wislicenus spoke in favor of a "complete abolition of the Congo red patent." Adolf Baeyer's opinion was read to the court: "The invention of Congo red is not patentable."

The court had also acted on its own initiative to call Heinrich Caro as an independent expert. Caro was a highly regarded dyestuff chemist and inventor of the group of alkali-resistant triphenylmethane dyestuffs known as "patent blue" and already a manager at BASF. He held a two-hour lecture that culminated in the claim that his lab assistant had been able to formulate all dyestuffs covered by the Congo patent without instructions.

Duisberg reminded Caro to consider the disservice his remarks were doing to the whole field of azo chemistry. But his pleas were in vain. Caro remained unmoved. Attorney Reuling lost his nerve and not only attacked the expert witness, but he also reproached the court for having reached a wrong judgment in an earlier case. All seemed lost.

At this juncture, Duisberg realized that he must take things into his own hands and asked the court for permission to make a few technical remarks. He launched into an impassioned explanation of the difference between chemical methodology and the patent process in relation to patent law. In a display of brilliant rhetoric, he proved that experience had shown how even in the case of a generally known reaction process such as azo coupling, new and unforeseeable properties of the end-product could result when new starting materials were used.

At the end of his disquisition, he beat Caro with his own arguments: if he, Duisberg, were to give his lab boy the number of BASF's rhodamine patent, the lad would be able to make this dye perfectly well alone.

Duisberg won the day: the Congo red patent remained untouched. With this verdict, the court set an important precedent by ruling that a process

could be patented if it led to end products that possessed new properties. Caro, Reuling and even the opponents offered their congratulations.

After this, Duisberg attended to all patent cases personally. In 1891, benzopurpurine was again the subject of a patent suit, this time in London. Duisberg was able to send a telegram home with the victorious news: "Brilliant win in English patent case."

But Duisberg could not be everywhere, so it was hardly surprising that the next step was the formation of a separate department manned by experts. This took place in 1896.

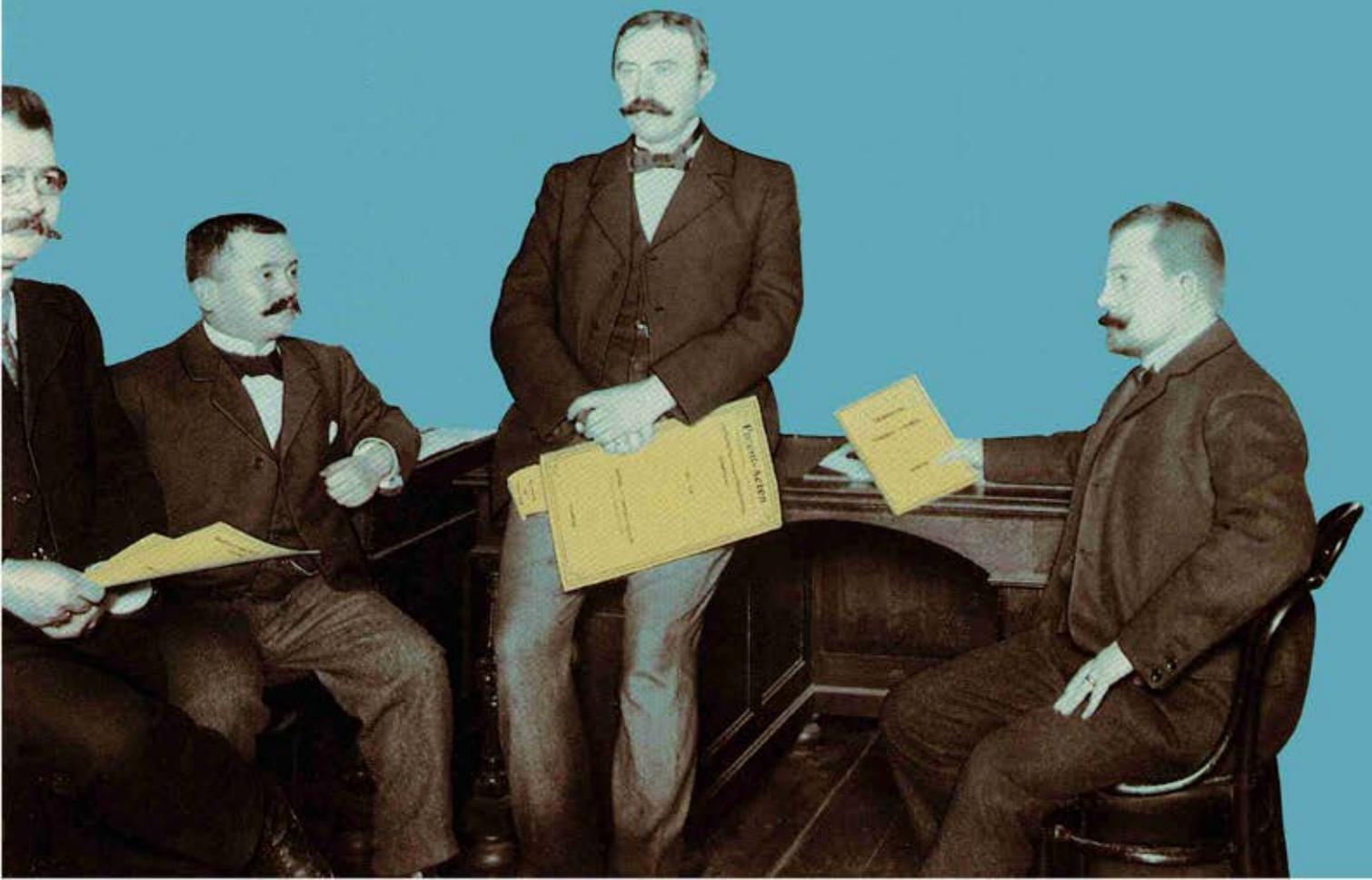
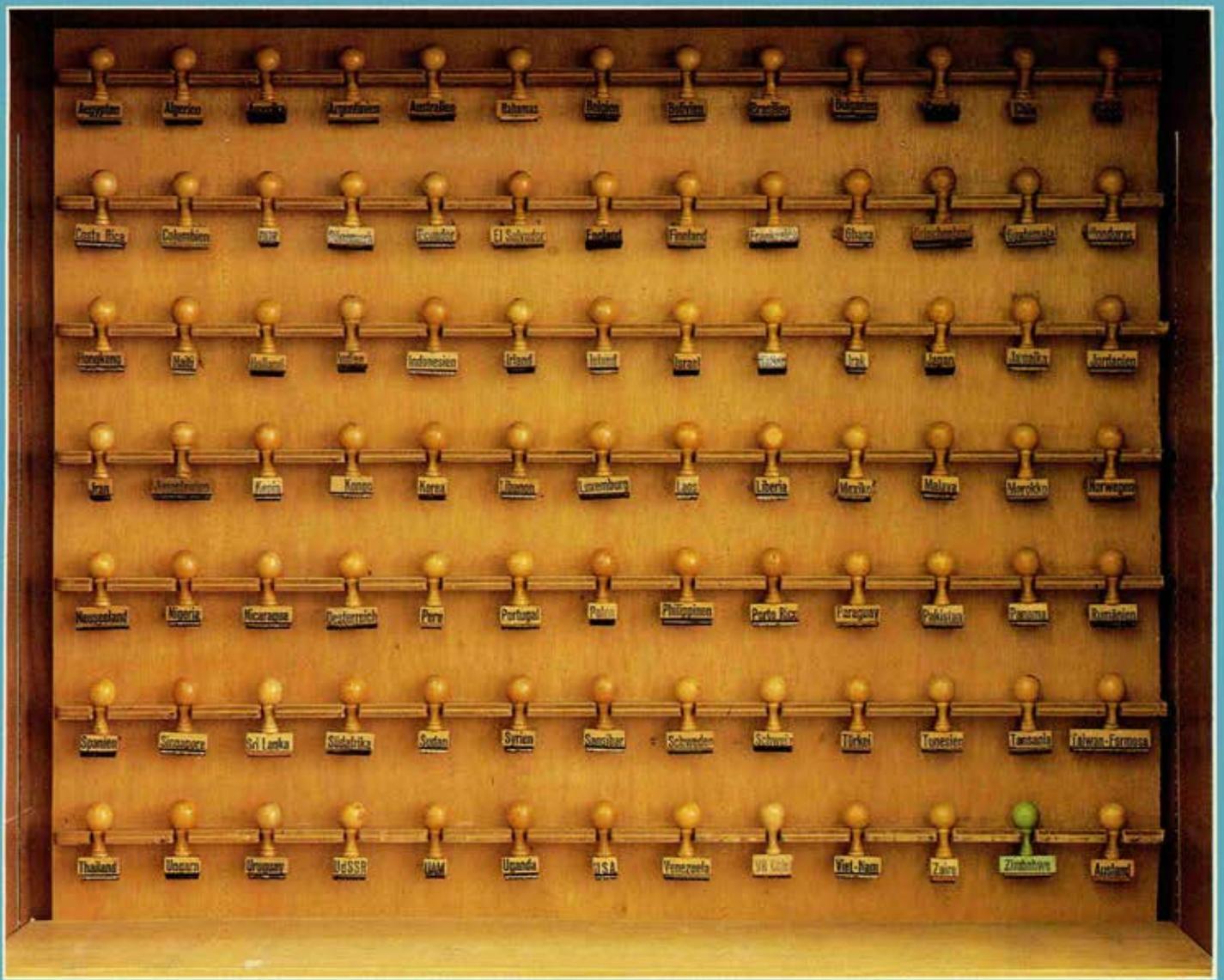
For all this, Duisberg continued to concern himself with fundamental questions in connection with patent law. In a series of lectures and articles, he stressed that a Patents Court should be created with an equal number of judges from the judicial and scientific sectors, since no one could expect such special comprehensive knowledge from lawyers alone. This was inconceivable at the time, calling as he did for "scientist-judges" with no legal background. In time, Duisberg's arguments were accepted. Today's Federal Patents Court has technical judges with scientific training. In some cases, they even chair proceedings.

"The duty of the Patent Department is the observance of all affairs involving patent law." This apparently self-evident statement covers a remarkably wide range of individual tasks. First and foremost, the Patent Department is responsible for obtaining protection rights for its own or for acquired inventions at home and abroad. This carries with it the duty to guard against infringements and counter objections, as well as to make sure that the company's operations are not hindered by unjustified patents registered by competitors. While filing formal opposition and legal suits are the most usual methods here, satisfactory results have also been obtained (as shown in the preceding chapters) by making settlements with the interested parties.

When laboratory experiments begin to show results worth further investigation, the Patent Department is called in. The job of the department is to describe the technical innovation inherent in the new process

Early in his professional life, Duisberg realized how important it was to evaluate systematically both the company's own patents and also those of the competition. He set up a corporate patents department in 1896, whose four experts were soon hard at work

protecting Bayer's intellectual property. The stamps shown above are used in the patents department to this day to mark jurisdiction of the patents.





經濟部中央標準局專利權證書

專利權人 拜耳廠股份有限公司

專利權號數 發明 第一三三一六

號

專利之名稱

新環丙烷環自代苯甲胺之製法

專利權期限 自中華民國六十九年九月一日起
至中華民國八十四年八月三十一日止

右專利權人依專利法第四十二條之規定專有製造販賣或使用其發明之權

此證

局長 葛茵 震歐

專利處處長 宋揚 曜

中華民國

六十九年十二月九日



so exactly that the patent registration can be successfully justified, and it should provide comprehensive protection for the invention in question. This demands extensive searches to identify existing patents or publications by third parties that may be cited against when registering for a patent.

As early as 1886, Duisberg was demanding that the patents staff should be abreast of the whole range of pertinent literature. This was possible, but required large amounts of reading. Today, the task has become so huge that it is unconceivable without the help of computers. The patents expert has to know exactly where he can look up any given fact (see next chapter) to do his job sufficiently.

Only a fraction of the patents granted are immediately used by the patentees or licensed to third parties. It frequently turns out in the months following registration that the idea concerned has been rendered obsolete in the meantime by a different solution, or that the process patented in the laboratory or pilot plant proves unreliable, difficult or expensive when converted to large-scale production. Or, it may be that after all the trouble that has been taken, the market is not yet ready for the end product. The annual decision whether it is worth paying the constantly rising fees for the renewal of a patent is by no means an easy or a straightforward one.

This problem applies not only to the Federal Republic of Germany, but also to other countries where the firm is active. Indeed, the matter is complicated by the national variations regarding the registration of patents, the extent of protection and patent duration.

The growing economic and political integration within Europe has brought gratifying progress in this field over the past years. Today, a total of 13 European nations are members of the European Patents Office in Munich, which uses a standard system to grant patents that are valid in all member countries.

In 1975 Bayer registered a patent application for an insecticide in Taiwan under the number 7730. Details of this and all of the 29,000 other worldwide company patents are stored in computer files today. The computer has become the most important

piece of equipment in the patents department. It permits the immediate retrieval of all necessary information.

Bayer chronicle 1896

A pharmaceutical research laboratory, which is shown in the photograph below, is established in Elberfeld.



A collection of the company's dyestuff sample cards is published as a "Cotton Album" and a "Wool Album."

New foreign sales subsidiaries are added to the list: The Elberfeld Farbenfabriken Bayer & Co. in Manchester and Farbenfabriken Bayer & Co. in Bombay.

The „Farbwerke Dr. E. ter Meer & Cie.“ of Uerdingen and "Chemische Fabriken J.W. Weiler & Co.," of the Cologne suburb of Ehrenfeld merge to form the Uerdingen-based company "Chemische Fabriken vorm. Weiler-ter Meer AG."

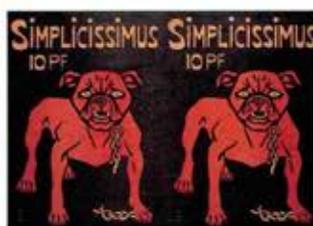
Iodothyryn, a vascular regulator used to combat arteriosclerosis, is introduced to the market. The iodine needed for this product is found primarily in the thyroid glands of sheep.

World events 1896

First Olympic Games since ancient Greece take place in Athens from April 6 until the 15th.

German Code of Civil Law is published on August 18. The Code, which has 2,385 clauses, is to come into effect at the turn of the century.

Political and satirical magazine "Simplicissimus" appears for the first time in Munich.



Another new publication in the Bavarian capital is "Jugend." The art nouveau style of contemporary artists (in German, "Jugendstil," or "youth style") is to be named after the magazine.

Otto Lilienthal, the pioneer aviator, perishes in an attempted flight on August 10.

Guglielmo Marchese Marconi, who had been performing experiments with Hertzian waves since 1894, succeeds in sending "wireless" signals over a distance of several kilometers.

French physicist Antoine Henri Becquerel discovers the radioactive nature of uranium.

It all started with a “reading circle”

With 600,000 volumes, 57,800 theses and a total of 7,000 periodicals, Bayer’s Kekulé Library is the biggest privately-owned special library in Western Europe.

Friedrich August Kekulé von Stradonitz, whose most significant discoveries were the quadrivalence of the carbon atom and the ring structure of benzene, died in Bonn on July 13, 1896. Carl Duisberg bought the 7,000 books of his library for the company from Kekulé’s heirs. Together with the 4,000 volumes Bayer already possessed, the company now had the biggest collection of any chemical firm.

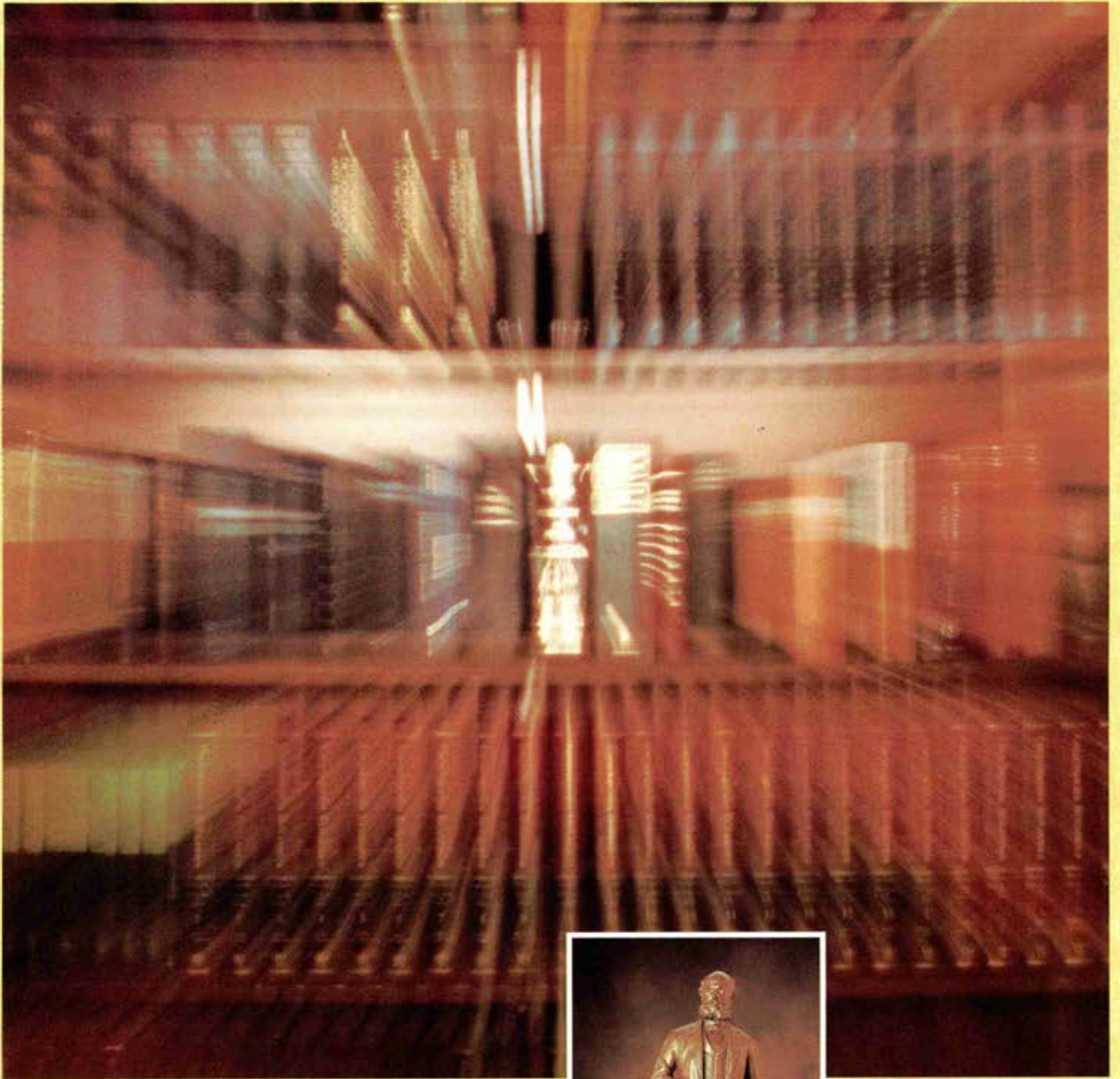
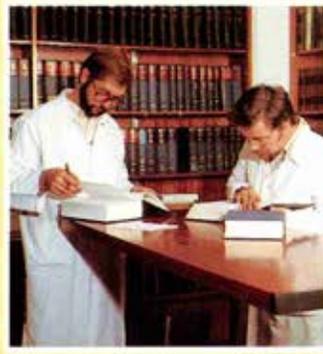
The mere size of the library and even the value of the individual books did not, however, mean much on their own unless there was a catalog system which helped users to find what they needed. As physicist John William Lord Rayleigh said in 1884, it can be harder to locate the description of an invention than it is to make the actual invention in the first place.

The invitation to set up a “reading circle” contained the following statement: *“In the past few years, chemical literature has reached such a volume that it is hardly possible for chemists engaged solely in the service of the chemical industry to retain the broad view of the subject necessary for their special studies. The undersigned are of the opinion that a collegial society within these dyeworks, working on the basis of a division of labor...would permit mutual support and cooperation and thus facilitate the reaching of this goal...”* The Chemists’ and Engineers’ Conferences that grew out of the “reading circle” had the same aim in mind.

During World War I, Bayer chemists who had been called to serve in the military feared they would lose touch with developments taking place in their absence. With the intention of helping these men, Bayer began regular publication of its “Report on Progress in Basic and Applied Chemistry” in 1914, including summaries of all publications and patents that had appeared in the latest chemical journals or had been disseminated by the Patents Office. In 1970, these “progress reports” were absorbed into the “Chemischer Informationsdienst,” which has since then been published by “Fachinformationszentrum Chemie GmbH” in Berlin. Bayer and the

Bayer’s Kekulé Library is considered the biggest private chemistry library in Western Europe. It is at the disposal of all employees and linked by leasing agreements to other libraries. The roots of this institution go back to Carl Duisberg, who bought up the

approximately 7,000 books from the estate of Friedrich August Kekulé von Stradonitz after the famous chemist’s death.



It all started with a
"reading circle"

Society of German Chemists are among the co-editors, Bayer being responsible for the important section, "Preparatory Organic Chemistry."

After the Second World War, Bayer began to publish further periodical works of reference in the style of the "progress reports." These dealt with specific subjects and bore titles such as "Macromolecular Report," "Textile Report" and later "Foam Report."

The Scientific Literature Department was formed in order to cope with this work. Other departments also began to produce special publications for their staff.

For example, the Engineering Science Department introduced the "Process Engineering Reports" (VtB), which still appears once a week. These reports are prepared with the help of a professional pool of some 700 experts from industry and universities, who compile some 7,500 reports per year on subjects that have been published in one of the 700 trade journals or special technical publications. Since 1968, the semi-annual indexes are collected every three years into one volume which registers some 160,000 interesting articles on chemical and process engineering.

Today's information expert and widely read author Professor Karl Steinbuch views information as *"the most important resource of our time."* On the other hand, he refers in one of his books to what he calls the *"informational inadequacy of mankind."* For physiological reasons alone, man is unable to absorb all relevant information, to store it in his memory and to make the correct connections.

By 1950, there were some three million scientific papers appearing annually in 30,000 reputable journals. Five years later, it was calculated that beginning about a century ago, the volume of scientific literature had been doubling every two decades. Furthermore, within the space of four to

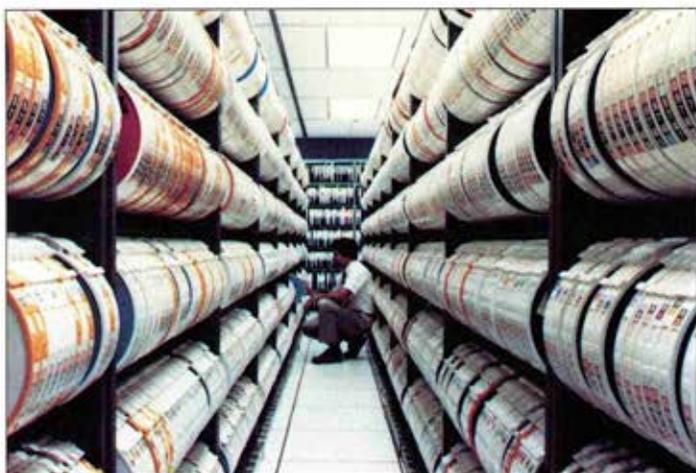
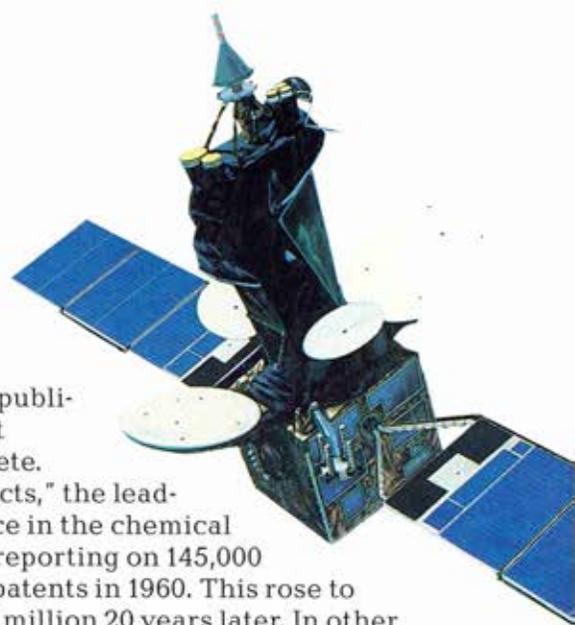
six years, scientific publications have in most cases become obsolete.

"Chemical Abstracts," the leading work of reference in the chemical sector, was already reporting on 145,000 articles, books and patents in 1960. This rose to a total of over half a million 20 years later. In other words, scientific works are being published alone in the field of chemistry every one and a half minutes, and that a chemical patent is being issued every six minutes.

What would have happened if Carl Benz in Mannheim had known in 1886 that Gottlieb Daimler, only 86 miles away in Cannstatt, was inventing the motor-car at the very same time as he was? If he—or Daimler—had known, would one of them have given up or would they have gotten together as Daimler-Benz?

Of course, the answer to these questions will never be known, but the phrase "simultaneously and independently" occurs over and over again in the history of inventions. To give just a few spectacular examples: Newton and Leibnitz simultaneously and independently discovered infinitesimal calculus. No fewer than four chemists discovered aniline at the same time. Dimitri I. Mendeleev and Lothar Meyer simultaneously figured out the Periodic Table of the Elements. Sir Joseph Wilson Swan and Count Hilaire Bernigaud de Chardonnet were neck in neck in the invention of artificial silk. And so on and so on.

In the late 1960s, American sociologist Jerry Gaston asked British atomic physicists how often they had had the disappointing experience of being beaten to the draw. His findings revealed that 38 percent of the sample had had this experience once, 17 percent twice and 9 percent even more frequently. Other American research shows that some ten percent of all research and development investment in the United States is spent on useless duplication.



Scientists all around the world are constantly tackling unsolved chemical problems. They are able to meet a substantial part of their information requirements from the data banks of the "Chemical Abstracts Service," which is offered worldwide via satellite.

Some 50 percent of all research, it is claimed, would have been carried out differently or not at all had there been sufficient knowledge of what work had been done previously.



The complaint was made in 1980 to the Federal German Parliament that 30 percent of the research budget was being wasted, because the things that were being researched had indeed long since been discovered. In issue no. 45 of "Bayer Reports," the situation was fittingly summarized: *"A scientist active in his special subject without being constantly informed of his colleagues' progress runs the risk of carrying out research in vain because the results have long been known. But if he tries to read all the relevant publications and undertake the necessary evaluation, he will have no time for his own research."*

This brings us back to today's Kekulé Library, which offers "customized" literature to Business Groups and Service Divisions. It transcends the role of a purely "chemical" library in that it covers the whole field of science, technology and medicine, as well as law, economics, sociology and statistics.

Since this information is also used outside headquarters, Bayer runs branch libraries in Dormagen, Monheim and Uerdingen in addition to the central library in Leverkusen. Various business groups and service divisions have libraries of their own, although they are supplied by the main Kekulé Library.

The acquisition of literature is, like its evaluation for catalog purposes, a centralized operation. All data required for the identification of a document are stored in KEBIS, the on-line Kekulé Library System. This enables the immediate delivery of such facts as subject references or authors' names. Conventional catalogs can be drawn up or the computer file can be searched to suit a user's individual needs.

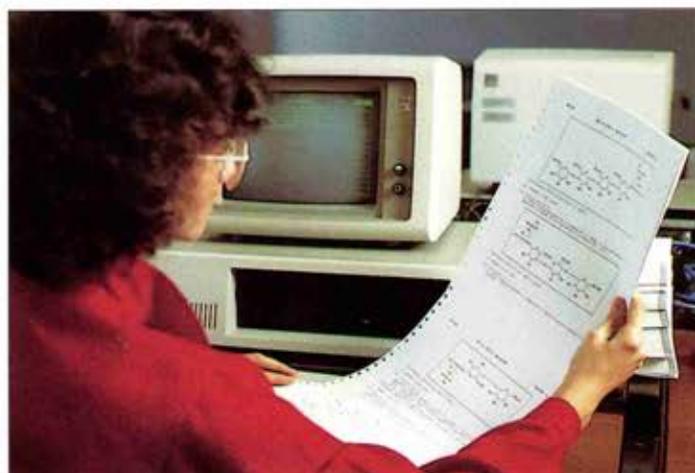
Thanks to the terminal-based clearing-house system, the "CAS" computer allows Bayer scientists to obtain information on current research projects and the findings of their colleagues around the world within seconds.

In 1909, some 45 percent of all chemical literature was still appearing in German; today it is no more than five to ten percent. Chemical literature in French and Japanese each have about the same share, with a further 10 to 20 percent in Russian. Between 40 and 60 percent is in English. An adequate knowledge of English on the part of researchers is a must. The most important Russian language publications are also available in English translation, as well as the original. For all that, the modern flood of information is rolling faster than even the most sophisticated library can handle.

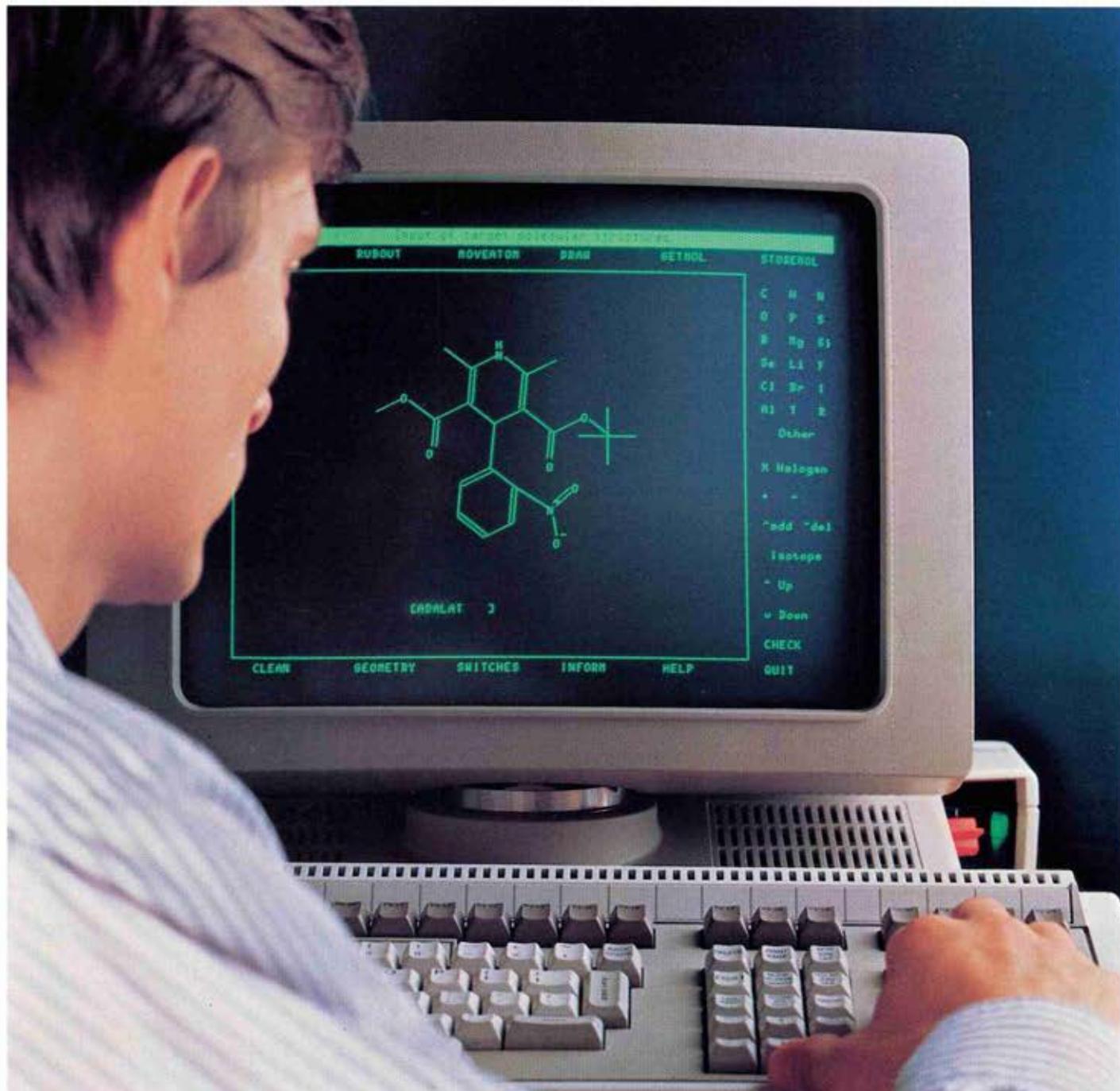
By the late 1960s it became obvious that the storing of all publications by every single company was pointless and uneconomical. For this reason, a number of German and foreign chemical firms set up the International Chemical Documentation Center in Frankfurt as a joint venture. This unit gives all member corporations access to its files. Only internal data, such as patent matters, are stored separately by the individual companies. In addition, data networks provide links to commercial data banks, many of them in the United States.

Great importance is placed on the data bank of the Chemical Abstracts Service (CAS-Online) in Columbus, Ohio. This data bank is the biggest information center of its kind in the world and is accessible via satellite in minutes—or even seconds—with use of only about half a dozen commands such as "find," "combine," and "print." The CAS-Online memory contains the structures of more than seven million chemical compounds and the details of ten million papers and articles; a further 8,000 are added weekly.

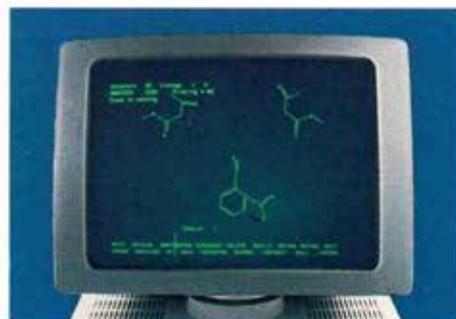
A system set up by Bayer and other companies offers even more. This sophisticated concept permits computer-aided synthesis planning, whereby the chemist simply has to draw the structural formula of a desired substance on the screen, and the



It all started with a
"reading circle"



Together with other companies, Bayer has developed a system of computer-aided synthesis planning. The chemist feeds a structural formula—in this case for Adalat—into the computer and receives a series of synthesis proposals on the screen.



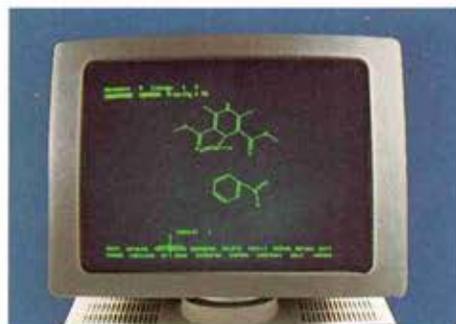
system comes up with possible synthesis solutions. Terminals are located in Bayer's Information and Documentation Center, at the Agrochemical Center in Monheim and in numerous laboratories.

The Pharmaceutical Research Center in Elberfeld is served not only by CAS-Online and other systems, but also by the computer of DIMDI, the German Institute for Medical Documentation and Information in Cologne.

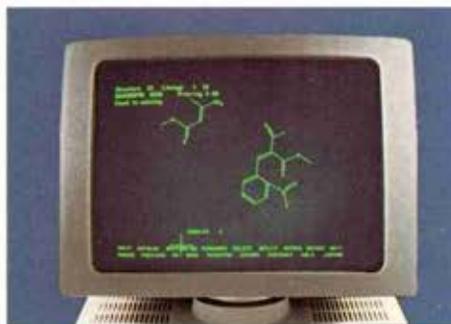
The Federal Department of Research and Technology is now planning to introduce a data bank in 1989. This system will even be able to supply answers to such questions as specialized as, which compounds melt without disintegrating at a temperature of 112°C and have a specific density of two grams per cubic centimeter?

But do the new techniques solve the problem of the "informational inadequacy of mankind?" "Bayer Reports" comments on this subject: *"The growth in the flow of information leads, paradoxically enough, to an increased realization of the lack of information. This in turn results in increasingly exact demands on the performance of our information systems. The availability of external data banks is causing an avalanche of information. For all that, it must be remembered that there has been little real growth in the volume of important information."*

"It is therefore the job of the scientist working in an information and documentation unit to separate the chaff from the wheat and pass on only information that is highly relevant to a given problem."



Bayer chronicle	1897	World events	1897
<p>First azo facility begins production in Leverkusen. The company continues its intensive search for new dyestuff groups.</p> <p>German chemist and pharmacist Felix Hoffmann synthesizes acetylsalicylic acid in a pure, stable and compatible form.</p> <p>The salaried staffs' pension fund is founded in Elberfeld.</p> <p>Seniority bonus is introduced.</p> <p>Two Elberfeld engineers receive official permission to carry out statutory tests and continuous examinations of steam boilers. This marks the start of in-house controls.</p> <p>Alinit, a bacteriological "inoculation fertilizer" that is to promote plant growth by improving the nitrogen supply, is introduced to the market.</p> <p>When a cattle plague breaks out in California, pharmacist Edward A. Cutter produces a vaccine. Cutter Laboratories is founded.</p>		<p>Author Emile Zola takes the whole front page of the French newspaper "L'Aurore" to demand from the President of the Republic a retrial in the scandalous Dreyfus case.</p> <p>The Dow-Jones Index is introduced on the New York Stock Exchange, collating the prices of 30 leading industrial firms as an indication of trading on the American stock market.</p> <p>August Andrée, the polar explorer from Sweden, tries to reach the North Pole by balloon from Spitzbergen and is never heard from again.</p> <p>Value of German chemical output reaches 984 million gold marks, as compared with total world production worth 3.5 billion marks.</p> <p>After 17 years of intensive research efforts, BASF succeeds in producing a synthetic indigo.</p> <p>Karl Ferdinand Braun develops a cathode-ray tube (the so-called Braun tube), which will later also be used in television sets.</p>	



More company doctors than the law requires

Today, it is only natural that an industrial plant has one or more doctors. In fact, this is demanded of employers by the German Occupational Safety Act of 1973. At the turn of the century, however, things were very different.

It was considered quite an achievement when Bayer engaged a physician of its own in 1898 and opened a polyclinic in Elberfeld. Until this step was taken, the works had relied on local doctors in Elberfeld and Barmen and, in emergencies, the public hospitals. This was helped by the fact that Bayer had telephones at its disposal.

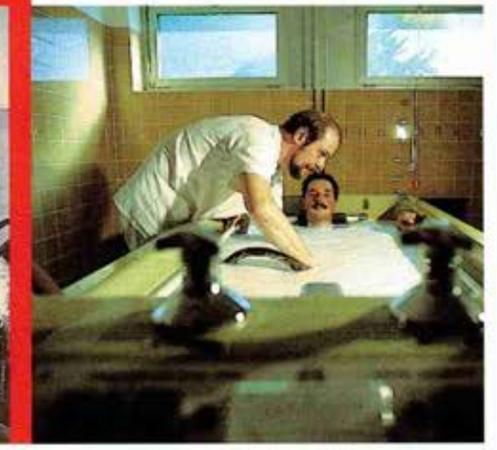
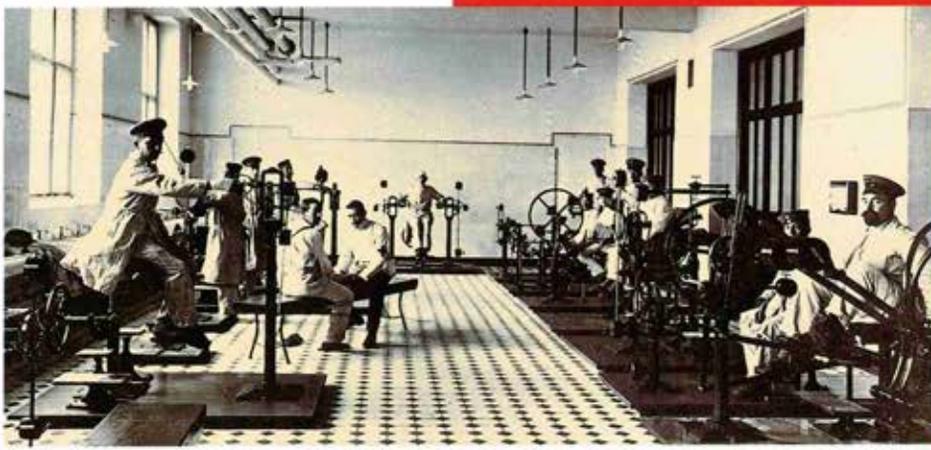
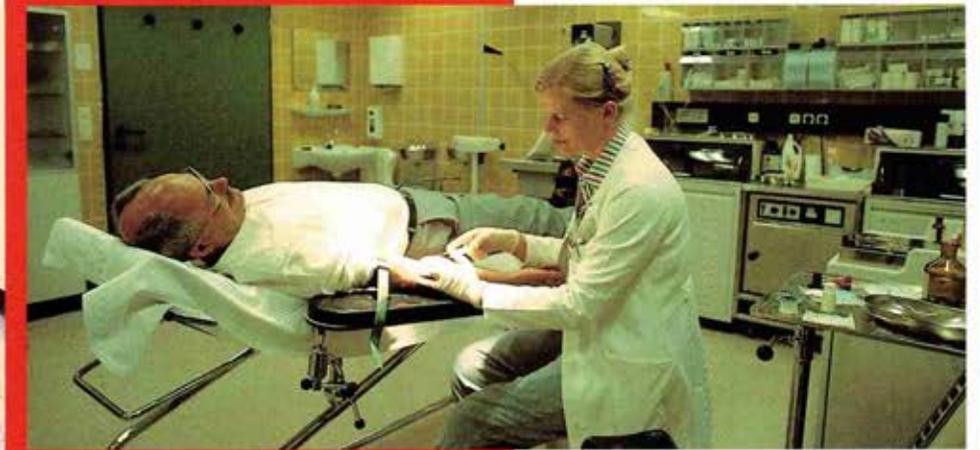
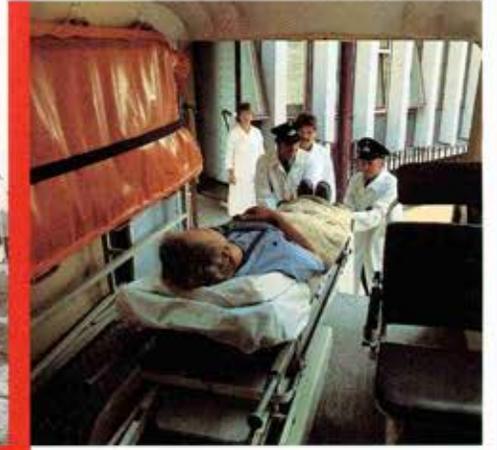
Otto Grasse reported on the state of medical care in 1888: *"In the twenty-square-yard room occupied by the Pharmaceutical Department scientists stood a chest full of bandages and a little leather sofa for the occasional accident case. When we needed to air out our combination office-and-first-aid room, we had to open the door to the stairs, because what came through an open window from the factory were such delightful scents, like those from sulfur compounds. The trouble was that half a flight up the stairwell was the home of dogs, mice, rabbits and guinea pigs that were on hand for pharmacological experiments. Even this alternative form of ventilation could hardly be said to have provided us with fresh air."*

Medical care evolved together with the growth of the company. Leverkusen also hired a works doctor, and the other plants followed. These doctors were not only present to render first aid to accident victims, they also acted as general practitioners to employees and their families. The health insurance funds actually recognized them as family doctors.

Today, a total of 29 physicians—more than the statutory requirement—work as doctors in Bayer's five German plants. Most of them are specialists: surgeons, dermatologists, radiologists, dentists, and orthopedists and two doctors who cater to the needs of women. In addition, there is a large team of 176 paramedics, including nurses, masseurs and various assistants. For different medical problems, including alcoholism, there is a staff expert who can advise his or her colleagues. Furthermore, every one of the doctors must have a basic understanding of the chemical and technological processes of the plant they serve, as well as training in occupational medicine. Each physician concentrates on one or more business groups with whose problems he or she is particularly familiar.

The Bayer polyclinic as it was and as it is. What began as a modest operation in cramped quarters has developed into a full-scale medical department with expert staff and the most modern of equipment. In Bayer's five German plants, the health

care program is in the hands of 29 doctors and a team of 176 nurses, masseurs and other paramedics.



More company doctors than the law requires

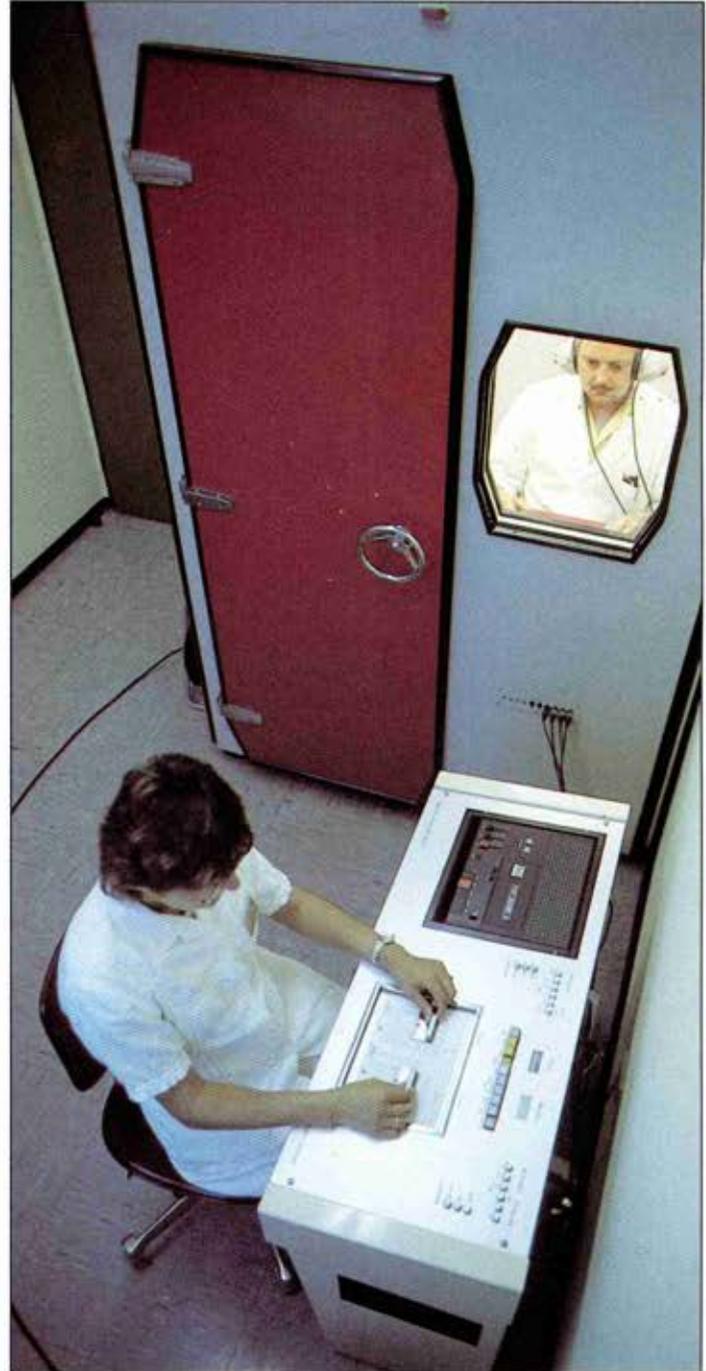
A large part of the doctors' work consists of measures that go beyond mere occupational medicine. They range from employee transfer examinations to preventive medicine. The doctors perform these various duties because Bayer believes that each employee should work in a capacity that is not only in keeping with his professional qualifications, but is also in line with his physical capabilities.

Working in cooperation with "safety delegates" (see chapter on 1974), the company doctors must scrutinize the individual workplaces in light of both medical and hygienic criteria. They are called in when shift schedules are drawn up and even in connection with the planning of new plants and buildings. The medics are also valuable back-ups to the air quality control at the workplace. They carry out so-called "biological monitoring," checking on a regular basis for any foreign substances that might have been ingested by the employees.

Accidents at work are naturally the priority for the on-site doctors, although these do not account for the largest single number of their patients. The emergency ward is manned around the clock so that any accident victim can be treated rapidly and expertly before arrangements are made to bring the patient to a recognized accident specialist or a suitable hospital. Accidents have fortunately become very rare in the chemical industry. The success of preventive measures and other safety programs has made accidents less frequent here than in many other industrial branches.

Since Bayer is active all over the world, specialized knowledge of tropical diseases is also part of the company doctors' responsibilities. This includes the examination of employees who are to be sent overseas to test their ability to withstand tropical conditions, and, of course, the examination of employees returning from the tropics. Another task is the advanced training of colleagues around the world and advisory visits to foreign plants.

The chemical industry is proud that it not only meets the demands of laws and ordinances in the field of occupational medicine, but also contributes



In the Leverkusen clinic every employee can have his or her hearing tested. Even those workers who already wear special hearing protection at work because of the high noise level are regularly examined.

to further development of this important sector of activity. This calls for original scientific research on the part of the industry. The Medical Department is in permanent contact with the Institute of Toxicology, which forms part of the Bayer Pharmaceutical Research Center in Wuppertal.

Long-term epidemiological studies are another field of scientific activity. Today's knowledge is sometimes based on facts that have been collected over a period of decades and have been evaluated in cooperation with university institutes. The recognition of the causality of certain working materials and of particular health hazards can lead to significant decisions on the business side. In the 1950s, for instance, an above-average frequency of bladder cancer was detected among employees in the betanaphthylamine and benzidine units. The plants in question were closed and the production of entire dyestuffs groups ceased as a result.

Investigations of this kind can also exonerate a suspected health risk. When three coronaries occurred in one production unit in the course of a single year, the entire staff was examined. Bayer proved that there was no connection between exposure to the substance in use and the occurrence of the coronaries.

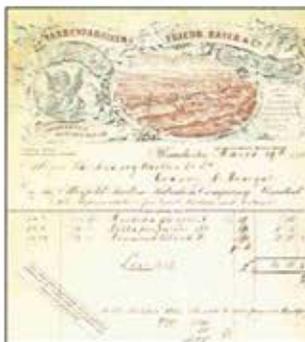
The history of the Medical Department shows a continuous expansion of duties. This was of course accompanied by a similar rise in operational costs. In addition to personnel costs, expenditures on installations, equipment and research grows from year to year.

In 1955, the department moved to new premises and in 1975 a special building was opened to house the physical therapy clinic, where aids to medical treatment, such as baths, massages, inhalation, gymnastics and electrotherapy are administered for rehabilitation after accidents, operations, orthopaedic treatment or illness. The installations also include the most modern equipment for heart and lung examinations. All of these facilities and many more serve to ensure rapid and efficient medical care close to the workplace.

Bayer chronicle 1898

Pharmaceutical Department publishes an information booklet and distributes it to 30,000 doctors.

Duisberg produces a 12-page document that expounds on the various "Duties and Responsibilities of the Chief Engineer, Senior Engineers and Works and Shop Engineers." Among other things, he lays down in this paper the following stipulations: "The Chief Engineer and senior engineers are responsible for making sure that the mechanical and plant operations in all works (Elberfeld, Leverkusen, Moscow, Flers and Schelploh) are kept up to date with the latest scientific and technical developments and take into account all improvements in the engineering sector."



Separate American and English sections are established within the Sales Office. (The invoice above of the English Bayer agency dates from 1898 and is addressed to a customer in Ireland.)

World events 1898

Empress Elizabeth of Austria, better known as "Sissi" (shown in a portrait below), is stabbed by an Italian anarchist on September 10, while walking along Lake Geneva.



Spanish-American War ends with the Peace of Paris. Spain cedes the Philippines, Puerto Rico and Guam to the United States and gives up all claims to Cuba.

Marie Skłodowska-Curie and her husband Pierre Curie succeed in isolating the radioactive elements polonium and radium from pitchblende in slag from the Joachimsthal smelter.

With his "plague formula" (rat to flea to human), Georg Sticker explains how the plague was spread.

Construction begins of the suspension railway Elberfeld-Barmen-Vohwinkel.

Maschinenfabrik Augsburg and Maschinenfabrik Nuremberg merge to form the M.A.N. group.

1899

Aspirin — a drug that transcends time

“Aspirin,” registered on February 1, 1899, was officially entered on the trademark list as No. 36433 of the Imperial Patent Office in Berlin on March 6. A winning trademark was born.





There is hardly a synthetic pharmaceutical that is as well-known, as widely used, as long-established (for over ninety years) and open to so little attack. Few drugs have been so successful for so long. It is not surprising that Aspirin has over the years come by such a flattering collection of descriptions: the universal pill, the miracle drug and even "a piece of our cultural heritage." The trademark made Bayer's name known literally all over the world. In the Federal Republic, Aspirin is a protected trademark of Bayer AG, while in some other countries, including the United States, "aspirin" has become a generic term.

Needless to say, the product had to be developed before the trademark could become so popular. The Aspirin saga therefore began quite unspectacularly two years earlier, in 1897.

At this time, eight chemists and pharmacologists were working in the pharmaceutical laboratory in Elberfeld. One of them was the 29-year-old Felix Hoffmann, who studied pharmacy and chemistry in Munich and graduated magna cum laude in pharmacy. He started working at Bayer in 1894.

Bayer's research program did not then include the search for an antirheumatic drug, but Hoffmann's father had been tortured by the pain of rheumatism for years, and young Hoffmann wanted to help him. The sodium salicylate used in therapy caused nausea because of its offensive taste, so Hoffmann looked for a method of modifying salicylic acid to make it more tolerable.

He was finally successful when he chose acetylation. In his laboratory notes, he described how he had discovered acetylsalicylic acid. The head of the pharmaceutical laboratory, 37-year-old professor of pharmacology Heinrich Dreser, tested the resultant powder for its therapeutic ability and its tolerability. He carried out extensive animal experiments, the first of their kind in an industry-run laboratory. His findings were that acetylsalicylic acid helped in treating rheumatism. The form he discovered had a long shelf life. It was subsequently proven that this stability remained in any climatic condition.

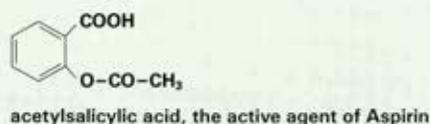
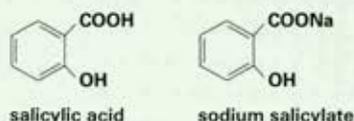
No other product contributed as much to making Bayer so well-known as Aspirin. It is used as an analgesic literally all over the world. Originally, it took the form of a powder packed in glass bottles (left). Today millions

of tablets distributed in modern packages like those shown above are sold daily.

Acetylsalicylic acid (Aspirin)

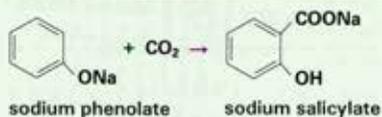
As found in the bark of the willow (*salix*), salicylic acid is chemically the same as *o*-hydroxybenzoic acid. The free hydroxyl group is

the cause of poor tolerability of this compound as an analgesic. It can easily be de-activated by acetylation:



The salicylic acid necessary for the production of acetylsalicylic acid can easily be obtained in large quantities from the sodium salt of phenol

by addition of carbon dioxide, CO_2 . This process is based on the Kolbe-Schmitt reaction discovered in the last century:



The basis for the molecular composition of Aspirin is salicylic acid, which occurs naturally in the willow, a species of willow. The similarity to the formula for acetylsalicylic acid, the actual active agent of Aspirin, is illustrated clearly in the above presentation. Hippocrates,

the Father of Medicine, had already in his day known the analgesic properties of the willow and used it in therapy.

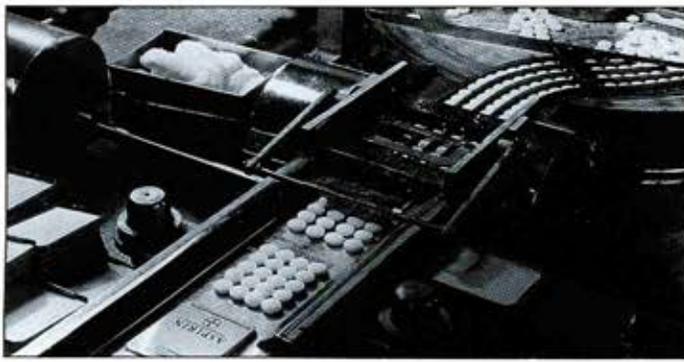
Furthermore, the new product was effective in relieving headaches, toothache and nerve pain; in reducing fever and combating inflammation. It had a "tart, acidulous" taste. Later on it was discovered that acetylsalicylic acid promotes the supply of blood to the heart.

Bayer's management did not need much deliberation to launch such a promising product. A name was sought and found in "aspirin," which was formed from the German word for an acid chemically identical to salicylic acid and found in the sap of the spiraea shrub, and the initial "A" for acetyl.

Like almost all pharmaceuticals of the day, it was initially made as a powder. The following year, it was compressed into a water-soluble tablet. Aspirin was thus the first major drug to be marketed in tablet form. This new way of producing the tablets saved the packaging of the individual doses in paper bags and cut costs in half. A few years later, some people joked that the tablet form was only invented to accommodate the Bayer cross introduced in 1904.

Actually, acetylsalicylic acid was not really new. As early as 1853, Strasbourg chemist Charles Frédéric Gerhardt had produced acetylsalicylic acid. This was, however, impure and therefore not stable, so it was soon forgotten. It was rediscovered by a chemist named Karl Johann Kraut in 1869 and went into production—without a brand name—at the von Heyden chemical works in 1897.

The origins of the substance go back to ancient times. Greek physician Hippocrates of Cos (460–377 B.C.), known as the Father of Medicine, was aware of the analgesic properties of willow bark juice, as was the philosopher and recognized Father of Botany Theophrastus (372–287 B.C.). While the therapeutic properties of the willow (Latin: *salix*) were forgotten by the medical profession of the Middle Ages, it continued to play an important role in popular medicine. Herb specialists boiled up willow bark and gave their suffering patients the bitter concoction. Not until 1763 did Rev. Edward Stone give a report to the British Royal Society on experiments with *salix* bark extract conducted on 50 fever patients.



Later, because Napoleon's Continental Blockade cut off quinine to central Europe, interest was revived in the domestic willow. In 1828, a professor in Munich boiled up a yellow substance that he named salicin; the following year a French pharmacist produced salicin in crystalline form and in 1838, an Italian chemist further processed it into salicylic acid.

In 1859, Marburg chemistry professor Hermann Kolbe determined the constitution of salicylic acid. His pupil Friedrich von Heyden started industrial production in 1874. In 1876, proof of the anti-rheumatic, analgesic and antipyretic properties of the acid was established in Berlin's Charité Hospital. The only thing that stopped its popularity was the appalling taste and the caustic effect on the stomach. This was the market niche filled by acetylsalicylic acid in the shape of Aspirin.

In the first decade of its availability, the new product was tested by doctors all over the world. They found that it worked in a broad range of indications in relieving pain and countering fever and inflammation, which include pleurisy, tonsillitis, inflammation of the bladder, and pains of the joints due to tuberculosis, gonorrhoea and gout.

When several influenza epidemics swept the world at the start of this century, Aspirin tablets were praised as the "queen of the salicylates." They helped tens of thousands of sufferers, and their name became as much of an international household word as Coca Cola is today.

It was hardly surprising that imitators soon began to appear on the scene. In the mid 1920s, a secret Aspirin factory was discovered in the basement of a private house in Hamburg. Bayer had to place newspaper advertisements threatening to sue pharmacies caught selling false Bayer Aspirin. In February 1926, the Norwegian Pharmaceutical Society went so far as to demand life imprisonment with hard labor for the criminal counterfeiting of pharmaceuticals, expressing concern not for the trademarks in question and their protection, but rather for the safety of patients. The contents of the imitators' packages were often far below the standard of Bayer

Only a year after its initial introduction, Bayer started marketing its Aspirin in tablet form. A short time later the tablets themselves were advertising the firm, bearing the Bayer cross trademark created in 1904.

Aspirin—and far from living up to the guarantees of the original product.

Headaches are certainly no stranger to writers. World literature would have been poorer in the past 85 years without the help of aspirin. Indeed, there is no lack of mention and praise for the product. José Ortega y Gasset, who named our century the "Aspirin Age," wrote in his book "Revolt of the Masses" (published in Germany in 1931) that *"the man in the street today lives more easily, more comfortably and more safely than the potentate in the past. It matters little to him that he is no richer than his neighbor if the world around him is rich enough to provide him with roads, railroads, hotels, a telegraph system, physical well-being and Aspirin."*

Franz Kafka wrote to his woman friend in detail about the product, while Thomas Mann repeatedly entered into his diary how "wonderfully" he responded to Aspirin. Enrico Caruso demanded German Aspirin from his impresario Emil Ledner, claiming it was the only thing that could tackle his headaches.

Aspirin also occurs in the works of Jaroslav Hašek, the author of "Good Soldier Schwejk," in Kurt Tucholsky's "Secrets of the Harem," in "The Human Factor" by Graham Greene, in Giovanni Guareschi's "Don Camillo," in the novel "Null-acht-fünfzehn" by the German bestselling author Hans Hellmut Kirst, and in Edgar Wallace's "Door with Seven Locks," where one excerpt sounds as if it had been written by Bayer's advertising department: *"The hammering gradually lost its power over Sybil, the roaring in her ears faded to a soft humming and the fog suddenly lifted from her memory."* Sybil had just taken an Aspirin.

A trademark that attracts so much unpaid word-of-mouth publicity is naturally a considerable asset. Like all trademarks of German operations in the United States, it was confiscated as enemy property in 1918. Sterling Drug, Inc., of New York, bought the Aspirin trademark, together with the Bayer name and the Bayer cross, after the U.S. subsidiary had been expropriated. They succeeded in buying the

There were no limits to the imagination demonstrated by the early advertising methods. This old-timer carried the message through the Netherlands that "Aspirin overwint alle pynen" ("Aspirin conquers every pain").



Aspirin—a drug that
transcends time



rights for the entire Western Hemisphere. Bayer was subsequently able to reach an agreement with Sterling in regard to Latin America and other countries, but in the U.S. itself, Bayer Aspirin remained a Sterling product. In 1986, Bayer finally paid \$ 25 million for the right to reestablish its corporate name in the United States. Bayer Aspirin and the Bayer cross were not covered by this agreement.

Miles Inc. of Elkhart, Indiana, has belonged to the Bayer group since 1978. One of the company's well-known products is "Alka-Seltzer," a popular over-the-counter drug containing acetylsalicylic acid. This has led to the paradoxical situation that "Bayer Aspirin" is not a Bayer product in the United States, while another drug containing aspirin with a different name is.

Today, the Aspirin trademark is still protected in some 70 countries. Anyone may produce acetylsalicylic acid in those countries, but only Bayer may call it Aspirin.

Total output of acetylsalicylic acid in the Western world is currently 36,000 metric tons annually, the equivalent of about 1,800 freight cars loaded to capacity. No other pharmaceutical is manufactured in this sort of volume. When acetylsalicylic acid products are called up from the CA Search data bank (see chapter on 1897), a yardlong list appears, featuring such imaginative names as Asperix.

Medical evidence has proven again and again that pure acetylsalicylic acid is an effective painkiller. In 1972 alone, there were two conclusive investigations. In a study of the U.S. National Academy of Science, 14 of the most common over-the-counter analgesics on the market were tested. The resulting decision of the committee of inquiry was that none of them were better than acetylsalicylic acid. The potency of other products was seen as depending on their acetylsalicylic acid content. At the same time, the Mayo Clinic in Rochester, Minnesota, carried out a double-blind test involving 57 cancer patients in which neither the doctor nor the patient knew which product was being used. This test investigated eight different painkillers, some of which were

much stronger than "aspirin." It was clearly shown that aspirin provided the greatest relief.

In 1969, "aspirin tablets" were included in the self-medication kits taken to the moon by the Apollo astronauts. They proved very effective in combating the headaches and muscle pains that frequently resulted from long periods of immobility.

In the Federal Republic, acetylsalicylic acid products are among the most popular forms of non-prescription self-medication. Per-capita consumption amounts to 55 grams annually in the United States and about eight in the Federal Republic.

As great as international confidence in acetylsalicylic acid is, it should be stressed that no pharmaceutical is totally free of side-effects and contraindications. These can read like horror stories, but it is prescribed by law that every danger must be drawn to the user's attention, even if the chances of complications are extremely small. Acetylsalicylic acid can be problematic for patients with stomach or intestinal ulcers, or when taken in combination with such medications as anti-coagulant and rheumatic remedies.

Over the past few years, much has also been said about the Reye Syndrome. This is a still unexplained, very rare disease in children that under certain circumstances can threaten their lives. Apart from a hereditary propensity to this syndrome and environmental factors, salicylates have also been discussed as a possible causative agent. For this reason and until the causes are conclusively known, the package slip recommends that Aspirin should be taken by children and juveniles suspected of having viral influenza or chicken-pox only upon doctors' instructions and only where other measures are not effective.

Felix Hoffmann discovered this remarkably comprehensive pharmaceutical in 1897. New scientific data collected over the past two decades earn aspirin the distinction of "product of the century."

In 1971, John Vane of London showed that the anti-inflammatory properties of the salicylates are due to their ability to prevent the biosynthesis of certain

The structural model of Aspirin shown on the left illustrates the relatively simple constitution of Felix Hoffmann's invention. Born on January 21, 1868, this chemist joined the company's central laboratories at Elberfeld in 1894 and synthesized Aspirin there three years later.

Aspirin—a drug that
transcends time



prostaglandins that promote inflammation. This provided the explanation for the then-unrecognized properties specific to coagulation of acetylsalicylic acid. For this discovery, Vane was awarded the 1982 Nobel Prize for Medicine.

Working from this, researchers discovered the effect of acetylsalicylic acid on the blood platelet function. As a result, Bayer introduced "Colfarit," a microcapsule form of the acid.

If it is possible to dissolve the blood clots responsible for embolism, it should also be possible to reduce the danger of coronaries and strokes. International studies involving 13,300 patients were initiated. A German and Austrian study reached the conclusion that acetylsalicylic acid reduced the overall fatality rate for infarct by 17.3 percent and for non-fatal re-infarct by 30 percent. Researchers in the United States found that the frequency of apoplexy could be halved with regular doses of acetylsalicylic acid.

The U.S. Food and Drug Administration (FDA) is extremely cautious in its statements. So when the FDA does give a judgment, the world listens attentively. Therefore, it was a sensation when the FDA announced on October 9, 1985, that daily doses of acetylsalicylic acid as an accompanying therapy reduced the risk of a second infarct by one-fifth, and with patients with unstable angina pectoris, by no less than 51 percent.

The Aspirin story is far from over. Recent clinical trials prove the efficacy of acetylsalicylic acid against acute cardiac infarct. And in small doses given as a prophylaxis, aspirin appears to reduce the frequency of infarct in healthy test persons, too. One possible additional use could be as a prophylaxis against cataracts in the elderly, an indication currently the subject of clinical tests.

Charles Berry, the medical director of NASA, claims that *"aspirin will be used as a standard pharmaceutical for all eternity."*

Aspirin plus C takes to the skies. This effervescent tablet combines the popular analgesic with vitamin C. The hot-air balloon of the Bayer's aerial sports club—shown here floating over the Leverkusen works—is a worthy successor to the car pictured on page 137.

Bayer chronicle 1899

The working day at all of Bayer's plants is fixed at ten hours as of February 1. A corresponding directive, which is subsequently distributed by management, contains the regulation that laborers or craftsmen "who have worked 24 hours without interruption will be sent home without exception."

A savings bank for workers is founded. Bonuses are paid into this fund, kept in separate accounts and yield five percent interest.

Two-thirds of all German chemists are employed in the dyestuffs industry. Bayer is now the second largest company, after BASF, among the "Big Three." Altogether Bayer employs 800 people on its clerical staff, 145 chemists, 35 engineers and 4,400 workers.

Bayer opens a branch office in Belgium.



The watertower (above), which is for many years to be a landmark of Leverkusen, is completed.

World events 1899

At the suggestion of Czar Nicolas II of Russia, 26 nations take part in the First Hague



Peace Conference. They agree on the establishment of an International Court of Arbitration in The Hague.

Samoa Treaty divides the Samoan Islands on the 171st degree of longitude between Germany and the United States.

In Aachen the "Vereinigte Glanzstoff-Fabriken AG" is formed for the manufacture of cuprammonium rayon.

Production of synthetic caffeine goes on stream at "C.F. Boehringer & Söhne." The process was developed by Emil Fischer in 1897.

Julius Elster and Hans Geitel develop the theory that radioactive radiation results from the decay of atoms.

The world's first automatic dialing telephone central opens in La Porte, Indiana, on November 3.

German Federation of Christian Trade Unions is formed.

The hard-won Alizarin Convention

Surpassed by the highly successful azo dyestuffs, alizarin had become a “poor relation.” Thanks to Robert Emanuel Schmidt at Bayer, it made a comeback. But the competition had their eyes on the product, too. It took a full decade before the second Alizarin Convention could be signed on April 19, 1900. A “cavalry charge” by Carl Duisberg was the decisive factor in reaching an agreement.

Every dyestuff factory was introducing new and improved azo dyes. This meant not only better dyestuffs than the forerunners, but also better than what competitors could offer. No manufacturer was able to rest on his laurels—not even top products like Duisberg’s benzopurpurine and Agfa’s Congo red were protected by their patents forever. And these dyes could be improved upon. New developments included Benzo Fast Scarlet and Benzo Fast Blue (1900). The same thing was happening with black dyes. Bayer had introduced Benzo Blueblack to the market in 1888 and Cassella its Diamond Black the following year. Both of these were surpassed in 1893 by Agfa’s Columbia Black. Bayer’s leading position in the black dyestuffs was not regained until the introduction of Direct Deep Black E in 1898.

At first there was no progress in the field of alizarin dyestuffs. On the contrary, things were deteriorating. Since the collapse of the 1885 Convention, prices had been falling, and no new products were marketed. In an attempt to keep the alizarin plant functioning, the company resorted to cost-cutting measures and an often ludicrous hunt to find out what mistakes were being made.

In 1887, 23-year-old university graduate Robert Emanuel Schmidt came to work for Bayer. He was anything but thrilled to be sent to the seemingly ill-fated alizarin department. But the energetic young man made a virtue out of necessity. Instead of wasting his time looking for faults in the existing system or aiming for minimal improvements, he decided to try for a radical change.

As early as October of the following year, he produced the first tangible results with the development of Alizarin Blue S, which was immediately hailed as a “new era in alizarin dyestuffs.” When Alizarin Bordeaux followed in 1890, management could finally heave a sigh of relief. It was in fact a new era in two different ways. Not only were the new products faster to light than the azo series, but Schmidt’s dyestuffs were the first with an alizarin base to be patented by Bayer.



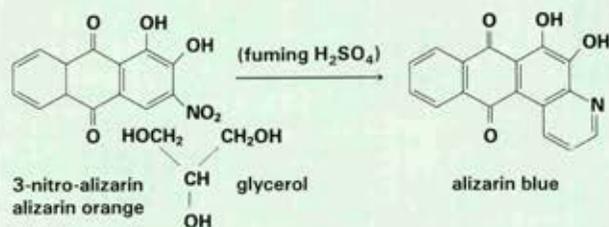
Robert Emanuel Schmidt was one of Bayer's first crisis managers. The trouble-shooting chemist, who was rarely seen without a straw hat, helped to boost flagging sales of alizarin dyestuffs by developing a new product generation soon after joining the firm. He felt happiest

in his laboratory. He returned to his research work in 1920 after eight years in the Board of Management.

Alizarin blue and alizarin bordeaux

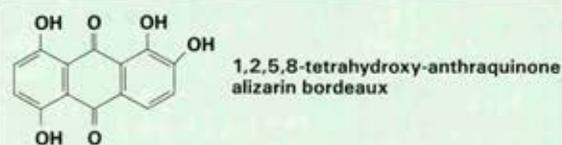
The further development of alizarin dyestuffs initiated by Robert Emanuel Schmidt was based on the modification of the original molecule either by newly attached ring systems or additional hydroxyl groups.

Alizarin may be nitrated as shown in the formula below. By treating this compound with glycerol and fuming sulfuric acid, a heterocyclic ring is attached.



Alizarin bordeaux can be obtained from alizarin by the Bohn-Schmidt reaction. The addition of boric acid referred

to in the chapter facilitates the introduction of further hydroxyl groups into the alizarin molecule:



BASF opposed the patents, but without success. Elberfeld soon came out with a new class of alizarin dyestuffs, the alizarin cyanines. Then Ludwigshafen introduced their Anthracene Blue in 1891. Patent disputes became the order of the day. For Duisberg, the only way the problem could be solved was by a new agreement.

In 1893, Friedrich Bayer Jr. and Carl Duisberg visited BASF in Ludwigshafen. They were impressed by the fact that the plant there was much larger than the Elberfeld works. Technical Manager Heinrich von Brunck showed them everything—except the alizarin production. The visitors only saw it on a blueprint, but this was enough to impress them once again. Duisberg estimated that BASF must be making one and a half times as much as Bayer.

The negotiations were unsuccessful. BASF agreed with Bayer's suggestion that licenses should be swapped for the major alizarin dyestuffs, but rejected



The figure on the neck of this sample flask indicates that it is the first sample of Robert Emanuel Schmidt's Alizarin Bordeaux Red from the year 1890. The patenting of this new generation of dyestuffs was opposed—but without success.

Bayer's further proposal that strict price levels be adhered to. Another attempt in 1896 to reach an agreement also failed.

In 1899, BASF registered an application for the patenting of a new process. Bayer opposed, as Robert Emanuel Schmidt already held a patent for the planned use of boric acid. Duisberg intervened personally in the proceedings at the Patent Office. Schmidt portrayed his appearance as if he were reporting on a military engagement: *"The battle went on to and fro for six hours. One had to admit that the enemy had prepared his attack well. His cannons were carefully aimed at our weakest positions and his operations included the laying of mines and other artifices of war. Our situation was dangerously jeopardized, but then Dr. Duisberg launched into a cavalry charge. This proved to be our salvation. After half an hour, the enemy had been overwhelmed. Though not dead, his forces were in such disarray that the battle had been decided. The patent office withdrew for an hour and a half and presented its judgment in the late afternoon: BASF was granted the patent—but it was dependent on our boric acid patent. This ruling was much more favorable for us than if the application had simply been turned down."*

The point was that BASF now had to reach a compromise. On March 19, 1900, the two companies agreed on an Alizarin Cyanine-Anthracene Blue Convention. On April 11, Hoechst and British Alizarine joined in what was, in fact, a second alizarin red agreement. After ten years, peace had been restored on the alizarin front. Duisberg had fought this battle as a Bayer executive, having officially been promoted to management on January 1, 1900. His promotion had already been promised him in October of the preceding year, at which time he immediately sat down to write a memorandum on the organization of management that was later accepted without demur. He proposed that the five top executives—Friedrich Bayer Jr., Henry Theodor von Böttinger, Hermann König, Carl Hülsenbusch and Carl Duisberg—should have equal rights, but that each should be responsible for a separate sector of activity.

Bayer chronicle 1900

In the meantime, Bayer has established 44 branch offices and 123 agencies at home and abroad.

The American sales department records sales of 7.3 million marks. Its head, I.J.R. Muurling, lives by the motto: "Success is duty."

During their search for dyestuffs to be used for fur, Arthur Eichengrün and Karl Demeler discover the photographic developer marketed under the name Edinol.

New plant for the production of sulfuric acid and oleum by the contact process is inaugurated in Leverkusen.

The second Bayer medical polyclinic for employees—this time in Leverkusen—is opened. (The photo below shows a view of the examining room.)



The "Dyeworks Orchestral Society" is formed, and a tennis club is set up in Uerdingen at the Weiler-ter Meer works.

World events 1900

Boxer Rebellion breaks out in China. Leading European powers, the United States and Japan send an expeditionary force to suppress it.

Boer War passes into a more violent phase; Boers embrace guerilla tactics and the British troops respond with a scorched-earth campaign.

King Humbert I of Italy is shot by an anarchist in Monza.

Count Bernhard von Bülow becomes German Chancellor.

The Paris World Exhibition is opened in a mood of general optimism. At the same time, the Second Olympics of modern times take place in the French capital.

On December 14, Max Planck publishes his pioneering work on the "Radiation of Black Bodies" in Berlin and thus lays the foundation for the development of the quantum theory.

Count Ferdinand von Zeppelin takes off from Friedrichshafen in his first blimp. The rudder breaks at a height of just over 1,300 feet and the "Zeppelin" crashes in Lake Constance.

Austrian Karl Landsteiner categorizes human blood into the three groups A, B and C (subsequently 0).

“Waste Water Commission” asks many questions

The first meeting of the “Waste Water Commission of the Leverkusen Dyeworks” took place on November 5, 1901. Its aim was to collect data on the effluent situation within the works and on the emissions into the Rhine.

This marked the real start of a systematic environmental protection program at Bayer. Now, over a billion marks a year is spent on environmental protection, and the company devotes almost a quarter of all its research funds to this effort. Environmental protection is such an integral part of today's operations that the head of the department responsible for it made the following explicit statement about the development of products and the construction of plants: *“Anything that does not meet the necessary ecological standards has no future.”*

Strangely enough, the terms “environmental protection” and “ecology” are relatively new. Only in the 1960s did a full realization of the significance of environmental protection begin to emerge, and not until the 1970s did it become a yardstick for the future development of technology and society as a whole.

The environmental situation is much better than it used to be, but then the attitude toward ecology has changed as well. Considering the circumstances of the time, the establishment of the Leverkusen Waste Water Commission in 1901 was indeed a historic date in Bayer's annals. It had, of course, long been understood that the chemical industry worked with dangerous materials. But people believed in the ability of nature to clean things up on its own accord.

In 1893, for example, Percy Frankland demonstrated that the self-cleaning powers of rivers were so great that out of the 14,937 bacilli contained in a cubic centimeter of Thames water, only 177 survived a few days in the large sedimentation basins of the Middlesex Waterworks.

Rapid industrialization had, however, already been too much for many rivers and streams. By the late 19th century, the public had become concerned about foul-smelling or colored liquid waste. Elberfeld and Barmen were not only home to Bayer, but also to thriving textile and metal industries. Although this business contributed to local prosperity, industrial waste and a constantly growing population proved a strain on the narrow valley and the rather small Wupper river.

“*Daphnia pulex*” plays a small, but nevertheless important, role in environmental control today. The water flea is a delicacy for fish in inland waters and the cleaner the water, the greater the water flea population. Bayer's water laboratories use

this tiny organism to help determine the purity of clarified waste water.



"Waste Water Commission" asks many questions

Setting up major production facilities on the Rhine was therefore a strategic decision not only based on considerations of space and better transport conditions. In keeping with the corporate philosophy of the day, Bayer also hoped the move would help solve some of its liquid and solid waste problems.

The trouble was that the Rhine was already subject to very special conditions. From Basel past the mouth of the Main river up to Leverkusen and the confluence with the Wupper, there was an unparalleled concentration of large chemical plants. Bayer did not want to share the guilt if the river was not in fact able to handle the volume of effluent arising from this industrial concentration. The four members of the Waste Water Commission thus set out to tackle the following questions:

"What is the nature of the waste water released in the morning, at midday and in the evening in respect to the following substances: free acid, sulfurous acid, hydrogen sulfide, fixed sulfuric acid, hydrochloric acid and sediments? The presence of all these

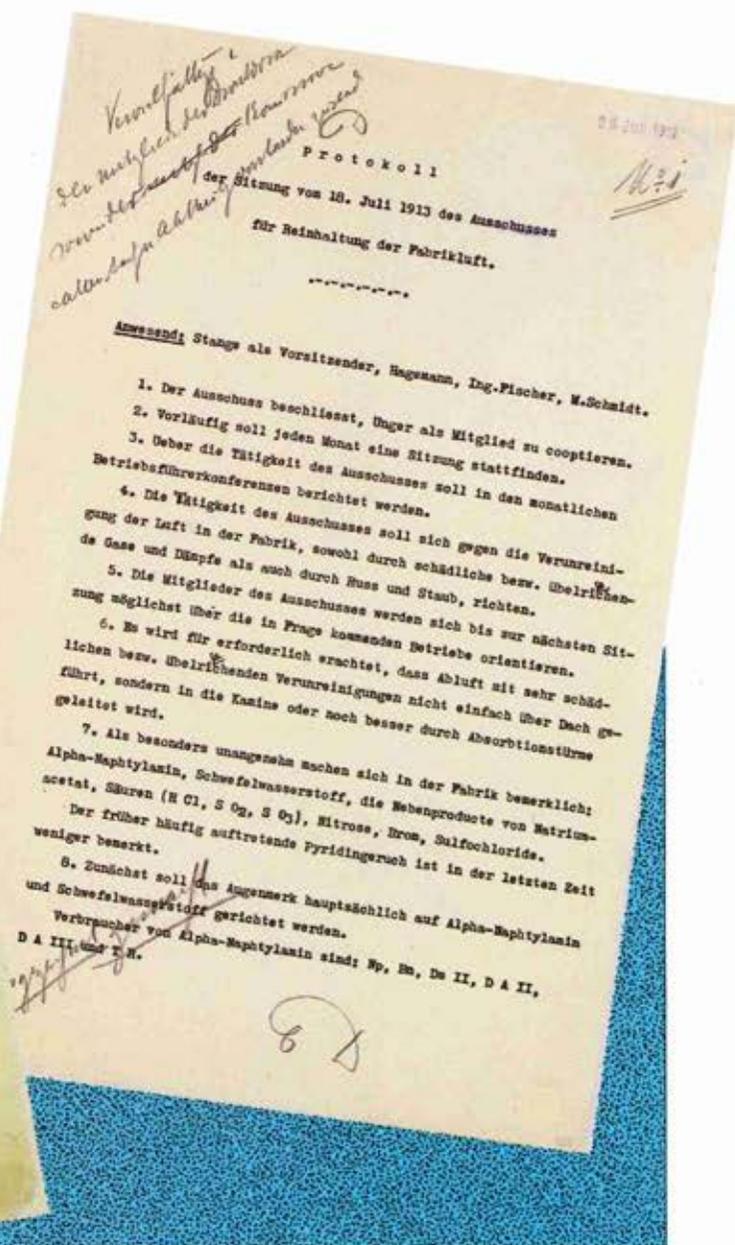
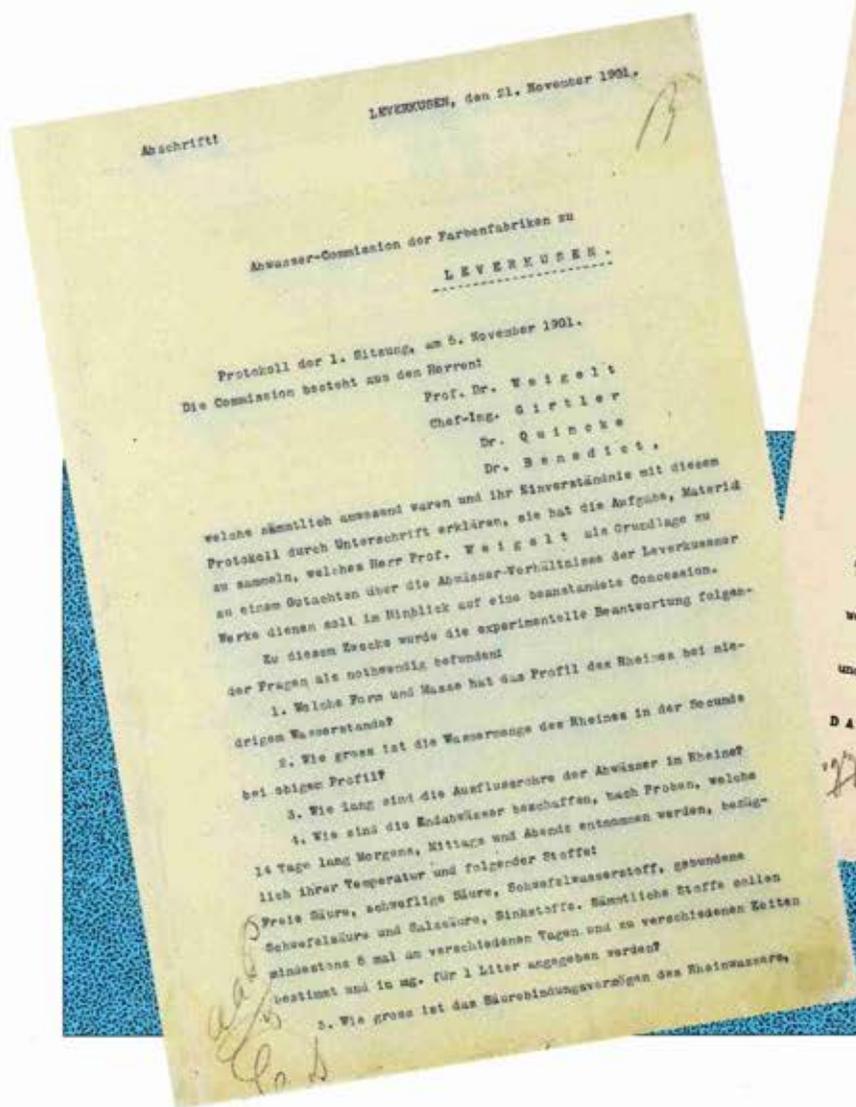
substances should be reported in terms of milligrams per liter at least eight times on different days and at different times.

"How great is the ability of the Rhine water to absorb acids upstream and downstream from the dyeworks?"

"How does the dyed waste water react as far as its coloring power and turbidity are concerned?"

"What are the contents of the liquid wastes produced by each individual factory? How much is released?"

These investigations took place at a time when public awareness was centered on totally different dangers. The discoveries of Robert Koch had given rise to a frequently hysterical "bacteria conscious" public. Ten years later, this gave way to a similarly intense public hygiene complex.



Chemists may not have had today's analytical processes at their disposal back then, but they could nevertheless track down harmful substances in concentrations as minute as a milligram. Bayer's commission put this state-of-the-art technology to good use. Its records show that during the initial years of the commission's activities, it was considered necessary not only to control type, quantity and sources of waste water contents, but also to work out proposals to improve the situation and pass them on in the form of concrete recommendations or instructions to the plants.

Early in its existence, the commission was already starting to look at other aspects of environmental protection. This soon necessitated a certain degree of specialization, and in 1913, a separate "Committee for Clean Factory Air" was formed.

From the very start, Bayer has taken its ecological responsibilities seriously. Waste water control in particular, to which this book devotes various chapters, has been a regular part of company operations since the first year of this century.

Environmental protection is not just a passing fad at Bayer. The necessity to protect humans and nature from any harmful effects of industry had already been realized in the early days of industrialization. Bayer's first Waste Water Commission met in Leverkusen as early

as November 5, 1901. A special Committee for Clean Factory Air was set up at the plant on July 18, 1913.

Bayer chronicle 1901

Difficulties in finding skilled craftsmen lead to the establishment of a training school and workshop (below) in Leverkusen. Only the sons of employees are chosen as trainees.



Alizarin production is relocated from Elberfeld to Leverkusen. One Alizarin Red plant is already there, which had been taken over from the company Carl Leverkus & Söhne with the acquisition of the property in 1891.

The pharmaceutical department introduces the diuretic "Agurin" to the market.

Carl Duisberg obtains an automobile for his trips between Elberfeld and Leverkusen. He is the second proud owner of a motorcar in the Bergisches Land region after the district judge in Opladen.



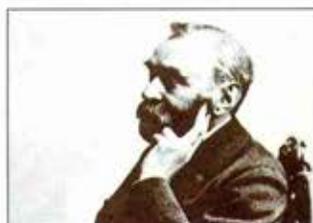
World events 1901

Victoria, Queen of the United Kingdom and Empress of India, dies on January 22 at the age of 82, marking the end of the 64-year Victorian era.

President William McKinley is assassinated by an anarchist in Buffalo. Theodore Roosevelt becomes the 26th president of the United States.

John Pierpont Morgan forms the United States Steel Corp.

To mark the tenth anniversary of the death of Alfred Nobel (photo) on December 10, the first Nobel Prizes are awarded in Stockholm and Oslo. Laureates are Wilhelm Conrad Röntgen (Physics), Emil von Behring (Medicine), Jacobus Henricus van't Hoff (Chemistry), and Sully Prud-



homme (Literature). The Peace Prizes were awarded to Henri Dunant and Frédéric Passy.

On the same day, December 10, Guglielmo Marconi succeeds in transmitting a radio signal across the Atlantic.

Jokichi Takamine discovers adrenaline and Robert Michael Forde the pathogenic agent of sleeping sickness.

The Bayer Fire Department goes professional

“By the power invested in Him, His Majesty the King has ordered” that the Bayer Fire Department be uniformed in accordance with the Prussian Uniform Regulations for Municipal Fire Departments and be permitted in addition to wear the company coat-of-arms.

That was in 1902. There had already been a voluntary fire department ever since the Elberfeld and Barmen plants had had enough workers to delegate a few for fire duties.

In 1893, when the first Leverkusen units were still being built, a fire crew chief from the Elberfeld department was sent to the site to organize a voluntary corps there as well. Two fire stations were at first equipped with hand-powered fire engines that had to be pulled along by the crew. In 1897, a horse-drawn engine was added.

Peter Lukas, a 23-year-old who had been working in the phthalic acid plant since 1895, joined the fire department in 1897 after his military service. He later reminisced: *“I was fitted out with a black cloth jacket that had nickel buttons, a pair of black cloth pants and a black cloth cap, mainly for Sunday and guard duty in winter; a blue jacket and a pair of blue linen pants for similar summer duties; two patched blue drill jackets and two pairs of patched blue linen pants for daily use; plus a second black cloth cap, a pair of corduroy pants and a moleskin jacket for winter work. No footwear was issued; everyone wore what he had.”*

A little later, the firefighters received red braiding for their caps as a status symbol. Boots also soon belonged to the outfit of the fire department, which in the meantime had a staff of 23 men.

Fortunately, fires were not frequent enough for the department to keep busy so that the firemen eventually became “jacks-of-all-trades.” The fire department was, for example, responsible for the ambulance service, for the vehicle park, for the works canteen, for the maintenance and safety of on-site roads, for gardening jobs, for accompanying visitors of the works, for the regulation and maintenance of works bicycles, for boot repairs, for nighttime and Sunday guard duties and for many more similar kinds of odd jobs.

According to Peter Lukas: *“The firemen turned up every morning like every other worker with their lunch box and sandwiches. At that time there were*

Officers and men of the Works Fire Department of Farbenfabriken vorm. Friedr. Bayer & Co. line up for the photographer in 1912. The firemen were particularly proud of their two motorized fire engines, among the first of their kind. The old fire alarm (above right) doubled

as a weather station and was one of the first relatively simple alarm systems installed in Bayer’s residential areas.

no train tracks; everything was transported by horse-drawn vehicles. These caused such damage that we had to even out potholed roads.

"Other jobs included shoveling lime and sulfate, moving coal into the boiler houses, from which we also had to remove the ashes; loading sludge and collecting scrap. Lighting was very poor. We had to light the 30 gas lamps in the evening and put them out again in the morning. On our rounds at night we carried oil lamps.

"When there had been a fire, we had to start our shift by cleaning out the hoses, using fiber brushes and working in an old 300 or 400 liter boiler."

In 1906, the fire department became part of the Engineering Department. Equipment was subsequently improved, not just up to the standards of the municipal fire corps but, if possible, ahead of them. A special cycle-mounted rescue unit was added, later a rail vehicle, a steam-powered fire engine (1909), a fire truck for the crew (1910), a motorized fire engine (1912) and the first motorized ambulance (1915).

When corporate headquarters moved from Elberfeld to Leverkusen in 1912, the first central firehouse was built with what was for those days a revolutionary communications system. It had a central alarm served by 60 individual fire alarms located all over the premises.



Duisberg liked to give a demonstration of this system to visitors. On one occasion, things worked a little too well. In the company of a Prussian general, Duisberg approached a fire alarm. As the host was about to activate it, his guest asked him a question. But even without the red alarm button having been pressed, two fire engines tore out ringing their bells for all they were worth. The firemen had been watching the movements of the "Herr Direktor," but not quite closely enough.

In 1913, the Royal Railroad Administration of Germany commended 14 Bayer firemen for their exemplary rescue efforts in connection with a train crash, and in 1921 the Archiepiscopal Vicar-General donated 3,000 marks to Bayer's fire department as a token of thanks for their work in protecting the Altenberg Cathedral from a conflagration nearby.

Up until the Second World War, the Leverkusen works fire department was staffed by 35 to 45 men. The war demanded all they could give. The plant was regularly bombed and in 1945, was also subjected to shellfire. Not only did they have to put out the fires, the men of the fire department also had bomb disposal duties.

The increase in staff and modernization of the fire department came with the company's rapid growth in the 1950s and 1960s.



The factory library offers everything from Goethe to videocassettes

Bayer was not the first industrial firm to open a factory library. Krupp in Essen, Zeiss in Jena and BASF in Ludwigshafen all had such libraries. But in Wiesdorf, where there were few forms of recreation and further education, a library was particularly important.

The Bayer factory library was set up on September 1, 1902. Its statutes included the following provisions:

- “§ 1 *The library is to serve the instruction and entertainment of all employees.*
- § 2 *The selection of books to be acquired shall be made by a committee whose decisions are subject to managerial approval...*
- § 3 *The use of the library is free of charge.”*

Four months after the library was opened, one-third of the workforce were members. They initially had the use of 5,544 books. A total of 15,375 marks had originally been invested in books, whereby some had been donated. By 1910, a total of 13,564 volumes were available.

In 1908, a reading room was set aside in the new recreation center with a selection of books, 13 daily papers and 115 magazines. The reading room, which was open until 10 p.m. every evening, was accessible to employees and their families. It even featured reading hours for children.



From the very start, the running of the library and the choice of books to be purchased were in the hands of an expert. A glance at the handwritten catalog shows that there was a comprehensive and broad selection of books. They ranged from Aeschylus and Aristophanes to Goethe; from Mark Twain to the daring French novelist Emile Zola and the then-modern German author Gerhart Hauptmann.

But what was really read? The most popular authors of the day were Jules Verne, Germany's rural-epic

Back in the early days of this century, Bayer had a corner set aside in its recreation center for bookworms. This reading room (above) functioned as a branch of the actual works library, which was housed in a building next to the Kasino.

As the picture on the right shows, many Bayer employees still make use of their lunch break to visit the library.

master Ludwig Ganghofer and German humorist Wilhelm Busch. Mark Twain and Theodor Fontane were also popular. These authors were followed by numerous writers who have long since fallen into relative obscurity.

The library was destroyed in an artillery attack in 1945. The only books saved were those in circulation or at the binder's—some 4,500 out of 28,000. The library then started off anew with these 4,500 volumes.

As a result of today's technological advances, the selection at the Bayer libraries (now in the plural because in the meantime, each plant has one of its own) has broadened enormously. Now the catalog does not list just books, "media units" have appeared on the scene. These units consist of books, newspapers, magazines and journals covering everything from physics and chemistry through educational psychology to hobbies of all kinds. Games, videotapes, audio cassettes and courses for eight foreign languages are included. The library even carries 30 language guides that range from Arabic to Thai.

A total of 186,000 media units in the four factory libraries were lent out some 575,000 times in all during 1987. This means that every unit was taken out an average of three times annually.

Over one-third of today's employees make use of the libraries—to be exact, one percent more than in the early 1900s. The only difference is that users are no longer dependent on library books (or, rather, "media units") against boredom as they were in the early days of the plant "at the end of the world" in Leverkusen.



Bayer chronicle 1902

Production begins of anthraquinone-1-sulfonic acid, an important raw material for vat and wool dyestuffs.

Diamond Black dyestuffs are invented. Bayer consolidates its leading position in the black-dye sector after the 1898 introduction of Direct Deep Black E.

Production begins of fixing salts and flashbulb powder.

Customer file contains 25,000 addresses.

Safety regulations are published.

Masures are taken against excessive turnover in the labor force: migrant workers who have worked for the company on three separate occasions may be reemployed only with the consent of management, while workers coming from other chemical plants are no longer accepted for work in Bayer's chemical facilities.

World events 1902

Boer War ends on May 31. The Boer Republics become British colonies.

Friedrich Krupp dies in Essen on November 22. The Krupp works employ 43,000—compared to Bayer's 6,540.

Australia becomes the first country to give women the right to vote (Finland follows suit in 1906, Russia in 1917, Germany in 1918, the United States in 1920, the United Kingdom in 1928, and France in 1944).

An eruption of the volcano Montagne Pelé on the island of Martinique claims 40,000 victims.

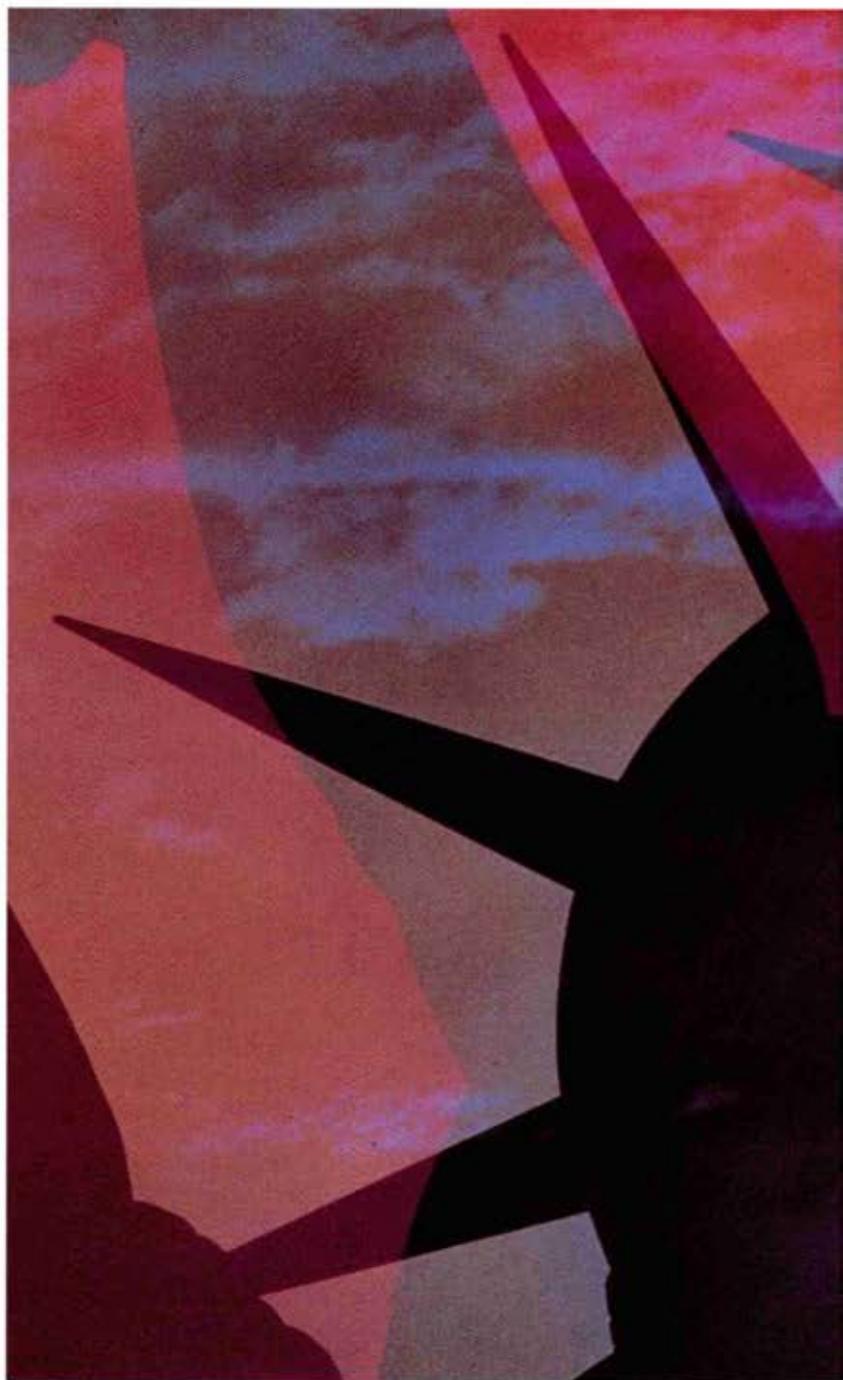
Emil Fischer is awarded the Nobel Prize for Chemistry for his research work on amino acids, polypeptides and proteins.

Between March and October a 9,000-mile deep-sea cable is laid from Vancouver to New Zealand via the Fiji Islands and Australia.

Robert Bosch and Gottfried Honold invent the spark plug.

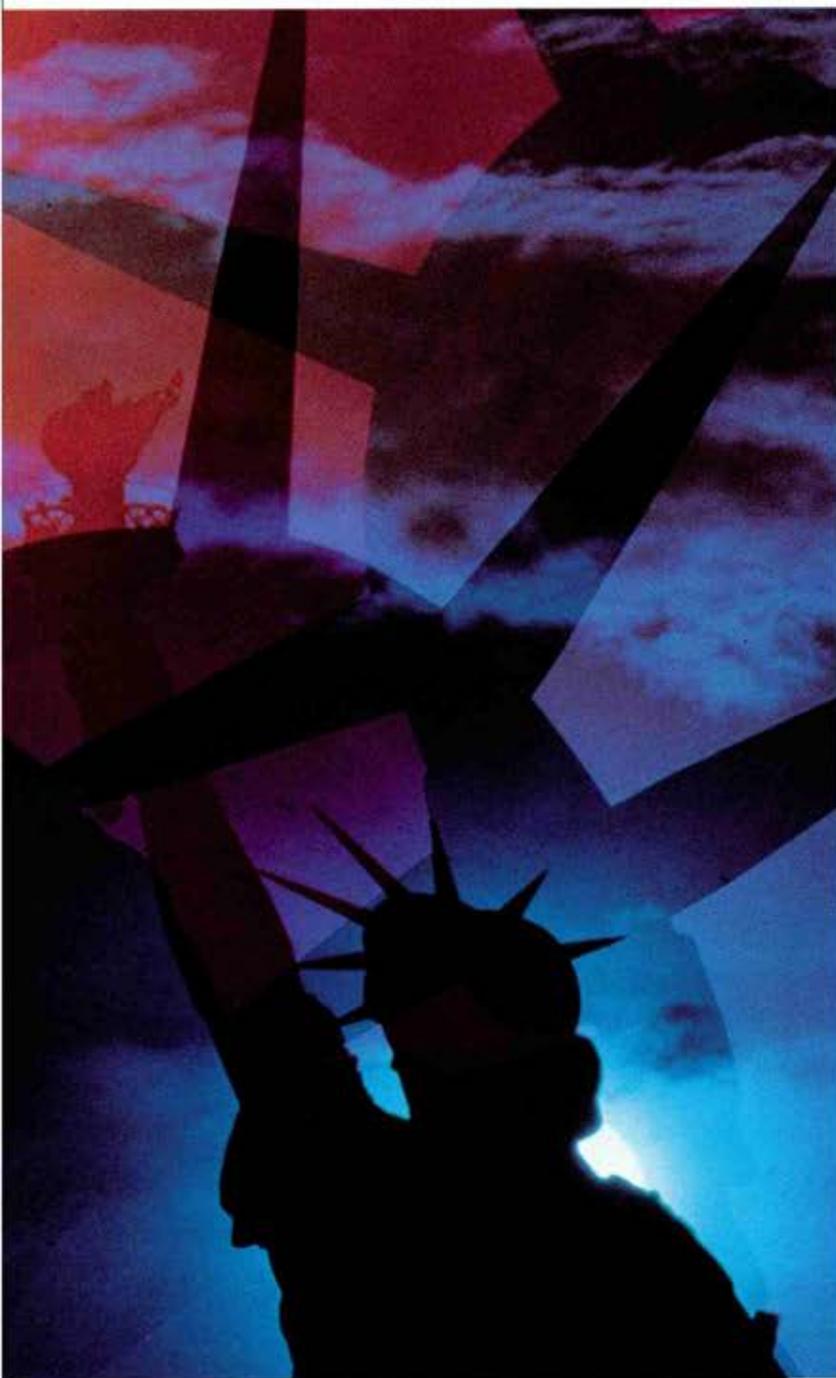
Bayer Jr. and Duisberg set up production in the United States

Bayer had held a controlling interest in the Hudson River Aniline and Color Works, a firm based in Albany, New York, since 1882. But the company's first contacts in the United States were established as early as 1865. On October 1, 1903, the dyeworks and a neighboring factory were taken over by Farbenfabriken vorm. Friedr. Bayer & Co.



The United States had already been a business partner of Bayer before the turn of the century. The small picture (right) shows the "office for American correspondence," which was responsible for writing to customers and agencies in North America.

One of these was the Boston branch, pictured above right.



Albany was the location of the first and only German-owned dyestuffs plant to operate in the United States. It remained the only plant for a long time.

While the import policy of the United States was fundamentally protectionist, dyestuffs were an exception to the rule. Their import put no strain on the American trade balance. Actually, such goods were needed to offset the large surplus in the balance of trade with Germany.

At the time, a total of 90 percent of all dyestuff imports for the U.S. textile industry came from Germany, the rest from Switzerland. Patents were granted without difficulty. Of the 819 U.S. patents issued for organic dyestuffs in the period between 1900 and 1910, no fewer than 84 percent were granted to German interests, a further 14 percent to Swiss patentees—and only one percent to American applicants.



In 1899, a group of American financiers offered Bayer a joint venture. Bayer was to provide the dyestuffs technology and the Americans would provide the necessary capital. At the time, there was no reason to accept. Duisberg wrote to the head of Bayer's U.S. agency, "We can get as much German capital as we need if we want to set up an American plant." Bayer's managers simply did not want to take the step at that time.

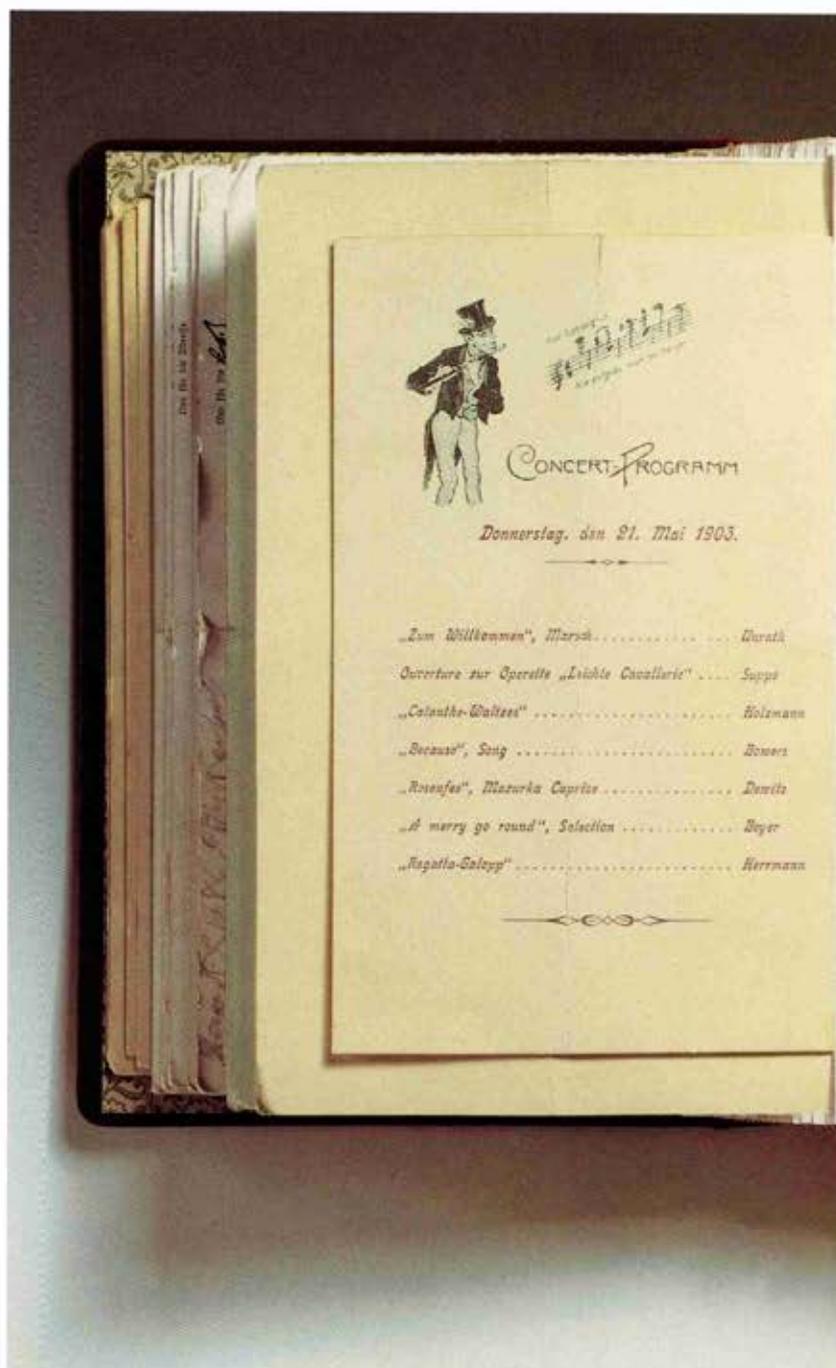


There were justified reasons not to operate a factory in the United States in 1899. The transportation costs for exporting goods from Germany were reasonable. And, while the wages that the firms had to pay in America were higher, there was a shortage of qualified American personnel. There were not many qualified works chemists in America, and the prospects for Bayer chemists posted in the United States were not attractive—careers were made in Elberfeld and Leverkusen, not abroad. From the firm's point of view, there was the additional danger that employees sent abroad would be wooed away by other producers or would even set up their own companies with American capital.

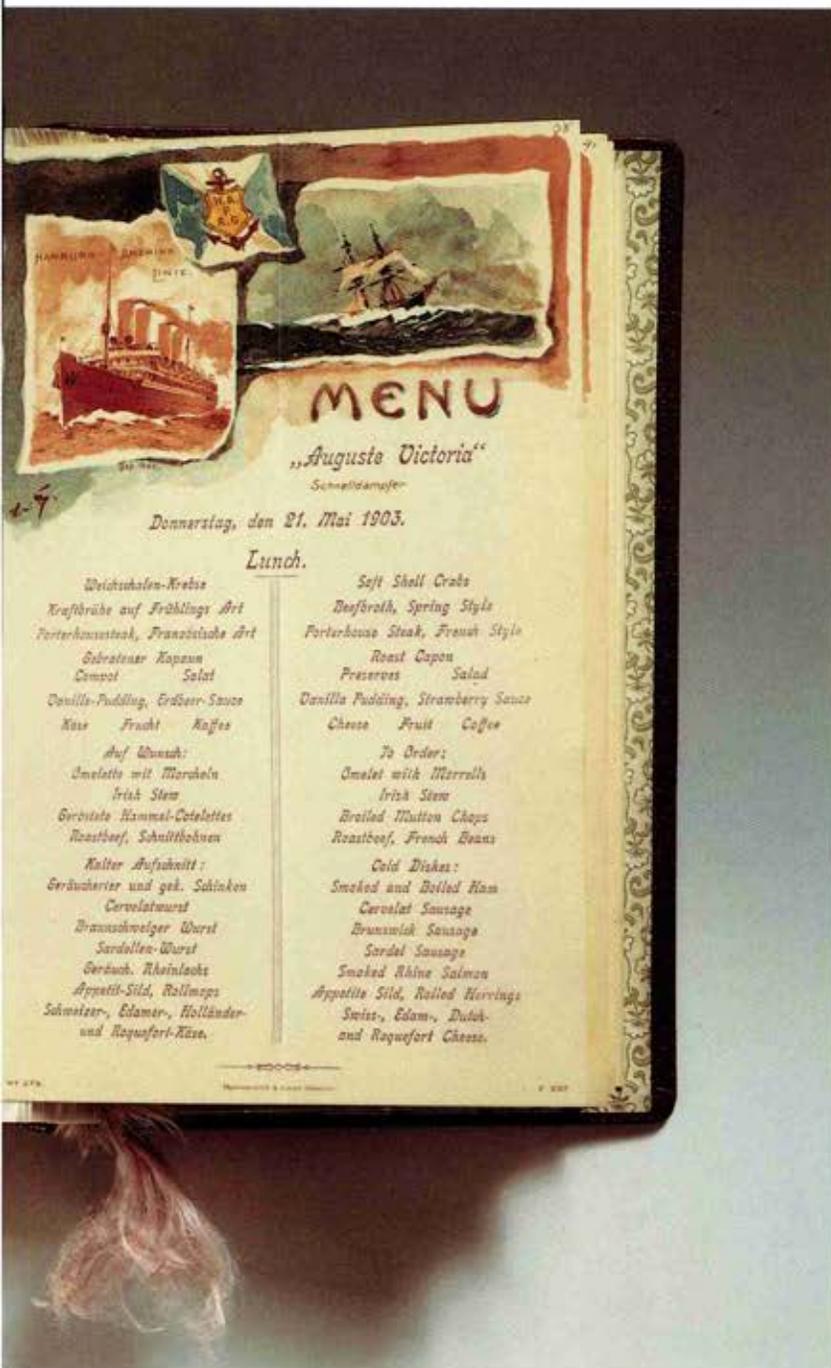
In the end, though, the situation on the pharmaceutical market was the decisive factor in starting production in the United States. The U.S. patent for Phenacetin expired and Bayer wanted to introduce Aspirin to this enormous market. The trouble was that in these cases, unlike the situation in the dyestuffs business, local firms were also interested in producing these products.

In the spring of 1903, Friedrich Bayer Jr., Carl Duisberg and chief engineer Ludwig Girtler traveled to the United States to look for a suitable production location. The choice turned out to be an easy one: Hudson River Aniline and Color Works, whose factory had just burned down, could be purchased on favorable terms, as could American Color & Chemical Company in Rensselaer on the opposite bank of the river. On September 9 of that year, Bayer made the following report: "Execution of the entire project will cost a total of 198,625 dollars, or about 844,000 marks. Since our liquid assets as of August 31 amount to 15.1 million marks, payment of the above sum will cause us no difficulties." The purchase was made discreetly and a new plant was set up where production of Phenacetin and Aspirin began in 1905.

In comparison to the Moscow plant, the new works was a small one. By 1913, it employed no more than 84 persons. But 50 percent of all the pharmaceuticals Bayer sold in America came from the facility, compared to only ten percent of the dyestuffs.



The enthusiastic collector Carl Duisberg brought back all sorts of mementoes from his extensive foreign journeys, some of which took months at a time. The above concert program and menu of the liner "Auguste Victoria" show how he spent his day on May 21, 1903.



Bayer chronicle 1903

World events 1903

Paul Eduard Liesegang, pioneer of photography and owner of the Düsseldorf company, "Fabrik für Photographische Papiere, Projections- und Photographische Apparate," offers Bayer the chance to buy his photographic paper. Duisberg's answer: "Not just the paper, but the whole factory!" Despite this, Liesegang gets his way with an initial contract, signed on October 22. The following year, Bayer also takes over the production and in 1913 the entire photographic paper plant with all its employees.

A new dyehouse is opened in Elberfeld. It is equipped for such special jobs as leather and paper dyeing and lacquer work.

Emil Fischer and Josef von Mering introduce the therapeutical use of Veronal as a sedative.

With support from the United States, Panama declares its independence from Colombia and cedes part of its territory to the U.S. in exchange for the construction of the Panama Canal.

German trade unionist Karl Legien, the pioneer of autonomous wage negotiations, becomes head of the International Federation of Trade Unions.

German Child Labor Law bans the employment of children under 13 years of age.

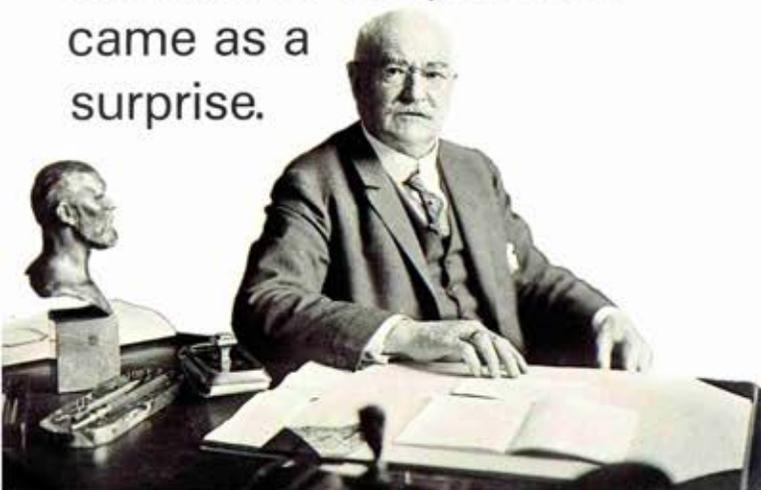
André Borrell formulates a viral theory in connection with cancer but it is not taken seriously by his contemporaries.

Brothers Orville and Wilbur Wright accomplish four flights of between 118 and 870 feet and lasting between 12 and 50 seconds with their motor airplane in Kitty Hawk, North Carolina.

To save his sports newspaper from bankruptcy, French publisher Henri Desgrange organizes the first "Tour de France" bicycle race, which in six stages covers a total distance of 1,500 miles.

Alliances are formed within the dyestuffs industry

During the first 40 years of their existence, the German dyestuffs manufacturers had experienced virtually unprecedented growth. The industry had a monopoly position on the world market, and the individual German firms flourished accordingly. For this reason, the idea of cooperation came as a surprise.



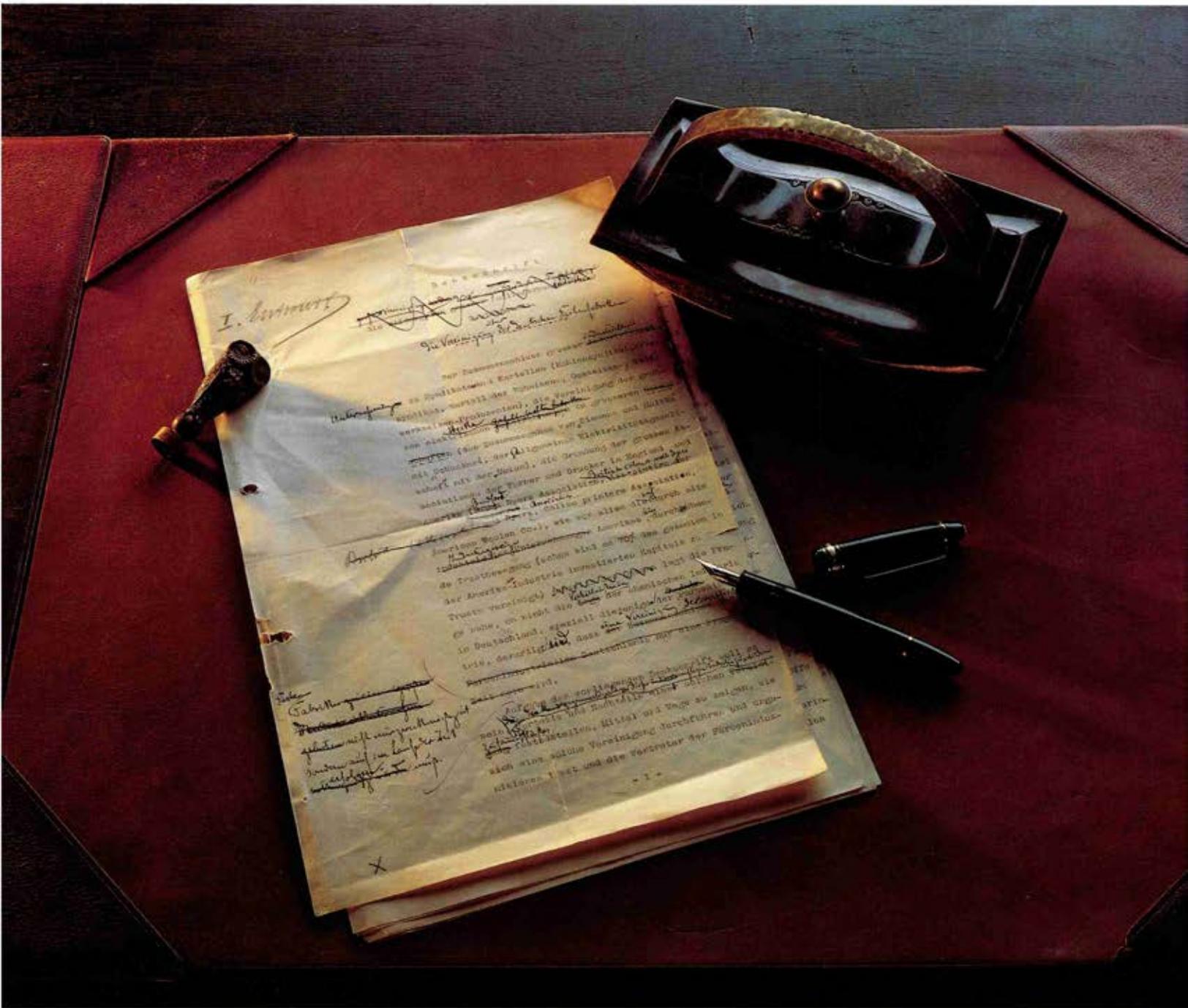
The purpose of Bayer's, Duisberg's and Girtler's trip to the United States was not solely the search for a production site. The executives were also keen to look around in the "land of unlimited opportunities" that Duisberg had first visited in 1896. The huge factories he had seen at that time made a great impression on him. So did their organization.

The journey of 1903 started in Canada and took the men as far south as New Orleans. Duisberg viewed things more critically this time, though there was still a great deal that fired his imagination. In his memoirs, he described the trusts as follows: *"They were seen as a panacea, offering as they did the merger of similar operations under a single management and supervision and with a single sales organization to remove competition of all sorts of products—particularly those subject to price pressure—and increase profits without a substantial rise in sales prices."*

Shortly after his return in September 1903, Duisberg met Gustav von Brüning, the head of Farbwerke Hoechst, and BASF's Heinrich von Brunck at a meeting of the Association of the German Chemical Industry in Elberfeld and discussed with them the possibility of cooperation between the country's dyestuffs producers. He was asked to put his thoughts down on paper.

Duisberg was in his element when it came to such work, so a 58-page memorandum was soon sent off to all interested parties. This "memorandum" presented a variety of considerations. For example, a merger should take place at a time of prosperity and thus as a voluntary act. And the partners should each be big enough to have an equal say in the form of cooperation.

The advantages of cooperation were obvious—the enormous costs of duplicating operations in such fields as research, purchasing, sales and foreign representation could be reduced. Participants could and indeed should close uneconomic plants and retain only two factories per product line; two were considered necessary for the maintenance of a healthy degree of competition.



Chemist Carl Duisberg soon became a member of management. Memorandums were his specialty, and his initials "CD" graced many such a document in those formative years. A bust of the discoverer of the indigo formula, Adolf von Baeyer, decorated the desk at which

Duisberg sat to formulate many of his famous memos. All his life, Duisberg held von Baeyer in great respect as a role model.

Alliances are formed
within the dyestuffs
industry

Duisberg proposed that the best plan would be to set up a joint venture under joint management as a "United German Dyeworks Company" (Vereinigte Deutsche Farbenfabriken AG), whereby instead of being managed by a monarchical chairman, it would be guided by a "republican constitution." The others all agreed. Heinrich Caro of BASF was to write later that Duisberg's memorandum was a *"masterpiece born of genius, knowledge and sincere conviction."*

As with his program for the creation of Leverkusen nine years earlier, Duisberg had described the ideal solution. The real difficulties arose when those concerned actually got down to discussing details. Back at home, the various company executives, including those at Bayer, started to voice serious doubts.

Duisberg was in favor of speeding up the process: *"Major unification plans of this kind are not unlike a marriage. When the couple spends too much time scrutinizing one another and begins to deliberate about the pros and cons of an alliance, the betrothal—or in this case the merger—will never take place."*

On February 19, 1904, there was another meeting, this time in Frankfurt. By this date, the companies were to have completed data sheets showing their financial status so that the basis for the finances of the joint firm could be ascertained. The plan failed.

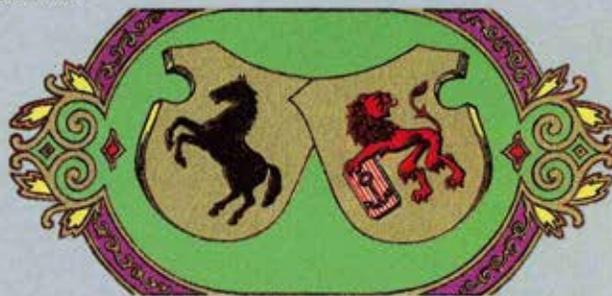
Heinrich von Brunck of BASF disapproved of the whole process. For its part, Hoechst had two objections. One of these was voiced publicly by von Brüning: it was feared that the shares of the merged company could eventually be taken over by the big banks, making the chemical industry a servant of the bankers.

Von Brüning presented the other argument to Duisberg in private: the timing was inopportune for Hoechst, which was ahead of the other firms with its pharmaceutical operations and was just at the point of making a major step forward with synthetic indigo. In a few years, he said, Hoechst would have improved its situation to such an extent that

A.G.F.A.
Actien-Gesellschaft für Anilin-Fabrikation,
Berlin



BASF
Badische Anilin- & Soda-Fabrik,
Ludwigshafen 9/Rh.



Bayer
Farbenfabriken vorm. Friedr. Bayer & Co.,
Leverkusen

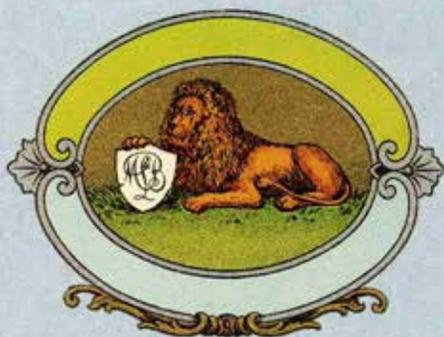


Of the six firms represented on these two pages by the logos on their dyestuff labels, five joined up in 1904 to form two distinct groups: Agfa, BASF and Bayer formed the so-called Triple Confederation, after Cassella and Hoechst agreed on the Double Alliance.

Cassella
Leopold Cassella & Co. GmbH,
Frankfurt a. M.



Hoechst
Farbwerke vorm. Meister Lucius & Brüning,
Höchst am Main



Kalle
Kalle & Co. Aktiengesellschaft,
Biebrich am Rhein



conditions for the intended merger would later prove to be unfavorable.

The draft contract laid down that a final agreement would not be signed until the level of each individual stake had been determined. But the companies were unwilling to open up their books.

In the end, there was more opposition than agreement among the parties. The various companies involved decided not to try to force a decision on an alliance too quickly. As a result, the "United German Dyeworks Company" never saw the light of day.

This is when Duisberg, to use his own words, began to "woo" BASF. The two companies had operations which complemented rather than threatened each other. But when the two companies exchanged financial data on August 27, 1904, it turned out that Bayer had surprisingly higher net profits than BASF. This situation made an agreement more difficult and the negotiations continued to drag on as a result.

The news hit "like a bombshell" when Duisberg learned from a report in the *Frankfurter Zeitung* that Hoechst had agreed to a cooperation with Leopold Cassella & Co. in early October. After this new development came to light, representatives of BASF and Bayer met in Cologne. This time both companies accepted the terms. On November 23, 1904, a cartel agreement was signed between the two firms.

Another surprise followed the conclusion of the agreement. BASF had been holding talks with Agfa, which it now invited to join in. The new arrangement was perfected on December 10, 1904; as of January 1, 1905, the so-called "Triple Confederation" had been forged.

The "Double Alliance" of Hoechst and Cassella was also expanded when Kalle & Co. entered in 1907. This cartel called itself the "Tripartite Association." More will follow on these two German dyestuff cartels.

When Kalle joined the Cassella-Hoechst consortium in 1907, the so-called Tripartite Association was created. Duisberg's vision became reality when the two groups joined forces in the "Interessengemeinschaft der Deutschen Teerfarbenfabriken."

Leisure time activities for Bayer employees

When the teams in Germany's top soccer league (the Bundesliga) meet, it's chemicals against gas; cars against batteries; insurance against computers. Companies pay a lot of money to advertise on a jersey. Bayer spends a large sum on sports too, but when athletes wear the Bayer cross, they are members of Bayer's own team.

If Bayer had been founded in a major city like Cologne or Düsseldorf, or even if it had stayed in Elberfeld, which had long since become a part of Wuppertal, things probably would have turned out quite differently. For example, Bayer's soccer talent would have been snapped up by the local league clubs. But places like Leverkusen or Uerdingen were not really even considered towns in the early 20th century.

Wilhelm Hauschild collected 170 signatures and presented them to management on November 27, 1903, with the request to form the Gymnastics and Games Society of Farbenfabriken vorm. Friedr. Bayer & Co. The proposal was welcomed because the company had itself been deliberating about ways to make life at the isolated sites more attractive.

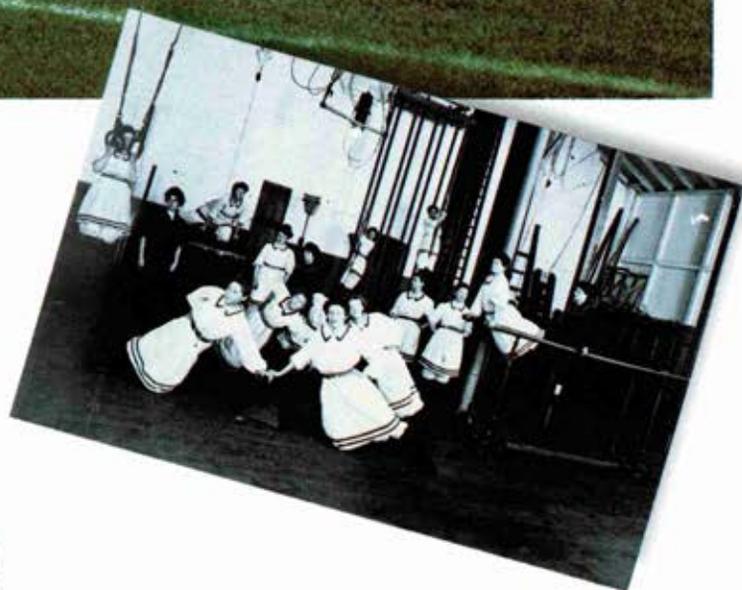
The "Society" was set up in 1904 and started its gymnastic activities in a warehouse. It was called TuS 04, an abbreviation of the German name. A women's gymnastic team was also included, a rarity for Germany at that time.

It seems strange that soccer was not highly regarded within the TuS 04 club. It was widely considered "English nonsense," rough and unsportsmanlike. Although the Leverkusen team had made it to the Second Cologne League by 1911, they were no more than tolerated outsiders in TuS 04. Boxing and European handball were also considered unrefined.

These tensions kept up until 1928, when the soccer, handball and fist-ball players, track athletes and boxers decided to set up their own club. Many of them had been founding members of TuS 04, and the new club took the title Leverkusen Sports Association 04. As of 1936, both clubs wore the Bayer Cross on their jerseys. In 1984, they finally united to become "TSV Bayer 04 Leverkusen."

In Uerdingen things developed differently. "Uerdingen 05" was a soccer club from the start, although it also catered to other sports. It did not incorporate the company name into its title until after the Second World War, when it switched to "FC Bayer 05 Uerdingen."

Uerdingen was the first of the two Bayer soccer teams to join the Bundesliga (in the 1975/76 season),



As well-known as they are, Bayer 04 soccer players represent only a small part of Bayer's total recreational program. In addition to the many prominent athletes in Bayer clubs, there are thousands of employees and

people from the surrounding communities who pursue their hobbies in the 70 works clubs. The above picture of the gymnasts recalls the modest beginnings of the society. Pins were awarded to longtime members.

though it was soon relegated back to the second league. Since 1979, however, both teams have been in the first league. In 1985, Uerdingen won the German Football Federation Cup against the favored Bayern München. Bayer 04 Leverkusen celebrated the biggest success in the club's history on May 18, 1988, when the team won the European UEFA cup.

With trainers like Bert Sumser, Gerd Osenberg and Bernd Knut, Bayer athletes have also recorded a long list of achievements in other disciplines, particularly track events. No Olympic Games have taken place since 1964 without a Bayer athlete winning gold, silver or bronze. In 1984, Bayer Olympians brought back seven medals from Los Angeles.

Today, Bayer has not only the "04" and "05" clubs, but a total of 31 company-promoted athletic associations. The biggest of these are: TSV Bayer 04 Leverkusen with 8,700 members; TSV Bayer Dormagen with almost 2,800 members; FC Bayer 04 Uerdingen with about 4,000 members; the swimming club Schwimmverein Bayer Uerdingen 08; RTHC Leverkusen, whose initials stand for Rowing, Tennis and Hockey Club; and SV Bayer Wuppertal.

Special clubs are offered for sailing, yachting and canoeing; riding, driving, table tennis, fishing and water sports; fencing and shooting; the breeding of German shepherds or carrier pigeons; skiing and even dancing. Bayer's aerial sports club is one of the biggest of its kind in the country.

Sports are costly. First of all, they call for a considerable commitment on the part of athletes who sacrifice leisure time for the clubs. Secondly, they require a good deal of money, only part of which comes from dues, entrance fees and advertising revenue. Public funds are also made available by the national, state and local authorities as well as German associations that promote sports. They all support athletic activities in the interest of health, particularly for the young. Industry has, or should have, the same interest at heart.

The 1932 Los Angeles Olympics were the last strictly amateur Olympic Games. Since then, the sports world has seen the development of, for example, the "State amateurs" of the Socialist bloc and "university amateurs" of the United States—all of them professionals. The real amateurs have a much more difficult time.

Bayer has developed its own sports philosophy, known as the "Leverkusen Model." The company builds and maintains sports facilities either alone or in cooperation with local authorities. At present, these facilities include 13 sports grounds, 35 tennis courts and hockey fields, ten gyms with training installations, seven "special facilities" (boathouses, airfields and riding halls), and seven clubhouses. But that's not all.

Sports clubs are by nature in the public interest, and this is why Bayer feels that membership should





not be restricted to certain groups such as employees. In fact, everyone is free to join a Bayer sports club. The large number of prominent athletes who are members is certainly one of the major attractions for young hopefuls.

A great deal of attention is quite naturally focused on these sports stars. To attain record performances, they have to be supported by coaches, masseurs, doctors, psychologists and the like—services which the company pays for. Such top performers also need more than just their personal time to train. Here, Bayer provides jobs that give them this extra time, as well as financial compensation for any loss of pay. But as popular as the stars are, they are only the top stratum of a broad athletic program, which includes sports for children, housewives, senior citizens and the disabled as a part of the Leverkusen Model.

The 31 sports clubs are themselves only one side of the total of 70 clubs supported by Bayer AG. Today, virtually every employee can find his or her pastime pleasure represented here. More than two-thirds of the payroll belong to one or more clubs. To name only a few outside the sports sector, there are clubs for nature study, aquarium and terrarium fans, beekeepers, stamp collectors, gardeners, chess players, stenographers, photographers and amateur film makers, mineral and fossil collectors, numismatists, canary breeders and even for those who collect matchboxes. There are also orchestras, choirs, amateur drama societies and music clubs in almost every plant. With its 20,500 members, the "Jubilareverein" for employees with many years of service is the biggest of its kind in the world.

Bayer athletes have been taking part in national and international championships for many decades now. Ulrike Meyfarth (left) won Olympic gold in the high jump competition at the 1972 Munich Games and in Los Angeles in 1984.

After 120 minutes of play and a dramatic penalty kick duel, Bayer 04 Leverkusen won the 1988 UEFA Cup, which Captain Wolfgang Rolff (above) holds up to a reveling crowd.

Bayer chronicle 1904

On January 6, 1904, the Bayer cross is registered as Trademark No. 65777 with the Imperial Patent Office. The illustration shows the



Bayer cross as a part of a dyestuffs label.

Bayer registers the first dry-spinning patent for acetate rayon.

A strike is called by the union "to do away with appalling conditions" at Bayer. It lasts six weeks and leads to fights between those on the picket line and employees who want to work. Management decides to stop hiring union members.

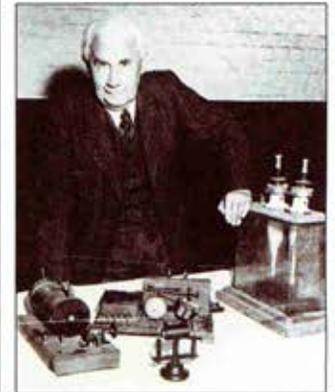
Various welfare units of the company are combined into a central Welfare Department. A so-called "Committee for Worker Affairs" is set up in the works office to counsel workers on matters of recruitment and dismissal and to hear complaints.

World events 1904

During the night of February 8, Japanese torpedo boats enter the Russian-occupied Port Arthur in southern Manchuria and destroy a squadron of the Russian navy anchored there. This attack marks the start of the Russo-Japanese War.

The United Kingdom and France sign the "Entente cordiale."

Düsseldorf engineer Christian Hülsmeier, shown with his invention in the photograph below, patents his "telemobiloscope," which is considered a forerunner of radar.



The third Olympic Summer Games take place in St. Louis, Missouri.

President Theodore Roosevelt declares the right of the United States to carry out policing actions in Latin America under certain conditions.

Carl Duisberg — a patriarch with social vision

“In my opinion, the foremost duty of an entrepreneur is to bring the social problem nearer to a solution,” wrote Carl Duisberg in his memoirs.

Elsewhere in the book he remarks, *“I agree with (Henry) Ford that if we industrialists do not contribute toward solving social problems, we have left our most important duty undone.”* In their day, statements of this kind were not only considered unusual, but even revolutionary.

Bayer introduced the nine-hour workday in 1905. That meant obligatory presence from 7:30 a.m. to 6 p.m., or ten and a half hours in all, with one and a half hours set aside for breaks. When longer shifts were necessary, ten-percent overtime was paid; up to 30-percent for Sunday work. This was a substantial improvement over the 1899 ruling in which 12 hours of actual presence and ten hours of work were required, and over the 1875 ruling of 12 and ten and a half hours, respectively. And this was even better than the pre-1875 situation with its 11 working hours daily and a presence in the plant of 13 hours.

Duisberg explained his reasoning: *“When it comes to the shortening of working hours, our industry must be in the lead. It cannot be denied that, even though the physical and mental demands on our workers are very small, the air cannot be kept in its original chemical purity and sometimes, albeit seldom, poisoning can ensue.”*

Statistical comparisons showed, however, that *“dangers of this kind are very slight and health conditions in our factories are by no means worse than those in, for example, the Krupp plant or the textile industry.”*

The introduction of the nine-hour workday was not exclusive to Bayer. There was a general trend at the time to reduce working hours. More significant was the philosophy behind the Bayer decision.

In his memorandum on the building of the Leverkusen complex, Duisberg had already attached a great deal of importance to matters of employee welfare. Factory premises were to be designed to do away with cramping, darkness, dirt, noise and general ugliness. One of his basic demands was for large halls with lots of windows. There should be large doors to enable easy escape in case of danger, while neighboring rooms should be installed for

Professor Fritz Klimsch's "Gazing Girl" has watched whole generations of swimmers and non-swimmers at the Carl Duisberg swimming pool. It is one of the many statues acquired by management for the Leverkusen site and its vicinity. Duisberg's interest in the quality of life

covered all aspects of the employees' existence: on the right a view of the interior of an apartment intended as a model for the company's tenants.

changing, washing and eating purposes. A number of welfare facilities had also been created for time outside the actual working hours. These included the retail cooperative (1895), the library (1902), a maternity home, housekeeping school, a kindergarten (1905) and finally the various company societies.

Employee housing was of particular importance, not only in view of the isolated location of Leverkusen, but also in light of the typical living conditions of the working class of the day.

"The families of the workers lived crowded together either in sublet rooms or in tenement houses with about three or four square yards of floor-space per person. The social distress even led to the so-called 'dozer,' who had no room of his own but instead rented only a place to sleep." ("Chronik der Menschheit," Chronik Verlag, 1984).

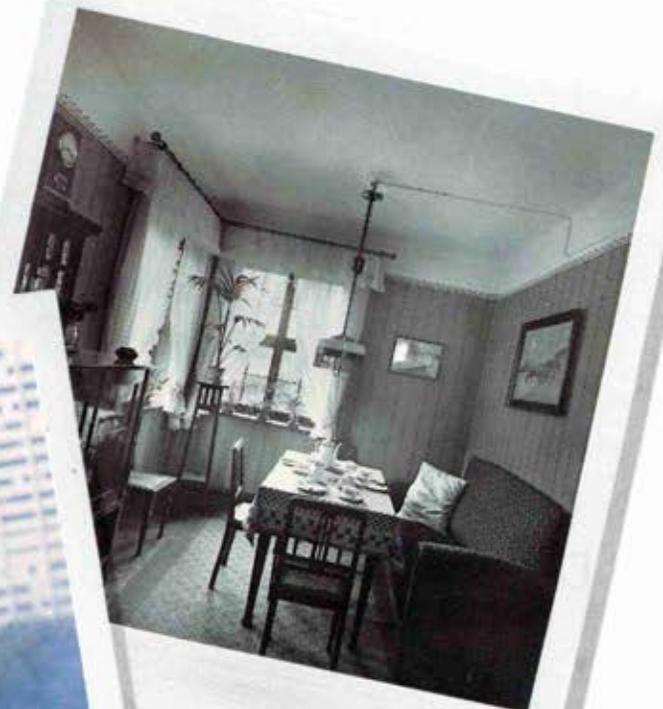
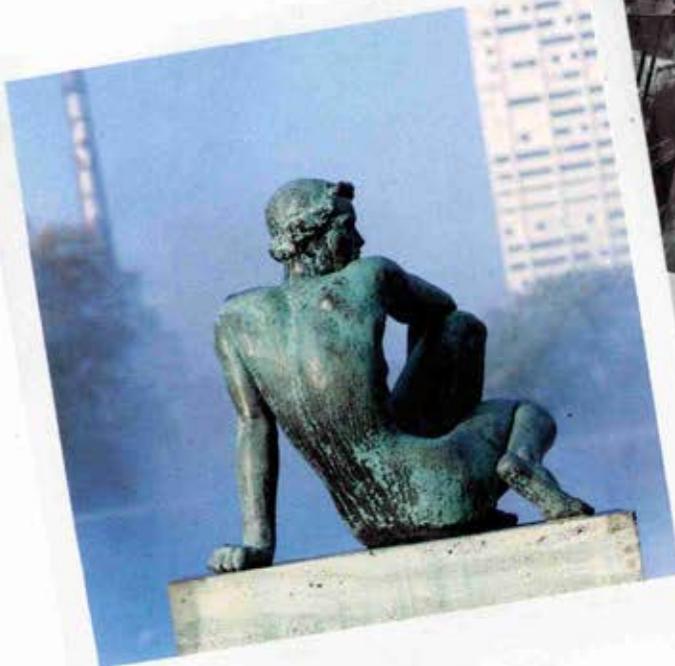
Bayer had complete residential areas built with accommodations to meet the needs of its employees' families. The avenues were lined with trees and decorated with statues and fountains by Fritz Klimsch and Hugo Lederer, two popular artists of the period. By 1913, 20 percent of all employees lived in company housing.

Wages were also being improved. Between 1875 and 1881, the daily wage was 3.50 marks. At the turn of the century there was a change in hourly wages intended to reflect the skill and performance of the individual. From 1875 until 1907, this figure rose from 26.5 to 40.2 pfennig for laborers and from 27.5 to 43.5 for craftsmen. Considering the stable prices of the times, these were increases in real as well as nominal terms.

To be able to judge how far its employees' wages went, Bayer paid 50 families a bonus to keep an exact tally of household expenses.

Paid vacations were introduced, although initially only for older employees. Five years of employment gave a worker the right to one paid day off with a further day for every additional five years, up to a total of seven days. Employees also had the chance to take up to six weeks of unpaid vacation—during harvest, for example—without losing their job.

In 1908, the company bought the "Grosse Ledder" estate, some 12 miles east of Leverkusen in the woods of the Bergisches Land. Between 1910 and 1912, vacation houses named Schwarzwaldhaus, Thüringerhaus, Anna Haus and Johanna Haus were built there, scattered among the trees on the 133-acre site. Henry von Böttinger and his wife donated money in 1912 for the construction of a convalescent home in Grosse Ledder for Bayer workers. It remained in operation until after the Second World War.



Members of Bayer management who had seats on the boards of other firms were obliged to hand over the fees they received for these posts to welfare bodies within the company. By 1909, Bayer was spending 1.6 million marks on voluntary welfare facilities per year, which is 18 times the amount that was demanded by law.

It might be expected that Duisberg's welfare efforts found public recognition over and above the approval of the beneficiaries. This was, however, not the case. In connection with the introduction of paid vacation, for example, a Hamburg newspaper wrote, "the Leverkusen dyeworks have had their welfare professor Dr. Duisberg contrive a hoax that is really an obtrusive advertisement for the ensnaring of workers."

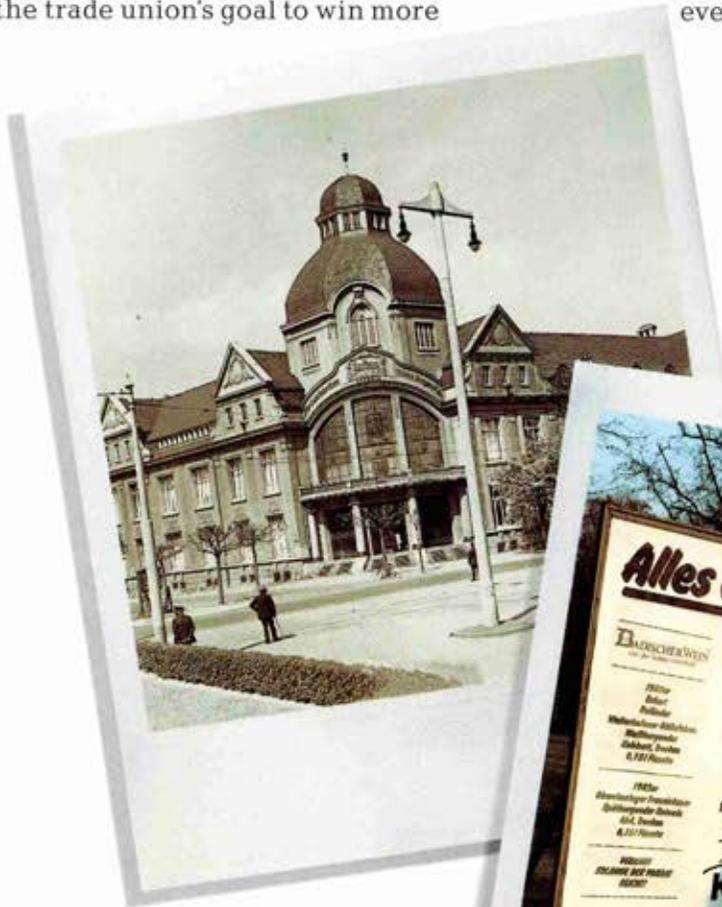
The newspaper's negative attitude must be viewed in the context of the trade union's goal to win more

rights for workers. It went hand-in-hand with the union's belief that to accept "gifts" from employers was to lose one's independence.

Duisberg was not the only "benefactor" in German industry. Ernst Abbe at Zeiss, Friedrich Krupp and Robert Bosch were among the others who did much more than what was prescribed by law.

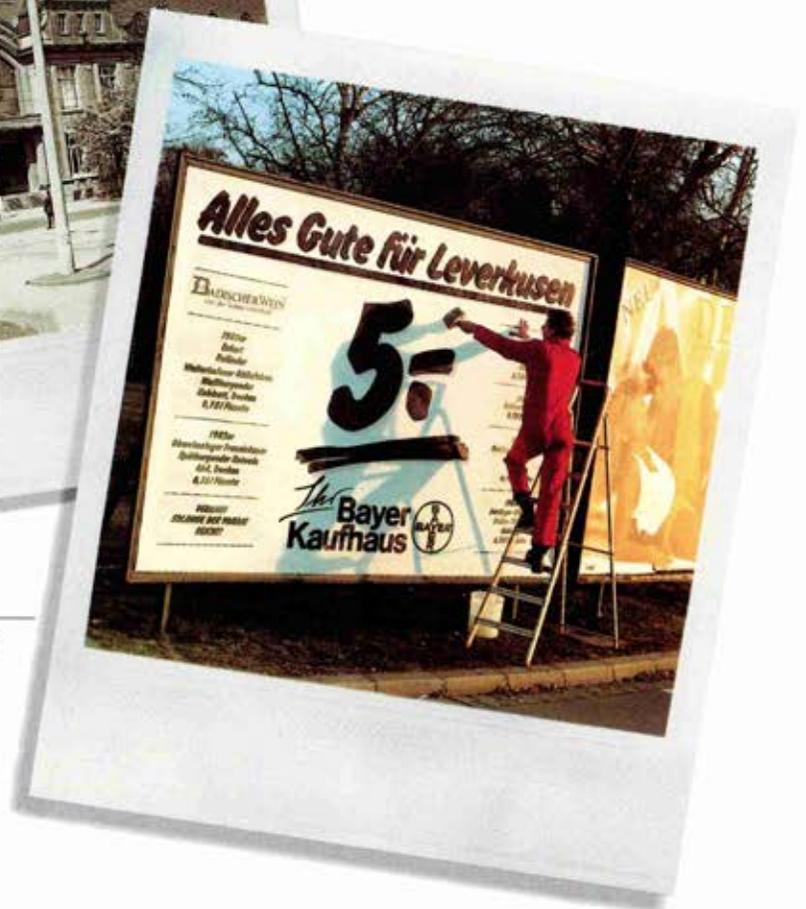
It was Duisberg's sincere conviction that "our welfare and educational efforts are not patriarchal in nature, but are based on a truly democratic attitude. All development has its roots in the lower echelons and cannot be imposed from the top. Self-government is part of every welfare facility, with representatives of the employees collaborating throughout."

This was indeed the case. Whether health insurance fund or pension fund, workers' committees or clubs, everything was run autonomously.



The company's cooperative store was a necessity back when it was founded in 1897. In the little village of Wiesdorf, there were simply too few shops to serve the hundreds of employees streaming to the new Leverkusen plant. The picture on the left was

taken in about 1910. Today, the "Bayer-Kaufhaus" is only one of many department stores in Leverkusen and offers its customers rock-bottom bargains (right).



All the same, Duisberg was a patriarch in that welfare and patronage were never very far apart. He had a hand in everything. For example, when two workers developed cancer in 1912, he personally wrote to Professor Klemperer in Berlin, *“As you can imagine, we attach a great deal of importance to doing all that is humanly possible to save the lives of these loyal employees.”* He went on to ask whether Klemperer could treat them with the new anti-cancer selenium product that had recently been developed by Emil Fischer.

At the same time, Duisberg was very anxious to “educate” his workers to furnish their apartments “properly.” He went so far as to carry out controls in the apartments to check whether there were suitable saucepans on the stoves and attractive curtains on the windows. He also saw to it that the company’s retail cooperative did not sell anything he regarded as “kitsch.”

In Duisberg’s eyes, the plant should present a harmonious whole and an island of social peace. Indeed, he coined the term “Bayer family.”

During the class conflict after the First World War, when the solidarity of his “family members” sometimes switched to trade union loyalty, he probably did not understand it, or he may even have seen it as ingratitude. Nevertheless, with his “patriarchal welfare,” he was successful—and far ahead of his time.

Bayer chronicle 1905

On the basis of cellulose triacetate, which at the time had little technical value, Arthur Eichengrün and his assistants develop the acetone-soluble cellulose acetate (Cellit), which will play an important role in the production of coating raw materials, low-flammability cinematographic and X-ray film, rayon and plastics.

Soccer club FC Uerdingen 05 (today Bayer 05 Uerdingen) is formed at the Weiler-ter Meer plant. Photo below shows the team in 1913.



The company signs a contract with the township of Wiesdorf for the supply of 2,000 cubic meters of drinking water per day from the Bayer plant at Leverkusen. By 1984, this is to reach 25,000 cubic meters daily.

World events 1905

Albert Einstein, a technical expert at the Bern Patent Office, develops the theory of relativity.

January 14 becomes “Bloody Sunday” in St. Petersburg. To plead with the Czar to relieve their miserable living conditions, 200,000 inhabitants of the Russian capital march to the Winter Palace with ikons and pictures of the Czar himself. Although they are unarmed, the Czar gives the order to fire, and some 500 are killed. This leads to a revolution and the October Manifesto, which turns Russia into a constitutional monarchy.

German coal miners strike for the first time for statutory protection.

Berlin’s first double-decker bus (photo) is introduced on the route from Halle’s Gate to Chaussee Street.



Adolf von Baeyer receives the Nobel Prize in chemistry for his work on organic dyestuffs and hydroaromatic compounds, and Robert Koch is awarded the prize for medicine for his experiments and discoveries in the field of tuberculosis.

The rocky road from indigo to indanthrene

By the turn of the century, the range and fastness of synthetic dyestuffs had banished most natural dyes into modest niches of the market, with one important exception. Despite all the efforts of the chemical industry, indigo, the “King of Dyes,” still held on to its dominant position.

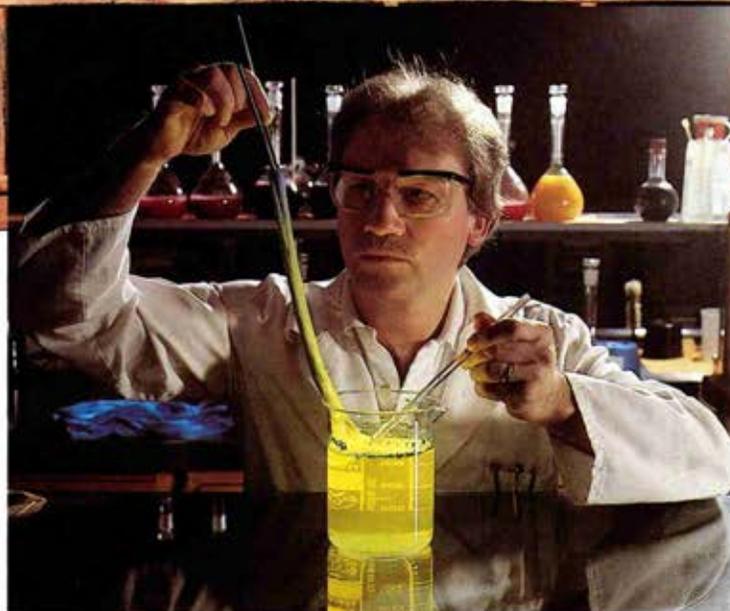
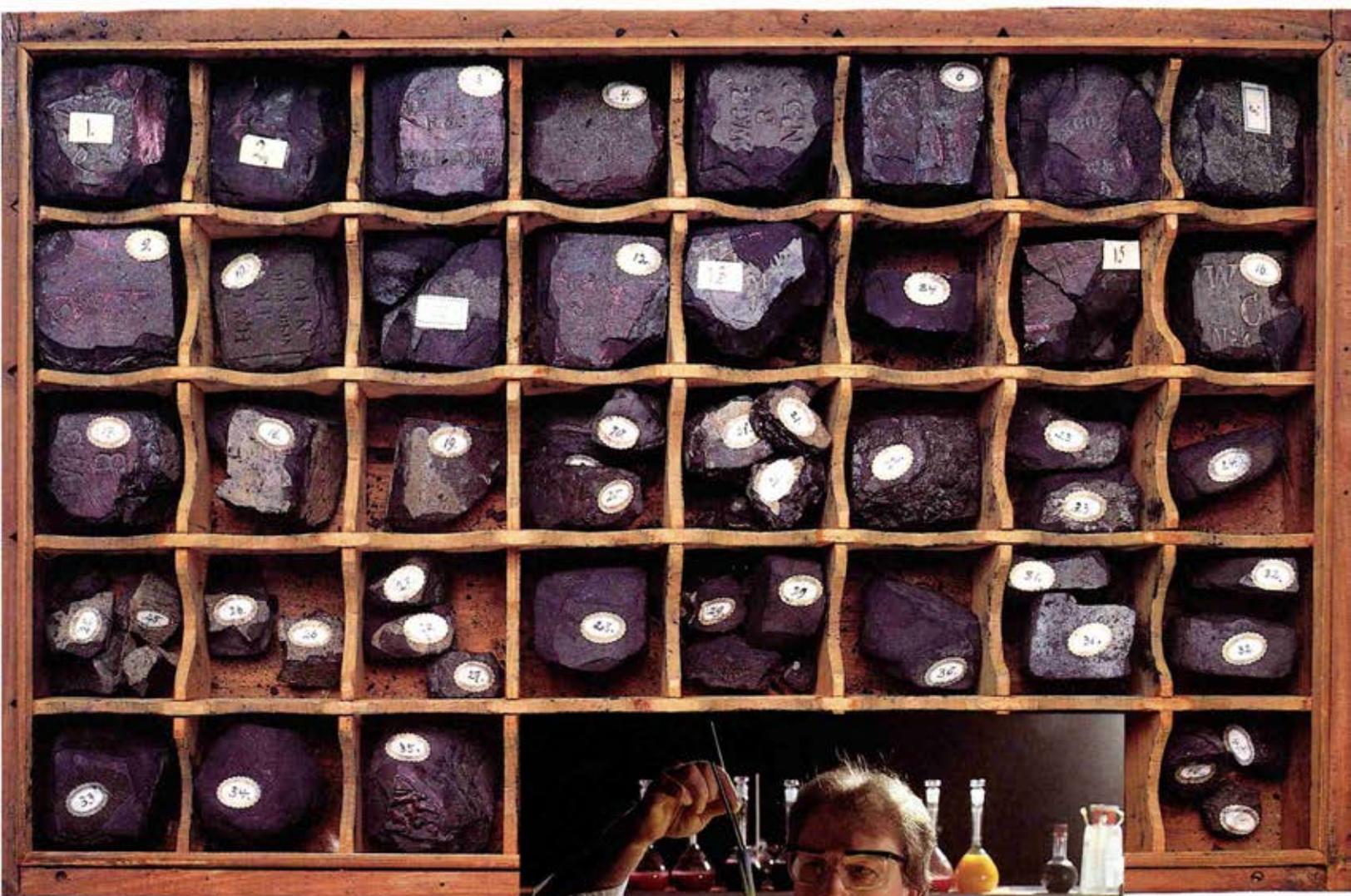
The bell rang for the first round of the fight many years earlier. On the announcement of Graebe and Liebermann’s successful alizarin synthesis in 1869, Heinrich Caro of BASF exclaimed enthusiastically, “*industry was now poised for battle with the natural product.*” This was a declaration of war on indigo, but it was to be a long time before the proper weapons could be forged to begin this battle, let alone win it.

Many scientists had long since investigated the structure of this ancient blue vat-dye, which had steadfastly defended its position as the market leader. As mentioned earlier, 23-year-old Carl Duisberg was given the assignment of matching the “star of all dyes” while working on a temporary basis for *Farbenfabriken vorm. Friedr. Bayer & Co.* in the laboratory of Strasbourg University. Not surprisingly, his attempt proved much too difficult a task for the young and inexperienced chemist.

It had also been in Strasbourg where Adolf von Baeyer, who was to be awarded the Nobel Prize for chemistry in 1905, had first come up with a laboratory synthesis proving the theoretical possibility of an artificial indigo in 1870. In fact, he had been working on indigo synthesis in Berlin five years earlier, not really in vain but without tangible results. By 1878, when von Baeyer had moved on from Strasbourg to Munich, he had developed a number of syntheses as the fruits of 13 years of work, but none of them would have justified industrial-scale production.

In 1880, BASF and Hoechst bought patent rights to use production processes based on von Baeyer’s indigo synthesis. All of these methods did, in fact, yield artificial indigo—but at an uneconomically high price. Von Baeyer finally concluded his studies in this sector after 18 years of work in 1883. “*The position of every single atom in the molecule of this dyestuff has now been experimentally determined,*” he wrote.

That in itself was not enough, however. As Heinrich von Brunck, BASF’s technical director, commented,



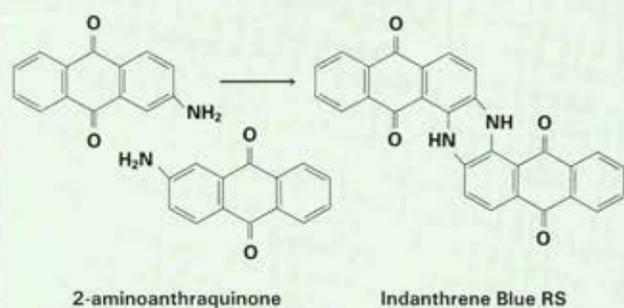
The blue dye indigo remained an enigma for scientists because they were unable to find a formula for its synthesis. Adolf von Baeyer first came up with a solution. The picture in the foreground shows how, in dyeing with indigo, the initial yellowish color turns into the typical shade

of blue when exposed to the oxygen in the air. This samples case of indigo specimens is a valuable rarity and can be seen at the Textiles Museum in Krefeld.

Indanthrene and Algol dyestuffs

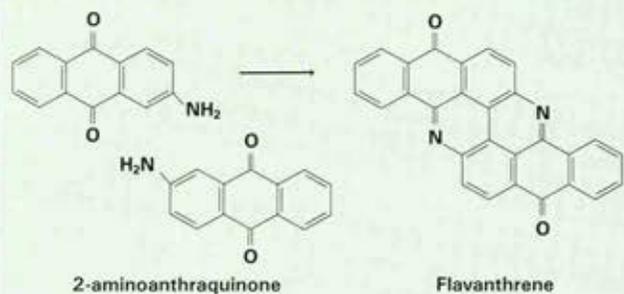
René Bohn (BASF) obtained the first indanthrene dyestuff by the fusion of 2-aminoanthraquinone and caustic potash at about 250° C.

Oxidation brought on by atmospheric oxygen gave rise to a new ring system between every two molecules:



By altering reaction conditions, it is possible to make a molecule of the 2-amino-

anthraquinone "move on one cog." This results in flavanthrene:

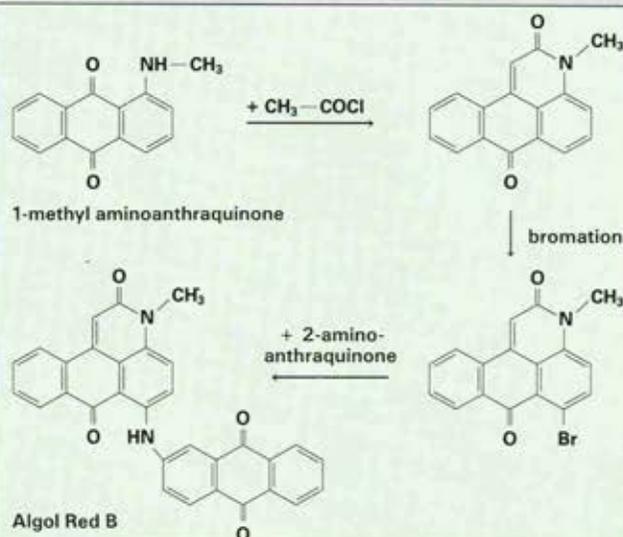


While Bohn was expanding his range of indanthrene dyestuffs, Robert Emanuel Schmidt was at work on the development of the Algol program. At first he concentrated on the basic indanthrene molecule and succeeded in a synthesis, independent from that of

Bohn, involving the condensation of 1-amino-2-bromoanthraquinone. He subsequently abandoned Bohn's molecular scheme, however, and invented his own dyestuffs using other reactions of aminoanthraquinone compounds. To obtain Algol Red B he attached a

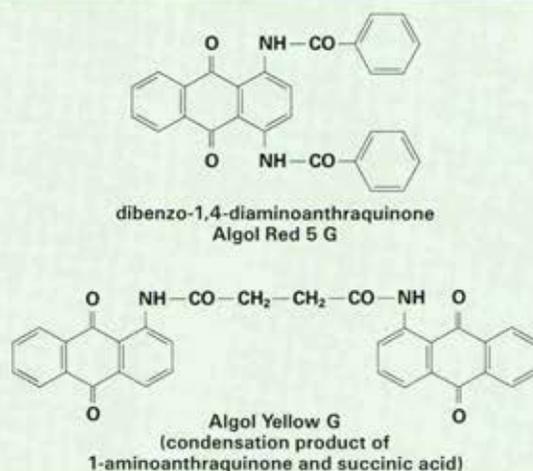
further heterocyclic ring to the anthraquinone compound, as had been

done in the case of alizarin blue:



Schmidt was able to develop most of the other Algol dyestuffs by the acetylation

of aminoanthraquinones with suitable carboxylic acid derivatives. For example:



In the race with its competitors, Bayer developed a range of particularly fast vat dyestuffs which it called Algol. The samples book from the year 1912 (right) showed customers more than 300 possible shades which could be obtained with the Algol product line.

"Methods alone are not sufficient for technology; this needs processes—and technically usable ones at that." They also must be economically viable.

Great hopes were aroused by a process that Carl Heumann, Professor at the Federal Polytechnic School in Zurich, had developed in 1890. Once again, it was BASF and Hoechst that adapted this discovery for their own production purposes. And once again the yield proved to be too low and the product too expensive.

BASF, which had invested more money in the search for synthetic indigo than in any other project to date, had to spend millions on improving and modifying the synthesis before the chemists at Ludwigshafen could finally, in 1897, proudly present their "Indigo Pure BASF." It was of such a high quality that loyal fans of the natural product alleged it was nothing but a purified form of the "real" indigo dye.

The synthetic indigo, initially viewed askance by the trade, had hardly been properly introduced when, in 1901, BASF came up with another surprise: a new blue vat dyestuff derived from a different chemical basis that did not exist in a natural form. It was used to color cotton and other cellulosic fibers better, brighter and, most importantly, faster than indigo. Its inventor, René Bohn, named the new product Indanthrene (the first of the line had the trade name Indanthrene Blue RS), a portmanteau word that is a combination of "indigo" and "anthracene," the chemical basis for the anthraquinones that Bohn had used for the synthesis. The new synthesis was not limited to blues. The yellow flavanthrene was soon to follow and show equally good fastness properties.

Bohn's congenial colleague and counterpart at Bayer, Robert Emanuel Schmidt, immediately recognized the importance of this new discovery. In his contribution to the book "History and Development of Farbenfabriken vorm. Friedr. Bayer & Co. in its first 50 Years," Schmidt came up with a colorful mixed metaphor on the psychological effect of the BASF success. *"It was a hard blow for us, who had hitherto always been in a leading position. No matter how much we tried to convince ourselves that the product was of only minor technical significance, the grapes were sour and deep inside, our ambition became chronically inflamed..."*

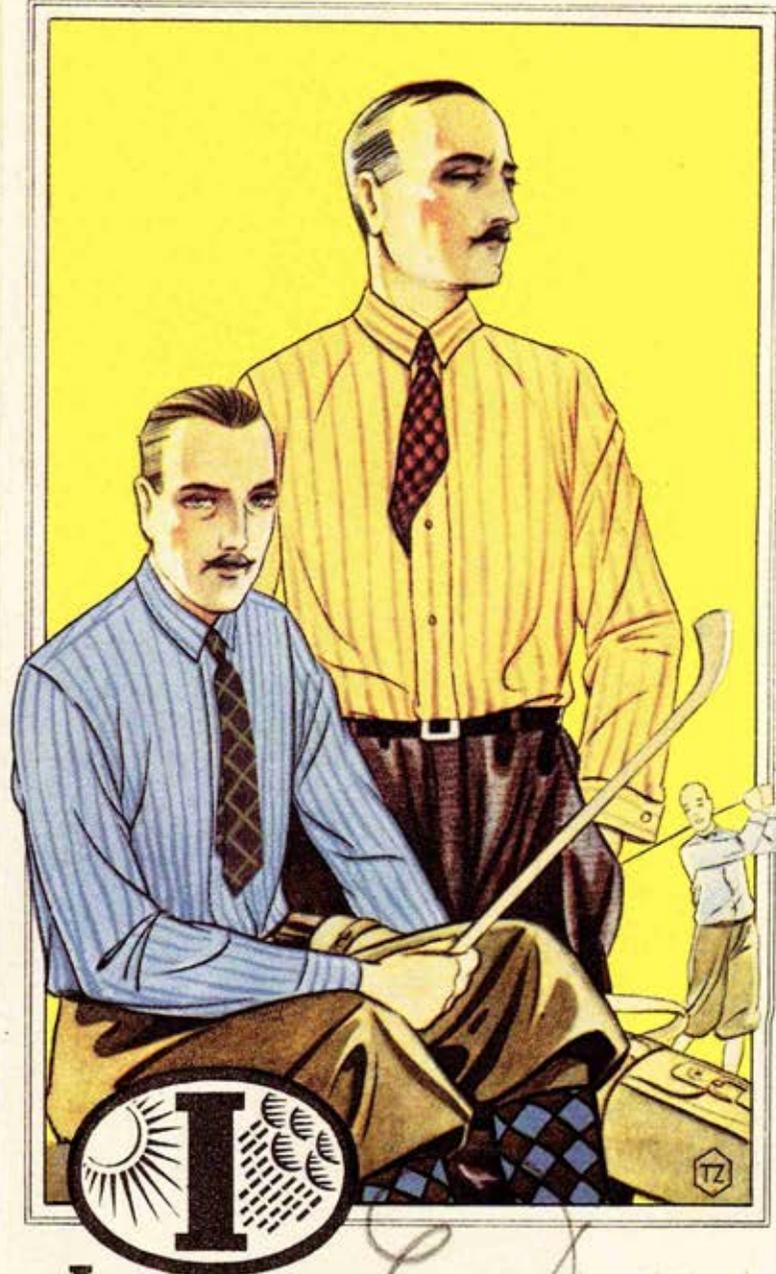
In fact, the "chronically inflamed" ambition described by Schmidt was to spur him and his research team on to new developments, just as had been the case with alizarin blue and other dyestuffs. It took time, but by 1906 there were at last real results in the form of a line of highly fast vat dyestuffs, which at first were given the trademark "Algol."





Indanthren
**waschecht
lichtecht
wetterecht**

Stoffe und Garne aus
Baumwolle, Leinen und
Kunstseide, die mit der
oben abgebildeten
Schutzmarke
ausgezeichnet sind,
haben unübertroffene
Farblichkeit



Indanthren

"Indanthren" became a household word for color quality after the market leaders Bayer, BASF, and Hoechst had agreed to sell their top vat dyestuffs under this joint trademark. One of the products covered by this umbrella designation was Bayer's Algol program.

The introduction of the Algol line brought about an unusual situation on the market: the "competition" between the top researchers of two leading companies had resulted in the production of dyestuffs with hitherto unparalleled degrees of fastness. Then Hoechst joined in with a series of excellent products, and subsequently, the chemists from other domestic and foreign manufacturers turned up with more of the same. Things reached the stage where customers were becoming seriously confused by the growing number of vat dyestuffs and the multitude of imaginative trademarks.

In 1922, Bayer, Hoechst and BASF reached an agreement based on a BASF proposal. They decided to put all their vat dyestuffs for cotton fibers on the market under a joint name. They chose the German "Indanthren" in honor of the pioneer product. The trademark served as a seal of quality for dyestuffs with unsurpassed fastness properties, and thus guaranteed the quality the client sought.

But quality had its price. The cost of these dyestuffs and a dyeing process that was considerably more expensive than for other synthetic dyestuffs noticeably influenced the price of the dyed article.

The consumer, however, was just as convinced as the dyer of the excellence of indanthrene products in respect to reliability and durability. Beginning in 1922, they had only to look for the special oval label, showing an orange (later red) capital "I" standing fast against the sun on the left and a raincloud on the right. Shoppers spent that little bit extra when they knew the product was "Indanthren."



Bayer chronicle 1906

Fritz Hofmann (photo) begins experiments at Bayer aimed at the production of synthetic rubber.



A news bureau is opened at Bayer to supply the various departments with scientific and press information and to establish contacts with the media.

To keep doctors informed about Bayer's pharmaceuticals, regular reports are issued in German and Russian. Journals are also compiled for pharmacists and veterinarians.

A Chinese study group, headed by Viceroy Tuan-fang, visits Elberfeld and Leverkusen.

World events 1906

At 5:14 a.m. on April 18, San Francisco, the commercial and cultural center of the North American West Coast, is ravaged by an earthquake. Within two days a total of 28,000 houses are destroyed by fire and 528 people die. Pharmacist Edward A. Cutter from the neighboring town of Fresno supplies vaccines of his own making against diphtheria and smallpox for the ravaged city and establishes the reputation of his firm.

President Theodore Roosevelt is awarded the Nobel Prize for his mediation in the Russo-Japanese War.

Paul Ehrlich believes there must be a "therapia magna sterilans" and gives it the name "chemotherapy."

One of the major north-south transalpine connections (12 miles long), the Simplon Tunnel, is opened.

Wilhelm Voigt, a Berlin cobbler, dresses up in an army captain's uniform bought in a junk shop, takes command of a troop of ten guardsmen and occupies the town hall of the Berlin suburb of Köpenick, where he arrests the mayor and confiscates the municipal funds. The whole world laughs at the exploits of the "Köpenick Captain"—and at the Germans' respect for uniforms.

Bayer secures a stake in the mining business

Today, Bayer mining experts are at work in South America, Southeast Asia, Australia, Africa and Germany's Black Forest.

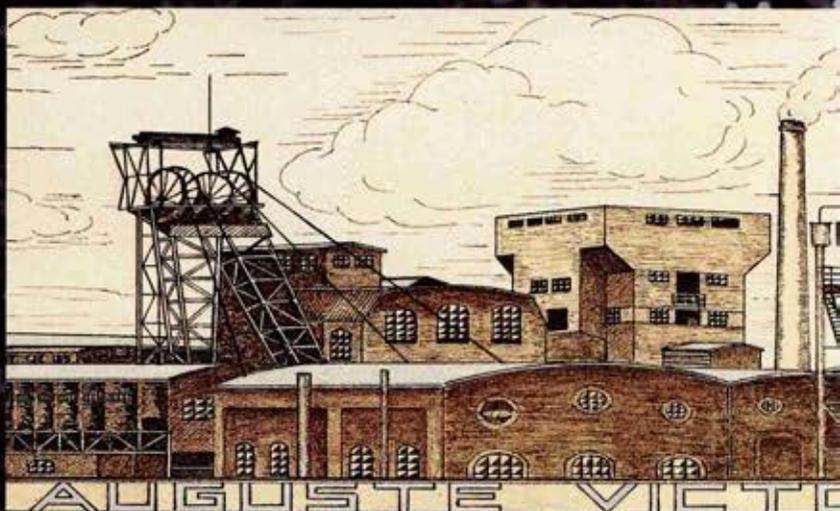
The "Mineral Raw Materials" business is now part of the Inorganic Chemicals Business Group. The company initially became involved in mining activities as early as 1907.

In that year, the consortium consisting of Bayer, BASF and Agfa bought the Auguste Victoria coal mine near Recklinghausen. Bayer had a holding of 43 percent, in accordance with its profit share in the alliance. The move was motivated by the chemical companies' desire to become independent of the Rhenish-Westphalian Coal Syndicate. In subsequent years, however, substantial investments were required to expand the mine enough to at least partially achieve this goal.

The chemical industry has always been a large-scale user of energy, and up until the 1960s, energy in Germany was virtually synonymous with coal. It was then ousted from the number one position by oil. Chemical production needs energy in a number of different forms: steam, electricity, compressed air, cold and heat.

In 1904, Bayer's Elberfeld and Leverkusen plants alone consumed a total of 242,000 metric tons of coal. By 1913, annual consumption had reached 404,000 metric tons. Almost the entire coal market and tar processing industry of western Germany were at the time in the hands of the Rhenish-Westphalian Coal Syndicate, because the chemical industry in the area was subject to the syndicate's delivery and price policies. The entry into coal mining was thus a first step toward a degree of self-sufficiency in the provision of energy.

Apart from its use as fuel, coal was also the biggest single raw material for organics production. The coking process produced not only furnace coke but also bituminous coal tar, ammonia, benzene and a number of so-called coke overgases such as hydrogen and methane. Tar distillation provided phenol, naphthalene and anthracene. All of them were important raw materials for organic synthesis, particularly in dyestuffs production. To add to its independence, Bayer also acquired a majority





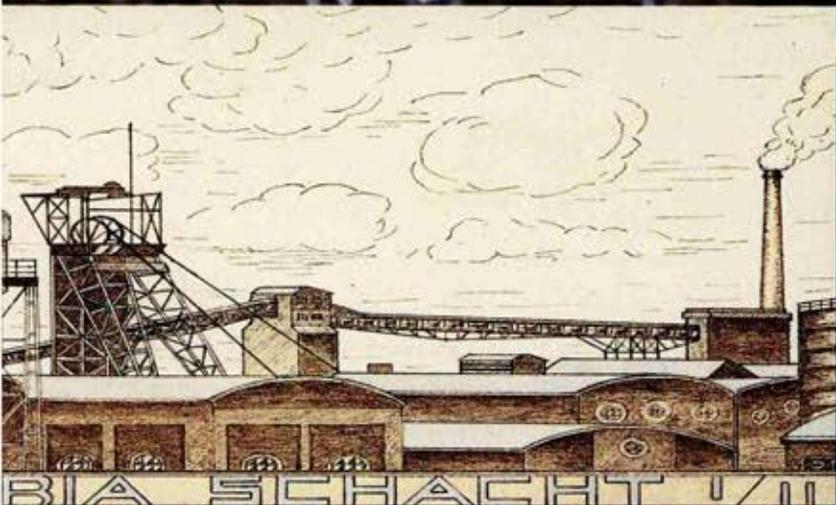
holding in the tar distillation factory Schoonaerde in Belgium in 1907.

During the First World War, the firms of the so-called "big I.G. trust" acquired all available brown coal companies in central Germany in order to secure an energy source for their large new plants.

Shortly after the war, Bayer took over the Wachtberg Group, whose three Rhineland mines were integrated into the company as the Brown Coal Department. In 1921, it had a joint production of 1.5 million metric tons. When the I.G. Farben was finally disbanded after World War II, the Wachtberg Group was divested.

In the postwar years, the mining operations of the newly formed Farbenfabriken Bayer AG were given considerably more importance and put on a much broader basis. In 1951, the company took over the fluorite and heavy spar mines of the old I.G. Farben in the Black Forest. But a large-scale commitment to mining came only with Ludwig Klebert. In his student days, he had gained a sound introduction to mining, and afterwards became head of the Inorganic Chemicals Department. Later, he was appointed a member of the Board of Management. While working in these positions, he devised a plan for securing raw material supplies which still applies today. The procedure was set down particularly for those products whose raw materials are only found in isolated locations and whose availability subsequently depends on various political and commercial considerations.

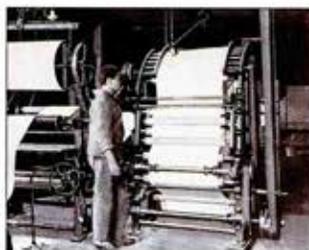
The entry into coal mining had given Bayer a source of its own for this important fuel and organic raw material. A similar policy was established for other organic bases. Bayer now owns mines and processing facilities in numerous countries for the production of fluorites and chromium ore. The company also participates in other mining ventures in the fields of titanium and zirconium ore, tantalum and niobium.



Bayer chronicle

1907

Bayer acquires the photographic division of Ed. Liesegang, Düsseldorf (photo). Until the completion of the photographic products plant in Leverkusen in 1912, the manufacture of photographic paper remains in Düsseldorf.



The three firms of the "Triple Confederation" form the joint venture Mersey Chemical Works Ltd. in England.

Inorganic Chemicals Department extends its production to include sodium sulfide and hydrogen peroxide. Sulfuric acid production reaches 67,000 tons per year.

Pharmaceutical Department introduces Sajodin, a vaso-regulator for the treatment of arteriosclerosis, angina pectoris and hypertension.

Librarian Hugo Caspari becomes head of the Education Department.

World events

1907

The United Kingdom and Russia sign the Treaty of St. Petersburg, regulating the countries' spheres of interest in Persia, Afghanistan and Tibet. The treaty complements the Anglo-French "Entente cordiale" of 1904.

In the United States, Leo Hendrik Baekeland makes the first phenol-formaldehyde resin and calls it Bakelite.

Henri Deterding, the Dutch industrialist, merges his oil company with Shell in the U.K. to form the Royal Dutch Shell Company.

The Düsseldorf firm Henkel introduces "Persil"—a word formed from "perborate" and "silicate"—as a combined detergent, bleach and disinfectant. It rapidly becomes



a worldwide brand name. (The picture above shows an advertisement dating from the year of its introduction.)

Coal has remained one of the most important sources of energy for the chemical industry to this very day. As early as 1904, Bayer alone had a coal consumption of 204,000 metric tons in Elberfeld and Leverkusen; today, the company's needs have reached

an annual 404,000 metric tons. To guarantee supplies, the so-called Triple Confederation of dyestuffs manufacturers bought the "Auguste Victoria" mine at Marl, near Recklinghausen, in 1907.

Cultural life begins with a brass band

On September 13, 1908, the so-called "Recreation Hall" was inaugurated in Leverkusen-Wiesdorf as a "center for social and instructive events." It could accommodate 1,000 people. But at this time, the plant had a total of only 5,300 employees, and the company could not count on the support of the very few local inhabitants who didn't have any ties to Bayer.

Nevertheless, the recreation hall was a great success. There was standing-room only for an audience of 1,300 on January 2, 1909, when the "Dramatic Association" staged a Kleist play.

The recreation hall had been originally planned as a location for the works' Gymnastics and Games Society, which had been formed in 1904. It was to have a roofed-in area for a broad-jump and high-jump pit and a few pieces of gym equipment. However, some new developments caused a change in thinking.

In 1900, for example, 11 brass band fans got together to make music, with a fire inspector organizing rehearsals and a clerk from the raw materials warehouse who had learned to play trumpet with the Dragoons in Metz acting as conductor. The rehearsal room for the band members, who called themselves the "Orchestral Society" from 1901 onwards, was a waiting room in one of the gatekeepers' lodges.

In 1904, the strings followed the wind instruments; a 14-man ensemble was formed. They started off ambitiously with pieces from Mozart, Bach and Beethoven and were soon so satisfied with their progress that they christened themselves the "Philharmonic Works Orchestra."

The singers were next. A male-voice choir with 33 members was soon entertaining audiences with their version of "Spring on the Rhine."

Further education and culture were very much the order of the day at the turn of the century. Everyone strove to "improve" himself. That meant making music, reading the classics and going to theater. For the working class, education was synonymous with "getting ahead," both at the workplace and in society.

On August 18, 1907, a group of employees formed the "Society for Further Education of the Workers and Craftsmen of Farbenfabriken vorm. Friedr. Bayer & Co." On October 5, Ludwig Schmunck started off with a lecture on the "Advantages of Further Education." Many other lectures followed, initially on career-related subjects with the purpose

Eleven employees got together in 1900 to make music. By the following year, they had formed the "Orchestral Society of Farbenfabriken Bayer." The picture on the right shows the Society members with their instruments in 1908. At that time, the Bayer Philharmonic

Orchestra that is reflected above in the bell of a brass instrument was still a dream of the distant future.



of instructing employees on the meaning and connotations of their work at Bayer.

For its part, the plant management set up a "Committee for the Promotion of Educational Endeavors." The members of this committee were Bayer executives who were willing and able to give lectures or conduct study groups.

In December 1907, philologist Hugo Caspari took over the responsibility of the works library and at the same time was named head of the Education Department. The scope of the remarkably well-attended lecture series was gradually extended to span a wide range of subjects, including literature, psychology and music. And the meetings still took place in one or another of the gatekeepers' waiting rooms.

Almost automatically, the idea of a gymnasium developed into plans for a recreation center. The project was to become a reality surprisingly soon. In addition to the concert hall, the building inaugurated on September 13, 1908, contained several rehearsal and lecture rooms, a reading room,



a restaurant (where a half-liter of beer cost 13 pfennigs), a double bowling alley and a billiards room.

A facility of this kind bred new activities. A dramatic association was formed by amateur actors and already in its first year of existence, it was giving 16 performances per season and

rehearsing for nine new plays. The group was headed by chemist Wilhelm Bergdoldt, who doubled as director and actor.

The company's cultural associations were eager to improve their standards. Outside theatrical companies were therefore invited to the recreation hall so that the Bayer actors could learn from them. The men's choir traveled to compete at a choral festival in Berlin.

All of these ambitious and promising activities were brought to a sudden end when the First World War broke out. A large portion of the workforce was called up and cultural events became few and far between. Admission fees from the performances went to a support fund to send food and parcels to the soldiers.

But it was precisely during the hard times of the war and the immediate postwar period when culture was needed as relief from the worries and cares of everyday life. In 1921, Caspari wrote: *"Music, the most intangible of all the arts, is not only inspiring in its own beauty, but also in its total lack of connection to daily existence; it allows people to raise their eyes from workday misery and look both inward and upward."*

Cultural events gradually reemerged after the First World War. The merger of the townships of Wiesdorf and Bürrig took place in 1920. By then, the town of Wiesdorf had a sizable population of 28,155. The new municipality set up an adult education school for its citizens and took over some of the "educational" events. By encouraging its employees to compose their own music and by arranging performances by well-known artists, Bayer centered its efforts on music appreciation. Famous orchestras were brought to Leverkusen and popular soloists added star appeal to the concerts.

The Wiesdorf Oratorio Society was formed in 1925. Its chairman was the mayor of Wiesdorf, and four Bayer directors acted as sponsoring members.

Cultural freedom came to an end in 1933. Culture, like everything else, was "brought into line" by the Nazi regime and new derogatory catchphrases were

Few people know that the "Erholungshaus" recreation center, today the home of so many cultural events, was originally a gymnasium for the works club TuS 04. Today the musicians follow the conductor's baton on the site

that once housed parallel bars and a vaulting horse.

coined; the powers that be harshly criticized the contemporary culture in fascist language, by condemning "decadent art," "cultural Bolshevism," "nigger jazz," and "Jewish music." Concerts were increasingly replaced by "socials," where political indoctrination was part of every get-together. The cultural societies were "brought into line" as member organizations of the National Socialist Culture Community, or the KdF ("Strength through Joy"). Even the admission tickets were distributed by the National Socialist Works Organization.

But in spite of this dark era, all was not lost. Erich Kraack became artistic director of the Philharmonic Orchestra in March 1935. He was appointed to the post by the head of the Lower Rhine Operating Unit, Hans Kühne, who himself was a talented performer of chamber music and collector of antique instruments.

Leverkusen soon had enthusiastic and demanding audiences, and even the neighboring cities of Cologne and Düsseldorf had to admit that Leverkusen had quite justly earned its reputation as a musical center. Famous pianist Wilhelm Kempff said, "*The Leverkuseners demand only the best.*"

Despite the political climate, the Philharmonic Orchestra was at its best, with top names like Elly Ney, Edwin Fischer and Ludwig Hoelscher frequently appearing as soloists. The orchestra reached its peak in 1939 with a performance of the overture to Weber's "Freischütz" under conductor Hans Pfitzner. Concerts in Berlin and the Netherlands carried the fame of the Philharmonic outside the Rhineland. For the last winter of the war (1944–45), Kraack planned a schedule of programs that was to have culminated with a concert featuring Elly Ney on March 15, 1945. Needless to say, it never took place.

Bayer chronicle 1908

Agfa of Berlin begins construction of a factory in Wolfen for the manufacture of film. Production begins in 1910.

Pharmaceutical Department introduces the drug Anti-leprol against leprosy.

An advisory bureau serving employees and their families in matters connected with federal and private welfare is set up as part of the works office.

Sulfuric acid plant begins production at the Uerdingen plant of Weiler-ter Meer.

World events 1908

The city of Messina, Sicily, is totally destroyed by an earthquake on December 28. In the town alone there are some 84,000 victims.

Hans Geiger develops the Geiger counter for the measurement of the number of alpha particles.

British General Robert Baden-Powell forms the Boy Scouts.

Henry Ford completes the first "Model T" on October 1. The car has a 2.9-liter cylinder capacity, 20 horsepower and a top speed of about 12 m.p.h. The price for the "Tin Lizzie," which is to become the world's most successful automobile, is only \$850. A total of 19,000 are sold in the first year—15 million by 1927.



The Staff Suggestion Scheme makes ideas pay

Encouraging employees to think about how their work could be improved has been a Bayer policy for nearly 80 years. Both for the benefit of the company and to the personal advantage of the employees, the Staff Suggestion Scheme was set up in July 1909.

In July of 1909, the following announcement was posted on Bayer bulletin boards: *"We have decided to grant suitable rewards for useful suggestions from workers and salaried staff that serve to prevent accidents or lead to improvements in instruments, tools, machinery or apparatuses. This will also apply when mistakes in blueprints are discovered and reported before execution or assembly. To this end, boxes will be hung up in all office buildings, laboratories and recreation rooms. These are to be emptied every Saturday. The suggestions received will be examined by the General Workers' Committee, which will then pass on all worthwhile suggestions to us with a recommendation as to a bonus payment. The final decision as to the amount will be made by us. Signed by F. Bayer and C. Duisberg on behalf of the management of Farbenfabriken vorm. Friedr. Bayer & Co."*

The first man to take advantage of the new program was toolmaker Wilhelm Wolf. He sat down and wrote the management a well-phrased letter recommending the acquisition of a water-separating vessel for the steam unit, thus not only saving on energy, but also resulting in greater safety for those handling boilers under steam pressure. The management accepted the proposal and Wolf was awarded 100 marks. Incidentally, the Bayer archives document that already in 1907, a written suggestion was made before the official incentive program from management began.

The person responsible for a patentable invention that improves the competitive position of the company in the market gets a share of the benefits. Why shouldn't the same apply when an employee's idea brings advantages within the company itself, even though the proposal cannot be protected by a patent?

According to Bayer's official definition, an improvement proposal is *"an idea that is not subject to patent protection, which goes beyond the duties and responsibilities of the employee suggesting it and which is aimed at achieving economic advantage by improving operating conditions or processes or at reducing health risks."*

The first employee proposal to earn a special bonus came from the toolmaker Wilhelm Wolf. In 1909, he was awarded 100 marks for his suggestion that a water-separating vessel with automatic drainage should be installed in steam apparatuses;

his original letter is shown on the right. Almost exactly 50 years later, his son made a suggestion that also led to a bonus, but it was considerably higher than 100 marks.

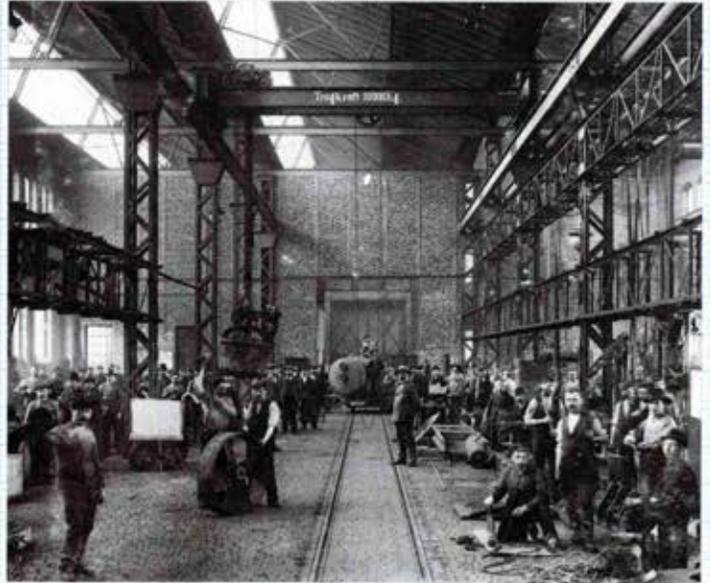
Wiesdorf, 16 Juli 1909

Ergebungsbericht auf den Vorschlag, ein
 Präventivmaß, von Dampfgeräten zu entfallen, dessen
 Zweck die Vermeidung von Unfällen ist, wie eine
 Beschreibung beigefügt, welche in einem Patent
 für einen Luftabschneidungsventil für Dampfleitungen
 angegeben ist.

Es wurde oft der Fall vorgekommen, dass eine abgegebene
 Dampfleitung sich plötzlich automatisch
 durch einen Ausfall des Ventils in Gefahr
 durch Luft und das sich ausbreitende Wasser
 entzündet, wenn bei vollem Dampfdruck steht.

- Die Gefahr liegt darin:
1. der Dampfdruck steigt nicht bis zu dem
 kritischen Punkt - wenn er über diesen hinaus
 von 3-400 mtr. entfernt - zu gehen fort
 und das Luftabschneidungsventil aufzuheben.
 2. beim Öffnen des Ventils der Dampf sich
 nicht zu verhalten vermag, ob das Luft
 abschneidungsventil auf ist.
 3. nach dem Öffnen des Ventils der Dampf nicht
 genügend aus abzufließen
 können, sodass das Wasser in die
 die Luftabschneidungsventil, das der Fall.

Woll



Wiesdorf, July 16, 1909

In reference to the notice concerning bonus payments for suggestions on measures that further the prevention of accidents etc., please allow me to inform you about my invention, which consists of an automatic water-separating valve for steam pipes.

The idea is that a closed-off steam pipe drains itself automatically. When steam is released into the pipe, air that is present and water that has begun to form escape into a vessel. At full steam pressure, the valve closes.

- The improvement lies in the fact that
1. the boilerman in question does not need to go to the end of the piping, which can be a distance of up to 300-400 meters, in order to check the water-separating valve.
 2. when turning on the steam, the boilerman does not have to make sure that the water-separating valve is open.
 3. after turning it on, the boilerman does not have to go shut it off.

It is possible that by not opening the water-separating valve, pipes and contoured parts could explode, thus resulting in accidents and shutdowns. This can be avoided with the help of my invention.

I would be happy to provide further details about my suggestion.

With greatest respect, I look forward to hearing your decision and remain

Yours faithfully,

Toolmaker Woll

Steam boiler
 No. 4946

Ich bin sehr dankbar für die
 schnelle und Materialspendungen
 die, nach dem meine Erfindung
 den mein.

Ich bin sehr dankbar für die
 schnelle und Materialspendungen
 die, nach dem meine Erfindung
 den mein.

Gewissen Maßstab anzugeben
 ist sehr wichtig!

Woll

Woll
 No. 4946

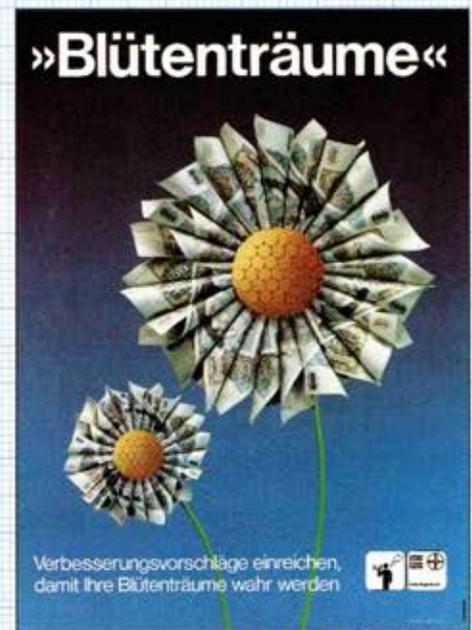
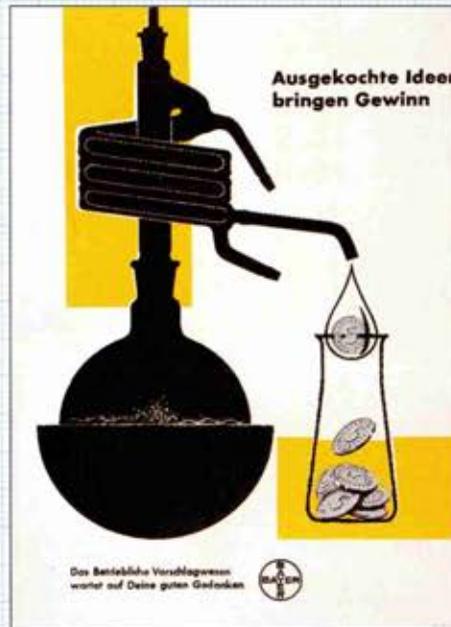
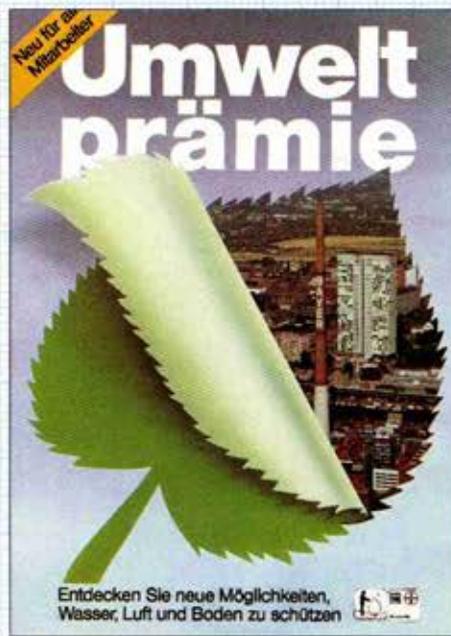
Wiesdorf, 16.07.09.

Wiesdorf, 16.07.09.

Wiesdorf, 16.07.09.



The Staff Suggestion Scheme makes ideas pay



Today, the evaluation of suggestions is in the hands of a commission formed of four representatives of both management and the Works Council. Special advisors in the various plants help applicants with the presentation of their proposals and pass these on to experts in the corresponding works unit or department. They calculate the cost savings or other advantages inherent in the suggestions and pass the proposals onto the commission for a final decision.

Participation in the program has varied considerably over the years. The fact that there were only three suggestions in 1914 and none at all in 1945 was undoubtedly a sign of the times, as was the low number of proposals in 1938.

Rewards are substantially larger today than Wilhelm Wolf's 100 marks. In 1972, a foreman in the Antwerp, Belgium plant received the equivalent of DM 21,000. In 1983, the top payment was DM 37,750; in 1984, the high was DM 26,450. The top prize-winner in 1985 received DM 24,765. And in 1987, the highest prize of DM 30,200 was awarded to an employee at the Brunsbüttel works.

In 1987, Bayer AG paid suggestion bonuses totaling DM 1.3 million; with a 48-percent increase in the submitted suggestions compared with the previous year, this figure broke a record.

The average individual award in 1987 was DM 1,000. This means, of course, that among the 1,308 winning suggestions, some earned very modest sums. For example, DM 50 went to someone who suggested simplifying a form used when samples are to be evaluated. From time to time, there is a lottery among all prizewinners, where there is a chance to win such special rewards as cars or trips.

With the help of posters such as those shown on the left, employees have been repeatedly reminded over the past decades how welcome their suggestions are, and how it pays to submit their ideas. The modest bonuses of 100 marks that were awarded when the scheme was introduced

in 1909 are long past. In 1987, the company paid some DM 1.3 million for more than 1,300 suggestions.

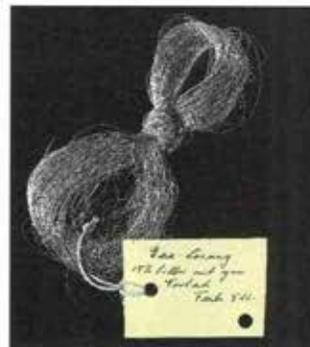
Bayer chronicle 1909

Bayer introduces the eight-hour shift.

The first central switchboard for the telephone system is installed in the Elberfeld plant.

Production of lithopone, the first inorganic pigment for paint, begins.

By making use of cellulose acetate solutions, Bayer develops a process to coat filaments with a shiny metallic pigment.



These "Bayko" filaments (above) are used to make gold and silver braid and trimmings.

Jakob Pohl is entrusted with the task of setting up a Bayer affiliate in Porto, Portugal. The company had been conducting business with Portuguese customers since 1884.

On September 12, Bayer is granted the world's first patent for a synthetic rubber process.

World events 1909

Louis Blériot, the pioneer of French aviation, crosses the English Channel by monoplane (photo) on July 25.



The flight from Calais to Dover, a distance totaling some 22 miles, takes Blériot 27 minutes and 30 seconds.

Theobald von Bethmann Hollweg becomes German Chancellor following the resignation of Bernhard von Bülow after his finance reform proves unsuccessful.

Germany's first legislation governing "traffic with motor vehicles" lays down traffic regulations and liability conditions.

Fritz Haber succeeds in synthesizing ammonia from nitrogen and hydrogen.

On April 6, American naval officer Robert Edwin Peary shown in the photograph below



is the first man to reach the North Pole.

Synthetic rubber — a technological breakthrough

Some 13 million metric tons of rubber are used worldwide each year. Synthetic rubber accounts for a good nine million tons, or about two-thirds of this total. The first patent for a “process for the manufacture of artificial rubber” was awarded to Bayer on September 12, 1909. Production began in 1910.

Frenchman Charles Marie de la Condamine spent ten years exploring equatorial America on behalf of the Académie Française. When he came home in 1745, he brought with him not only the first reliable map of the Amazon river, but also samples of the black, resinous substance called curare that was used to poison the tips of arrowheads and of a sticky brown mass known to the Indians as “caa-o-chu,” or “cahuchu.” In their language, “caa” meant wood or tree and “chu” to cry or to flow.

Condamine had seen the natives making a cut into the trunk of a certain tree and subsequently collecting the white, milky sap that oozed out of the bark of the “crying tree” into gourds. It was then cooked over smokey fires until it was brown. The resultant mass could be used to make bouncing balls as well as for more utilitarian purposes. For example, when applied as coating, it made cloaks, footwear and even clay pots waterproof and formed a skin for canoes. Since the Tupi Indian word was difficult to pronounce, the French decided to call the unfamiliar substance “caoutchouc.”

In the following years, more pieces of this strange material arrived in Europe, where it was closely examined and described in detail. The only trouble was that for the longest time, nobody knew what to do with it.

In 1770, English theologian and chemist Joseph Priestley, who would go down in history as the discoverer of oxygen, reported that mechanic Edward Nairne had quite by coincidence hit on its erasing properties. By mistake, he picked up a piece of “caoutchouc” instead of the usual breadcrumbs to rub something out of a pencil sketch. When he saw that it did a better job as an eraser than the bread crumbs did, Nairne started to sell tiny pieces under the self-explanatory name of “rubber.” Since the substance was originally discovered by the South American Indians, it was also known as “Indian rubber.”

And that was, for many years, its only use. It took 53 years before British chemist Charles Mackintosh carried out the successful experiment in which he

Methyl rubber, created from dimethylbutadiene by the process of polymerization, could become hard or soft depending on the reaction temperature. The soft kind, Type W, proved to have serious drawbacks; this rubber lacked stability and remained elastic only at higher

temperatures. The photograph on the right shows original samples that have not yet been dyed black with carbon. They have been preserved in the flask for over 70 years.



Nachtbülhaat. süß
Abarke N.

agents, which together with other additives largely determine product quality.

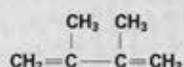
After vulcanization, the high-molecular product is present in the form of cross-linked molecular chains that are "tangled" in their natural condition, but they can be stretched out by elongation. When the tension decreases, they return to their tangled state. This means that the raw rubber has taken on properties that make its processed form into an indispensable industrial material. But since double bonds remain after vulcanization, rubber is sensitive to oxidation.

Either from atmospheric oxygen over a long period of time, or more rapidly from ozone, the rubber "ages" and becomes cracked and brittle. The addition of antioxidant and antiozone agents to rubber compounds largely counteracts this tendency to age.

The rapid rise in demand for rubber before World War I made the development of a synthetic rubber an attractive prospect, since the structure of natural rubber was already known. The idea of producing isoprene and then simply polymerizing it was obvious, logical—and unsuccessful. Apart from the difficulties of finding economical production processes for isoprene, polymerization worked differently in the synthetic process than in nature.

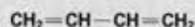
The average chain length, the degree of chain branching and other parameters are decisive in achieving the

properties of a high polymer. When isoprene was replaced by the more readily available dimethylbutadiene,



significantly better results were attained. However, history clearly shows that it was only the wartime shortage of natural rubber which made any large-scale production of methyl rubber practical.

The first real breakthrough in the field of synthetic rubber did not occur until more than ten years after the end of the First World War, and that was the result of a new method of polymerization for the methyl-free substance butadiene:



dissolved rubber in naphtha. He then coated two pieces of fabric with the solution, pressed them together and cut a raincoat out of the resulting material—the first mackintosh saw the light of day.

The fabric that Mackintosh created did not exactly make an ideal garment: it was sticky and smelly in hot weather and stiff as a board when cold. But as interest in this elastic material grew, people began to examine its potential.

In the first half of the 19th century, two inventions opened up all sorts of possibilities in the field of rubber processing. In England, blacksmith Thomas Hancock made the first breakthrough when he discovered that rubber could be changed into a malleable mass by a long and vigorous kneading process called mastication. The resulting substance could be formed into different shapes.

In 1839 in New Haven, Connecticut, another layman invented the vulcanization process as a means of retaining rubber's elasticity over a broad range of temperatures. As the story goes, the inventor, Charles Goodyear, stumbled across this process by accident. He had bought a license for a process to mix rubber with sulfur. After drying the mixture in the sun, he intended to use it for the production of mailbags.

But Goodyear was still faced with rubber's unsatisfactory temperature resistance. When one sample got too close to the furnace, however, he noticed a radical alteration in its characteristics. Full of optimism, Goodyear started working on the development of a commercial process. But this venture cost him much more money than he could afford, and he died a poor man.

Nor did Hancock, whom Goodyear sued under patent law, achieve much from his efforts to make marketable products. The point was that there was no real need for rubber at the time. Europeans took a long time to realize its potential, and even then it was only used in small quantities.

By the time the 1855 World Exposition took place in Paris, however, rubber was on exhibit in a whole range of different applications including garments,

shoes, pontoons, lifeboats, combs, buttons, ammunition pouches, rifle butts, eyeglass frames, umbrellas, machine components and more.

As early as 1845, Scotsman Robert William Thomson invented the pneumatic tire. It consisted of one or more sailcloth inner tubes impregnated with a rubber solution and a leather cover. But this invention also came too soon—there weren't even bicycles on the market yet.

A good 40 years later, Irish veterinarian John Boyd Dunlop made the same invention and obtained a patent. He became a rich man in the process, since the world now needed air tires for bicycles and later for automobiles.

Until the turn of the century, all rubber was extracted from Brazilian rain forests, where it was laborously collected by the natives. Brazil was quick to recognize the value of this new raw material, which was not found anywhere else in the world. The smuggling of rubber tree seeds out of the country became a capital crime.

British planter Henry Wickham got away with this in 1876, when he managed to smuggle 70,000 *hevea brasiliensis* seeds into England. He was rewarded with a knighthood for his effort, which led in 1880 to the opening in Ceylon of the first rubber plantation. "Plantation rubber" was introduced to the market in 1900.

The early days of this century saw the start of large-scale motorization. As expected, the wild rubber from Brazil and the plantation crops from Ceylon, Singapore and other parts of Southeast Asia were not enough to meet the demand. Prices began to rise, and by 1906 had reached a peak of between 21 and 28 marks per kilogram, which was the equivalent of a good weekly wage in the German industry.

At about the same time as these developments were taking place, Carl Duisberg was beginning to have doubts about the future of dyestuffs production. He wrote to Adolf von Baeyer: *"In an era when, as I see it, scientific and technical chemistry has reached its peak or is even on its decline, we should*

not shrink from our duty to open the eyes of a disillusioned public."

Bayer consequently decided to take a closer look at rubber. The minutes of the management conference of October 18, 1906, show that the firm was ready to offer a 20,000 mark prize to the *"chemist in our employ who, within three years, which means by November 1, 1909, develops a process for the manufacture of rubber or an equivalent substitute. The manufacturing costs of the quality product are not to exceed 10 marks per kilogram."* Fritz Hofmann, the 40-year-old chief chemist of the pharmaceuticals department, took up the challenge.

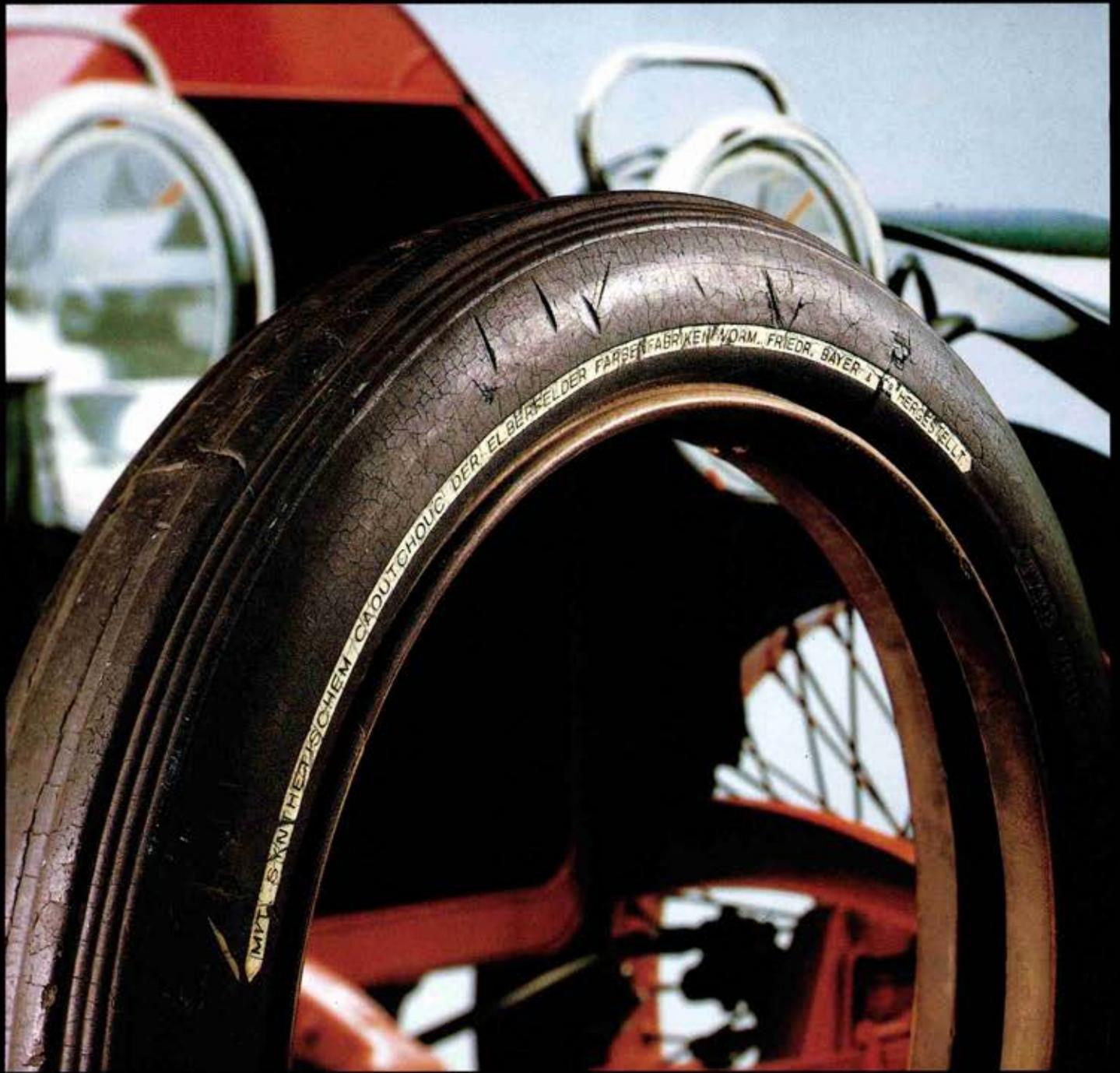
Rubber chemistry was still very young, but the basics had already been investigated sufficiently to enable research targeted for industrial applications. As early as 1860, British chemist Greville Williams had discovered isoprene, which leading German expert Professor Carl Dietrich Harries subsequently identified as a primary building block of rubber in 1905.

Natural rubber consists of long chains of hundreds of linked isoprene molecules. The first step therefore had to be the synthesis and polymerization of pure isoprene.

A research team led by Fritz Hofmann reached this goal by August, 1909. A patent was granted the following month. The first sample of the product was tested by the "Continental Caoutschouc und Guttapercha Compagnie" in Hanover and found by Harries to be "veritable" rubber.

That was a promising start. But difficulties had arisen from within the firm at about the same time. While on the one hand, there was reason to fear that other companies were also working on rubber synthesis, on the other, the budgeted costs had already been exceeded and both the Board of Management and the Supervisory Board felt that they were too high in view of the fact that eventual success was uncertain. Only Duisberg wanted to stay with it. As Hofmann said later, *"Had we not had his support for years on end, we would have had to throw in the towel long ago."*

One of the first tires made from methyl rubber can still be seen in the technical department of Bayer's Rubber Business Group in Leverkusen. The words on the rim translate as "Made with synthetic rubber from the Elberfeld Dyeworks, formerly Friedr. Bayer & Co."



MIT 5 KM HERTSICHEM CAOUTCHOUC DER EL. BERFELDER FARBEFABRIKEN VORM. FRIEDR. BAYER HERGESTELLT

Synthetic rubber—
a technological break-
through

The first success proved to be only a limited one. The isoprene-rubber patent was not put to use. Hofmann and his team had obtained the isoprene from the coal tar component para-cresol. This starting material was unfortunately in short supply, which meant that isoprene could not be synthesized at an economical price.

The researchers consequently changed to the more readily available dimethylbutadiene, or "methyl isoprene," whose polymer was called methyl rubber. The production process was simple enough, but it took a lot of time.

Polymerization, carried out in metal cans, lasted up to six months. Depending on the reaction temperature, either 30° or 70° C, the product texture varied. The hard rubber was superior to the soft. Nevertheless, methyl rubber was commercially viable and Continental in Hanover declared its willingness to buy up as much as it could for further processing. In 1910, they made the first methyl rubber tires.

Bayer did not try to keep its progress a secret for long. At the International Congress for Applied Chemistry in New York in 1912, Duisberg let the cat out of the bag. He presented two tires from his own car with which he had driven 2,500 miles without a blowout. He announced that the Grand Duke of

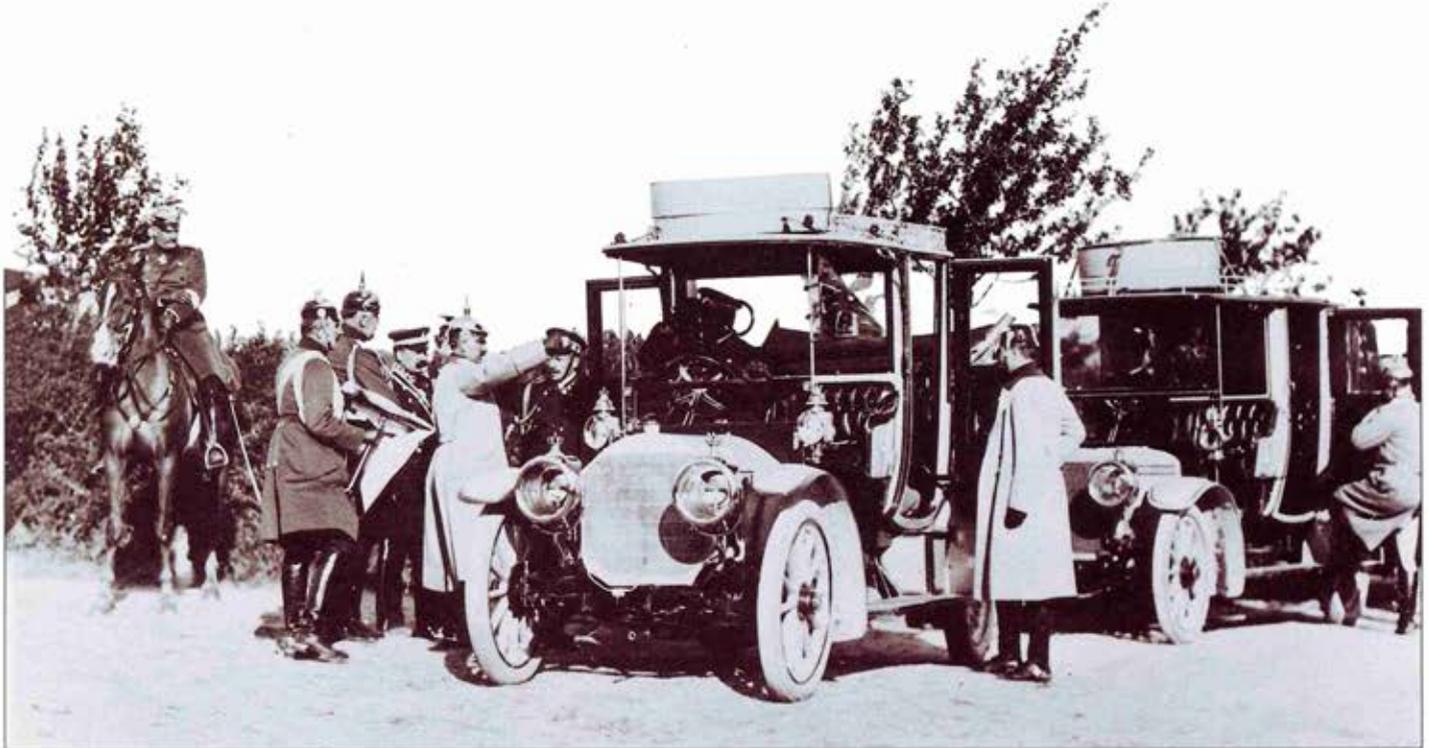
Baden and the Kaiser himself had methyl rubber tires on their cars. Indeed, His Majesty had claimed to be "extremely satisfied" in a telegram dated June 4, 1912.

Duisberg livened up his presentation with a joke: "And do you know what artificial rubber is made of? Alcohol! So make sure there's enough left over." The New York Tribune wrote that "the German Emperor drives a car whose tires are made of a substance extracted from schnapps."

Unfortunately, the faults of methyl rubber came to light when used in car tires. It had a short storage life and decomposed relatively rapidly due to oxidation.

In 1912 Continental declined to carry on with its processing. Production was stopped at Bayer in 1913 and only lab research continued. It wasn't really worthwhile anymore—the British had opened up huge new plantations in Borneo and the Dutch in Java, and prices slumped.

But this was not the end of methyl rubber. During the First World War, production started up again. Only the hard version was of value; it was used for such important wartime products as accumulator cases for submarines. The soft methyl rubber did not bear comparison with the natural product



because it was less stable and elastic only at higher temperatures. For example, the tires of army trucks used in Russia were worn out only after some 1,250 miles. The sole reason for continuing production until May 1919 was because of the ongoing British sea blockade after the end of the war and the desire not to put employees out of work in a time of need.

Methyl rubber had been no more than an ersatz, and one which could not beat the natural product. But a start had been made, and the know-how was retained for later.

There was another important consideration: Bayer had entered the totally new field of rubber chemicals. The chemists had put a great deal of effort into finding substances to improve rubber processing yields as well as the properties of finished rubber goods. This scientific work led to the development of the first antioxidant chemicals and vulcanization catalysts.

Fritz Hofmann, who went to the Kaiser Wilhelm Institute for Coal Research in Breslau (today Wroclaw) after the war, said in a speech in Gleiwitz (Gliwice) in 1924: *"Synthetic rubber is dead! Long live synthetic rubber! Let us hope that a more fortunate generation can carry on our pioneering work."* This indeed proved to be the case (for more information, see chapter on Buna beginning on page 248).

After Carl Duisberg, Kaiser Wilhelm II was one of the first car owners to have tires that were made out of Bayer's methyl rubber. (The Kaiser is shown on the left standing next to his Benz with the honeycombed radiator.) At the 1912 Congress for Applied Chemistry, Duisberg

had the pleasure of announcing that in a telegram dated June 4 of that same year, His Imperial Majesty had claimed to be "extremely satisfied" with the tires.

Bayer chronicle 1910

Bayer becomes the first German company to organize its accounting according to the Hollerith system.

Another first in German industry is Bayer's appointment of a so-called "social secretary." He acts as a mediator in disputes between workers and works staff.

A chemotherapeutical research institute is opened in Elberfeld.

First issue of the company magazine "Die Erholung" ("Recreation") appears in January.

The first reception for long-serving employees is held on October 16 to honor 16 people who have been with the company for 25 years.

To mark the 75th birthday of his teacher, Carl Duisberg establishes the Adolf von Baeyer Memorial Medal.

Bayer chronicle 1911

Friedr. Bayer & Co. is set up in Japan with offices in Kobe and Yokohama.

Branch office Frederico Bayer & Cia. opens in Rio de Janeiro.

World events 1910

German car builder Ferdinand Porsche reaches a speed of 87 m.p.h. with his tulip-shaped automobile.

A total of 144,150 organic compounds are listed in the third edition of "Beilstein's Handbook of Organic Chemistry."

Halley's comet becomes easily visible in May. Widespread fear breaks out that the end of the world is at hand.

World events 1911

On December 14, Norwegian Roald Amundsen becomes the first man to reach the South Pole and thus wins the competition with Briton Robert F. Scott, who arrives there on January 17, 1912.

Manchu dynasty of China is overthrown during a revolution. Sun Yat-sen is proclaimed president of the new Chinese Republic on December 30.

Kaiser Wilhelm Society for the Promotion of the Sciences, today's Max Planck Society, is formed in Berlin on January 11.

Marie Sklodowska-Curie is awarded the Nobel Prize for chemistry. Together with her husband Pierre Curie, she was also the physics laureate of 1903.

Leverkusen becomes headquarters and Duisberg Chief Executive

Up until 1912, people referred to the “Elberfeld Dyeworks” when they wanted to avoid using the official company name “Farbenfabriken vorm. Friedr. Bayer & Co., AG.” When the headquarters moved from the Wupper to the Rhine, the shortened form became what it has remained to this day—Bayer Leverkusen.

On January 1, 1912, Carl Duisberg took over the top management position as Chief Executive of Bayer. He was almost the last of the “old guard,” as Hermann König had died in 1902, and the others had moved out of their executive positions and onto the Supervisory Board. Carl Hülsenbusch had become a member of the Supervisory Board in 1906, Henry von Böttinger Board Chairman in 1907 and Friedrich Bayer Jr. Vice Chairman in 1911.

In 1907, four men had been named deputy directors—chemists Robert Emanuel Schmidt, Karl Krekeler and Christian Hess, plus Rudolf Mann from the commercial side. Together with Carl Duisberg, they now made up the Board of Management.

The first major job facing them was the relocation of Bayer's headquarters to Leverkusen. In fact, an increasing number of individual operations had already been moved to the plant on the banks of the Rhine.

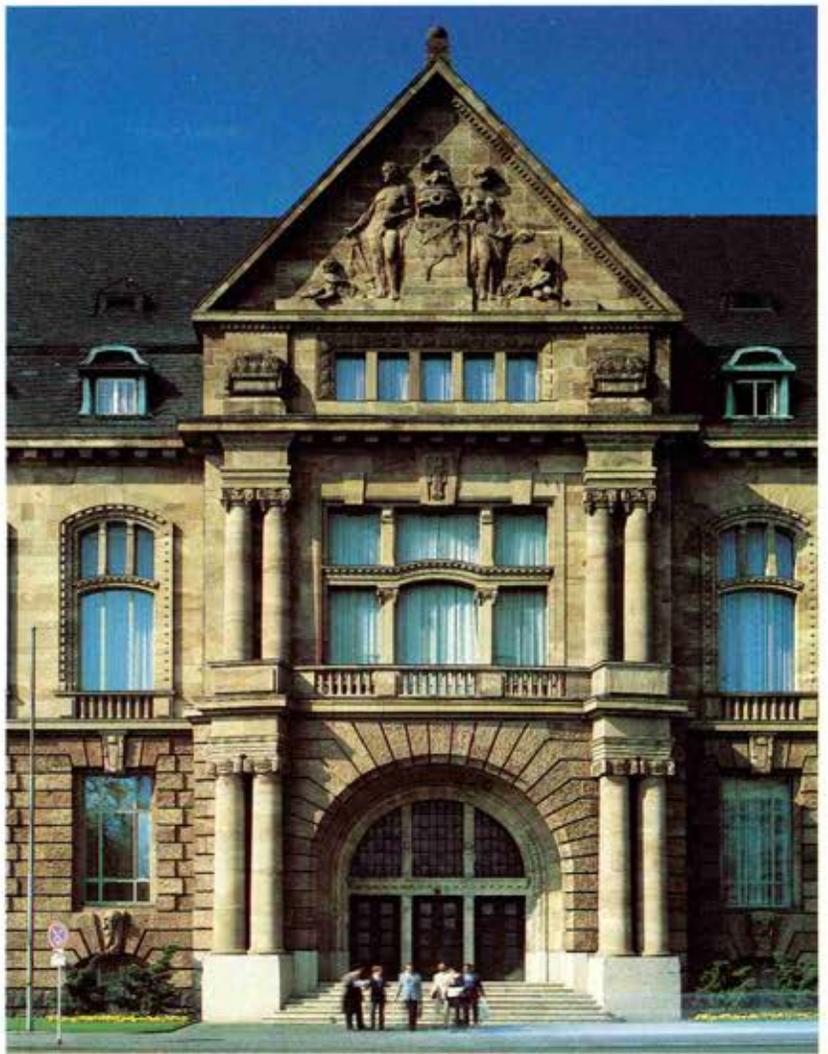
Actual planning for the transfer of corporate headquarters had begun as early as 1902, when heads of departments and office managers had been sent the first blueprints for their comments and reactions. Initial drafts were discussed the following year and by 1909, a date had been set for the move, “*the projected expansions to be handed over ready for use by spring of 1912.*”

The architectural plans were the work of Willy Günther and Hubert Amrhein, whose designs were based on practical considerations of space, light, heating and necessary connections between individual facilities. A further consideration played an increasingly important role: the plant should be the company's “calling card.”

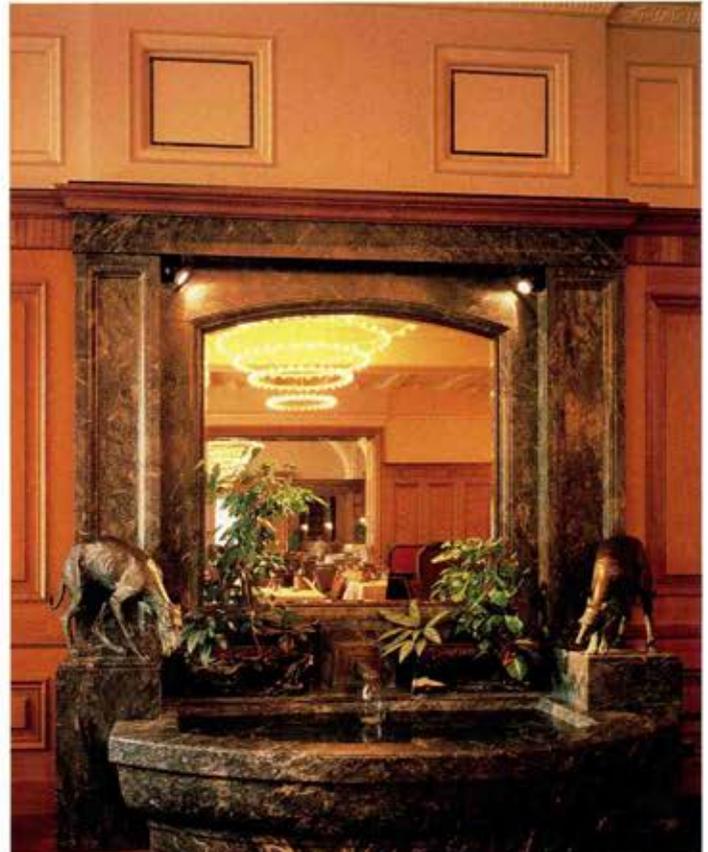
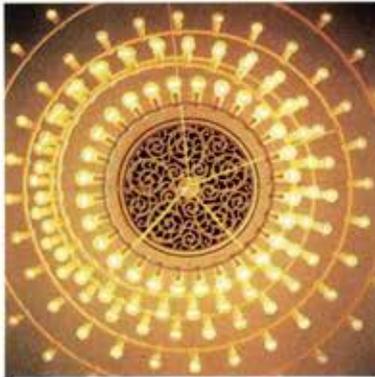
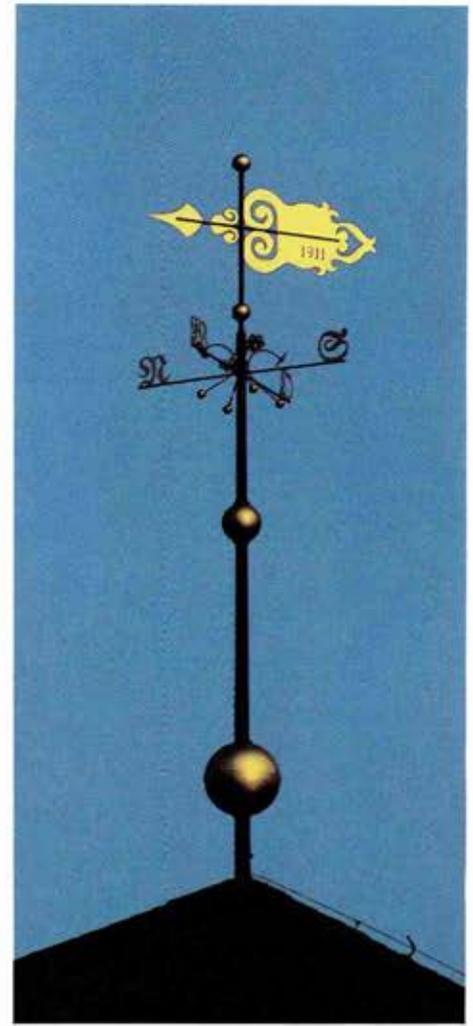
The era of Kaiser Wilhelm was very much preoccupied with the joys of self-expression. These were the days when any self-respecting city gave itself a splendid city hall. The prefix “neo” was in fashion, with grandiose Neo-Gothic, Neo-Baroque and Neo-Renaissance buildings intended to reflect equally significant periods of history. The eclectic taste of the day can be seen in city halls in Vienna, Stuttgart and Hamburg, or in the Berlin Parliament Building.

The former main administration building located on what used to be called Schwarzer Lane (today's Kaiser-Wilhelm-Allee) was officially referred to as Q 26. Still in use today, this building is considered to be, along with the Kasino, a veritable architectural jewel. The red sandstone

facade with its artistic frieze gives the visitor an idea of the splendor which is in store for him inside.



Leverkusen becomes
headquarters and Duisberg
Chief Executive



The Kasino on the Kaiser-Wilhelm-Allee is as magnificent today as it was in times past. The fire-gilded weather-cock, the richly adorned, filigreed stucco ceilings and the marble fountain in the dining room for guests are only a few examples of the festive setting in which employees and guests enjoy their meals.

Theaters and churches were designed with the same principles in mind, as were the villas of the prosperous middle class. But the era was not wholly imitative. It produced its own style, art nouveau, which gained in importance in many countries as an elitist contrast to the popular culture of industrial society. Duisberg's own villa, situated opposite Bayer's new main office, was typical of the "Jugendstil" of the early 20th century.

The main administration building itself, located on Schwarzer Lane (today's Kaiser-Wilhelm-Allee), could only have been constructed in the days before World War I, with its rich ornamentation and costly materials dominated by the "royal colors" gold and blue. Bayer's business visitors from all over the world were supposed to be conscious of the fact that they were at the headquarters of an international company.

The so-called "Kasino" was built opposite the main administration building. It was a restaurant for salaried staff, complete with a wine cellar and rooms for social events.

In 1912, Duisberg said at a party for long-service employees: "*We now have our hand on the pulse of this important plant, not only by day but also by night.*" This was more than just a figure of speech. Duisberg, who himself had set a good example, included a clause in the contract of all top managers that they should live in the immediate vicinity of the works with the intention of "*keeping their hand on the pulse of the plant by day and by night.*" A further consideration was that the attractive surroundings of the managers' homes would do something to brighten up the sober landscape of an industrial installation.

In time for its 50th anniversary, Bayer had thus provided itself with a new headquarters worthy of a leading corporation and in the spirit of the times.

Bayer chronicle 1912

Heinrich Hörlein develops Luminal (below), a soporific and antiepileptic drug.



The Böttinger Home is opened in Grosse Ledder, near Leverkusen, as a recreation center for Bayer employees. The Robert Emanuel Schmidt Foundation finances employee vacations in such places as Helgoland and Switzerland.

A salt electrolysis unit for the production of chlorine and sodium hydroxide starts up in Leverkusen.

Photographic paper production relocates from the Liesegang plant in Düsseldorf to the newly built photographic plant in Leverkusen, where developer and unprocessed film as well as photographic paper are manufactured.

The "Therapeutic Reports," published in German and Russian since 1906, are now issued in French, Spanish, Italian, Dutch, Portuguese, Japanese and Turkish editions.

World events 1912

The attempt of Viscount Haldane, head of the British War Office, to defuse the Anglo-German navy rivalry fails on February 11. On May 15, the German Reichstag decides to go ahead with the building of 41 battleships and cruisers, as well as to increase the peacetime size of the army.

Bulgaria, Serbia, Greece and Montenegro oppose Turkey in the First Balkan War.

During the night of April 14, the British luxury liner "Titanic" collides with an iceberg off the coast of New-



foundland and sinks. Only 703 of the 2,203 passengers are saved.

A national library and archive for all German language literature is set up in Leipzig.

Casimir Funk discovers the first-known vitamin (B). The term vitamin is taken from the words "vita" (life) and "amine," because vitamin B reacts like an amine.

At the end of its first 50 years, Bayer ranks number three

In 1913, Bayer was Germany's third largest chemical company, with 10,600 employees, some 7,900 of whom were now based in Leverkusen. It held 8,000 patents at home and abroad. Its international operations included five foreign subsidiaries, 44 sales offices and 123 agencies in all parts of the world.

The Imperial Bureau of Statistics announced on June 20, 1913, that the German chemical industry was composed of 158 joint-stock corporations with a total share capital of 510 million marks. Ten of these alone accounted for 293 million marks of this amount; the three biggest companies were Deutsche Solvay, BASF and Bayer.

The period from 1900 to 1913 had, in fact, been a golden era for Bayer. By 1913, its share capital had increased to 36 million marks and its net profits to 16.8 million. Of that amount, ten million could be paid out in dividends. The company's overall stockholders' equity had been rising at an annual average of 9.3 percent since 1899 to reach a level of 74 million marks in 1913. Over the same period, total assets had increased annually by 10.7 percent and were listed as 127.5 million by 1913. Earnings had quadrupled.

Also in 1913, the German dyestuffs manufacturers accounted for almost 90 percent of total production for this industry worldwide. Their major customers were countries with important textile industries, such as the United States, Russia, China, Great Britain, British India and France.

In pharmaceuticals and photographic paper, the German chemical industry was—like the electrical engineering sector—the world market leader. Only heavy chemicals were an exception. On the other hand, chemical production came nowhere near that of iron and steel.

The German chemical industry was very much a growth sector, but did not play the role that it does today in the industrial economy. Just how important chemical manufacturers have become is illustrated by the following figures: they accounted for 11.6 percent of total industrial sales in Germany and 7.5 percent of the labor force in 1984.

The strength of the German dyestuffs industry—and its Achilles' heel—was its high export share; between 60 and 80 percent of sales were outside Germany. Such a highly export-oriented industry was destined to do well as long as the world was at peace. And who was thinking of war in 1913?

The winged lion with the caduceus and globe had been the company symbol since 1895. It was then decided to use a cross formed by the five letters of the firm's name as a logo as well. The lion symbol on the right is taken from an illustration appearing in a color sample book dating from the era of art nouveau.

Bayer chronicle**1913**

The Main Scientific Laboratory, the Colorist Department and the Patents Department move from Elberfeld to Leverkusen.

A "Committee for Clean Factory Air" grows out of the Waste Water Commission. Paragraph 4 of its statutes reads: "This committee is to take steps against air pollution in the plant, whether from harmful or foul-smelling gases and fumes, or from soot or dust."

Bayer buys almost 750 acres of land in the Worringen area (near Cologne) on the left bank of the Rhine.

The Pharmaceutical Department introduces Cymarin for the treatment of heart trouble.

Bayer begins with agro-chemical research; the wet seed dressing Uspulun emerges as the first commercial product.

Affiliates are set up under the name Friedr. Bayer & Co. in Arnhem, The Netherlands, and Shanghai, China.

Members of management write a history of the company's first 50 years. It is printed on art paper of large format in 1918. It was never published, but instead was deposited in the archives.

World events**1913**

First Balkan War ends on May 30. Albania gains its independence. A month later, Second Balkan War breaks out.

British suffragettes' battle for the right to vote for women reaches its peak; almost 200 suffragettes are in jail.

Taking the Chicago stockyards as its model, the Ford Motor Company introduces conveyor belt production. The price of the Model T can be reduced from \$850 to \$290.

First wireless telegram is transmitted from Nauen, near Berlin, to Sayville in the United States on October 18. On January 27, 1914, the German Post Office introduces "telegram greetings" to the United States.

Friedrich Bergius proves that liquid reaction products can be obtained by the reaction of hydrogen with coal at high pressures.



1914-
1918

The First World War hits the chemical industry without warning

In 1914, the German chemical industry suddenly found itself faced with a war it had not foreseen and had not prepared for.

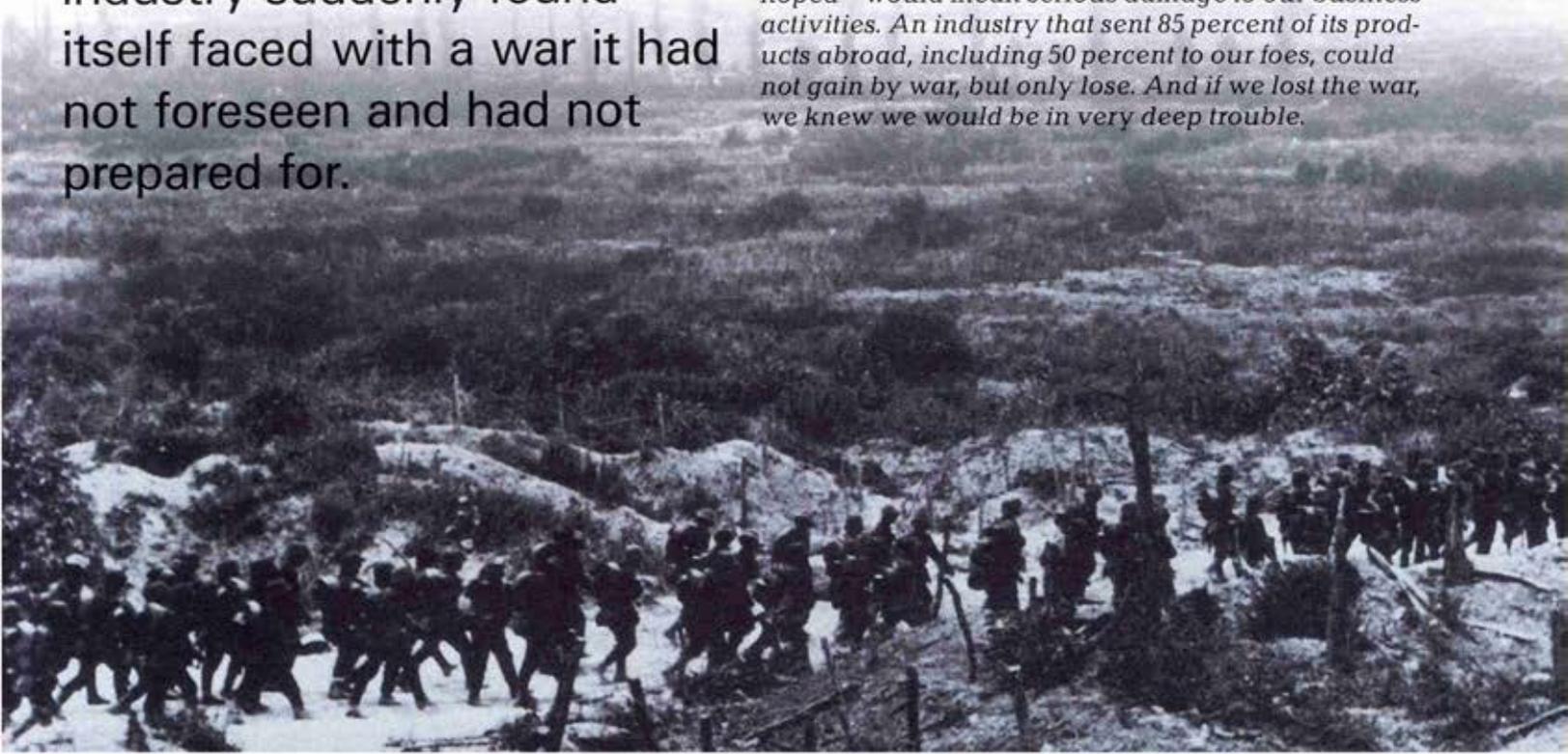
In the second half of June 1914, a crate of 25 bottles of champagne was delivered to the Duisberg residence. It was sent by a Dr. Lepetit. Duisberg needed some time to figure out what this unexpected present was for; he was much too preoccupied with his plans for a vacation in the Engadine in Switzerland.

Then he remembered. Lepetit was a Milanese industrialist whom he had met in New York back in 1896. Lepetit had predicted at the time that Germany's economic growth would eventually lead to a serious political conflict. He even bet 25 bottles of champagne that there would be a war between Germany and Britain within 20 years. Duisberg had accepted the bet and although this 20-year period would not have ended until 1916, the Italian was convinced that he had already lost the bet and was paying up. Lepetit proved to be much too optimistic.

On June 28, an assassin shot Archduke Franz Ferdinand of Austria and his wife Sophie in Sarajevo, Yugoslavia. This act set the world on fire. For Germany, the war began on August 1.

At a 1919 meeting of the association representing the interests of the chemical industry (Verein zur Wahrung der Interessen der chemischen Industrie), Duisberg commented on the war:

"When enthusiasm was running at full tide in August 1914, we representatives of the chemical industry could only stand by in deep depression and shake our heads. We were unable to join in the zeal, particularly those of us from the pharmaceutical and dyestuffs industries. We all knew without any shadow of a doubt that the war—even if it ended in victory, as we hoped—would mean serious damage to our business activities. An industry that sent 85 percent of its products abroad, including 50 percent to our foes, could not gain by war, but only lose. And if we lost the war, we knew we would be in very deep trouble.



"We were not in any way prepared for this war... No representative of the Department of War or the general staff ever came to ask us to consider how we could ward off a future war. None of us could have imagined such a war or believed that there could be such a worldwide conflagration. None of us had made any kind of preparation for a war..."

In the fall of 1914, Duisberg reckoned that the war would last a hundred days. The families of draftees and the survivors of the fallen soldiers were assured that they could stay in their works accommodations and that they would receive financial aid. A military hospital was installed in the main laboratory; its first patients already started arriving from the Western front in August.

Almost half the workforce was drafted. Production dropped by half, and the government banned the exportation of dyestuffs. Although Henry von Böttinger succeeded in having this ban lifted, shipments were made impossible because the railroads needed the freight space to meet military needs.

Dyestuffs production was concentrated on Field Gray and Navy Blue, while the photographic paper and chemicals industry was aimed at serving air force requirements. For example, Cellit and Cellon were needed for aircraft windows and large quantities of pharmaceuticals were destined for the front.

When the Department of the Interior wrote from Berlin in September 1914 to ask whether Bayer was able to resume output of synthetic rubber, the company said no. The war would have ended long before this was possible, Bayer reasoned. When the government called upon the company to manufacture explosives, Duisberg remarked curtly that Bayer was unable to on technical grounds and did not want to for reasons of safety.

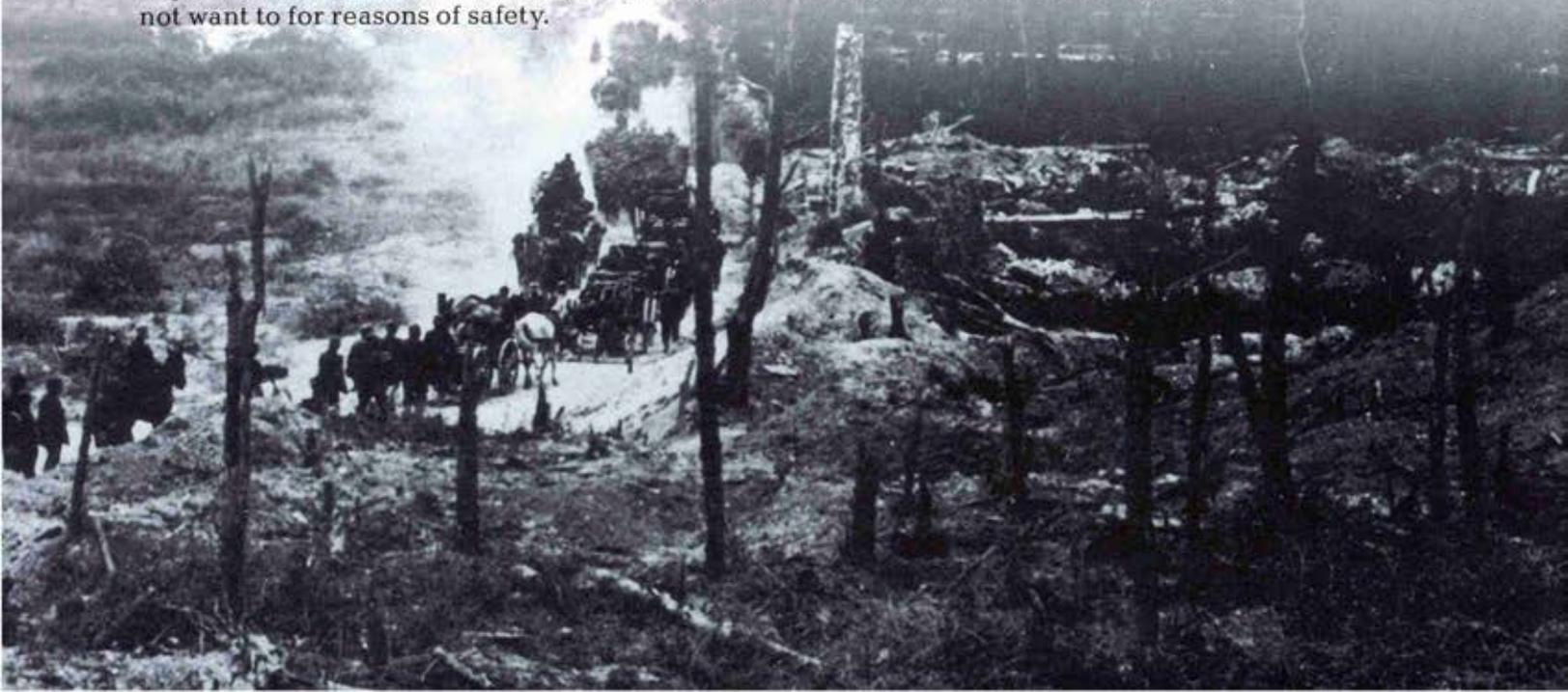
The first few weeks showed how blindly Germany had stumbled into the war. The mobilization program had, for example, reckoned with requirements of 600 metric tons of explosives per month. In reality, 20 times this amount was needed. At the peak of fighting, no less than 30 times this amount was actually used.

Walther Rathenau, at the time in top management of the AEG concern and later secretary of state for the postwar Weimar Republic, pointed out as early as August 1914 to the Prussian secretary of war that the economy must be adjusted to meet wartime exigencies. One of the particularly serious problems was the lack of raw materials. The secretary therefore entrusted Rathenau and his staff member Wichard von Möllendorff with the job of setting up a department to procure raw materials for the war economy.

The countries involved soon realized that the war would last a long time. It also became clear that comprehensive industrial mobilization was necessary. This effort would naturally also include the chemical industry.

Germany was in a special situation in that the major dyestuffs producers had unused capacities. Instead of having to shut down plants, the manufacturing units could be used for production vital to the war effort. Most of these units, however, would not even have been profitable during peacetime. It was thus necessary to create a sound commercial base.

A system of guaranteed plant construction and delivery contracts was developed, whereby the federal government provided full or partial financing for the plants and paid attractive prices to the manufacturers for their products. This policy obviously encouraged top output.



The First World War
hits the chemical industry
without warning

At the end of August 1916, Paul von Hindenburg and Erich Ludendorff took over as joint chiefs of staff. Army headquarters soon thereafter announced the so-called Hindenburg Program.

Duisberg had been instrumental in the realization of this plan by acting as a liaison between the military and industry. Major (later Colonel) Max Bauer had initially established the contact. He and Duisberg had known each other since the munitions crisis in the fall of 1914.

The Hindenburg Program meant the mobilization of the entire economic and manpower potential. The chemical industry, integrated into the war effort since the end of 1914, devoted almost all of its energy to this task.

From a technological point of view, the chemical companies worked wonders. The greatest of these achievements was undoubtedly the nitric acid process. Over and above this, ways were found to make guncotton from cellulose, acetone from lime and coal, glycerol from sugar and to replace copper with aluminum.

The share of production going to the war effort at Bayer rose from 0.29 percent in 1914 to no less than 73.5 percent two years later. Plants were expanded and a broad inorganics product range was created. The production program now included nitric acid, chlorine, sulfuric acid, oleum and superphosphate. Cellit capacities were also extended. Film and photographic paper production increased threefold. Larger and larger amounts of Cellon were employed for the manufacture of windows in the aircraft and auto industries. Soon it was also used in gas masks.

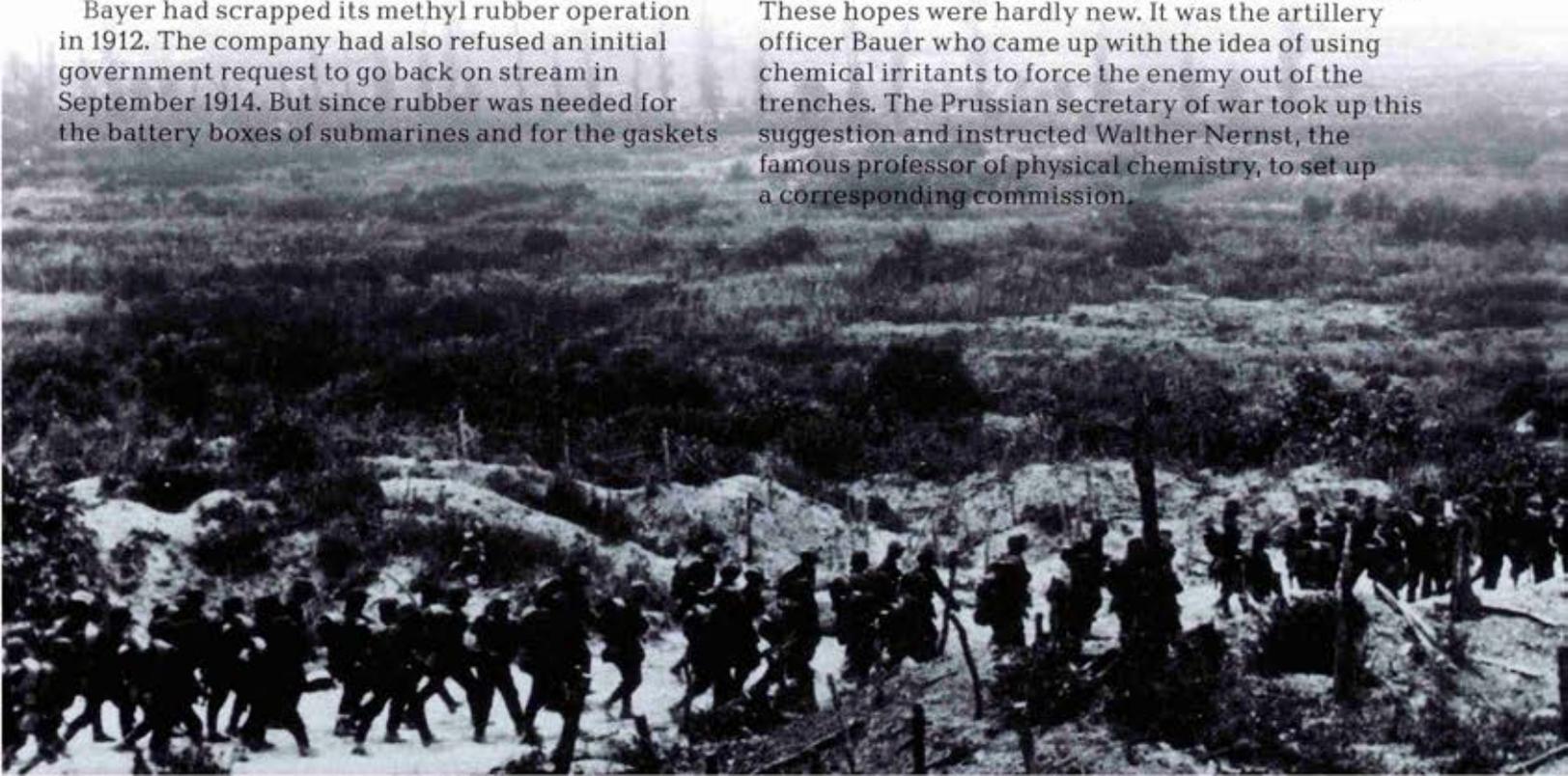
Bayer had scrapped its methyl rubber operation in 1912. The company had also refused an initial government request to go back on stream in September 1914. But since rubber was needed for the battery boxes of submarines and for the gaskets

used in machine construction and the electrical industry, Bayer finally resumed production—on an even larger scale. During the war, the company manufactured a total of 2,500 metric tons of methyl rubber.

The greatest effort was made in the explosives field. As stated earlier, Duisberg had said in September 1914 that the firm was unable to enter this field for technical reasons and for fear of plant safety. Despite this initial decision, Bayer was in fact making the explosive trinitrotoluene (TNT) by the end of the year at a new facility in Flittard near Leverkusen with a monthly output of 200 to 300 metric tons. By the end of the war, Bayer had become Germany's biggest single explosives manufacturer, meeting more than a third of total demand, including the necessary starting and intermediate products. At army command's request, the company also filled grenades.

On January 27, 1917, there were Siberian temperatures on the Rhine. At -21° Celsius (-6° Fahrenheit), a manifold on the TNT pipeline had frozen. A foreman tried to free the pipe from the ice by using a hammer. An explosion of 60,000 kilograms of TNT resulted, killing eight workers and injuring hundreds more. The Flittard plant was completely destroyed and damage was even done to the Leverkusen plant.

Military operations on the Western front had soon become virtually immobile. Trench warfare had become the order of the day, and even constant shelling by the artillery did not accomplish much. The army was consequently hoping for a "wonder weapon." These hopes were hardly new. It was the artillery officer Bauer who came up with the idea of using chemical irritants to force the enemy out of the trenches. The Prussian secretary of war took up this suggestion and instructed Walther Nernst, the famous professor of physical chemistry, to set up a corresponding commission.



Apart from Nernst and two artillery officers, Carl Duisberg belonged to this body as chief executive officer of the leading Prussian chemical concern. The irritants recommended by the commission were not enough for the War Department, and the mandate of the commission was altered. In early December of 1914, the government called for lethal substances to be carried in artillery shells, a clear violation of the international convention pertaining to war. It is hard to understand today why the commission did all it could to fulfill these instructions, too. Nevertheless, it was unsuccessful. Professor Fritz Haber, head of the Kaiser Wilhelm Institute of Berlin, then suggested that chlorine gas be released from steel flasks rather than fired from shells. The generals agreed to this proposal.

On the evening of April 22, 1915, the signal was given to open the valves of thousands of chlorine flasks near Ypres in Belgium. A vast cloud of gas was carried by the wind over the enemy lines. The result was appalling. Thousands died or fled in panic. In military terms, however, the overall success was only modest.

Military authorities on both sides were still convinced of the efficacy of chemical warfare. The Allies struck with gas attacks of their own beginning in September. In Germany, Haber set up a Chemical Division in the War Department, collaborating with such prominent scientists as Richard Willstätter (Nobel laureate 1915), Walther Nernst (Nobel laureate 1920), James Franck and Gustav Hertz (Nobel laureates 1925) and Otto Hahn (Nobel laureate 1944). This group worked not only on chemical warfare agents, but also on corresponding forms of defense.

The next poison gas to be used was phosgene. The Germans hesitated at first, since there was as yet no adequate defense for their own troops. It was the French artillery who took the first step this time.

An even more dangerous substance was introduced by the German army in 1917, also near Ypres. It attacked skin and mucous membranes and could not be detected in time to take defensive measures. Soon being used on both sides, the Germans called it Lost (after its inventors Lommel and Steinkopf); the British called it mustard gas and the French called it yperite. But this weapon never attained strategic importance and in the end was not even of tactical significance.

Although the situation called for the all-out effort of all parts of the company, Bayer's management was also thinking of what would happen after the war. Business could not resume where it had left off in 1913. Other industrialized countries, for example, had done all they could to replace German tar-based dyestuffs. And in 1915, the Allies announced their aim of cutting German industry out of the competition once the war was won. Obviously, the German industry would have to work hard to get back in the running.

Following a proposal by Duisberg, the companies got together and decided to set up an organization to promote the interests of the German coal tar dye manufacturers. The agreement for the creation of this "Interessengemeinschaft der deutschen Teerfarbenfabriken" was signed on August 18, 1916.

The body had as its members the firms of the "Triple Confederation" (Bayer, BASF and Agfa), those of the "Tripartite Association" (Hoechst, Cassella and Kalle), as well as Weiler-ter Meer and "Chemische Fabrik Griesheim-Elektron." On the other hand, the organization did not cover such non-dyestuff activities as BASF's ammonia synthesis or Griesheim's light-metal operations.



The First World War hits the chemical industry without warning

The German term "Interessengemeinschaft" (I.G. for short) indicated a community of interests within which the member firms would retain their independence, but they would pool their profits and divide them up on the basis of a fixed ratio. An "I.G. Council" was to be responsible for the necessary standardization of corporate strategies. In fact, subsequent developments during and after the war were to prove that the system could not be restricted to dyestuffs.

However, the war was not over yet. While the chemical industry proved able to solve a host of technological problems, it was powerless in the face of a growing shortage of manpower. When war broke out, Bayer had 10,600 employees; as early as September 1914, only 6,750 were left, the remainder having been drafted. But the demands of wartime production and the corresponding expansion of capacity were impossible to meet without an enlarged labor force and one which should really have exceeded the prewar strength.

But where were the new workers to come from? Some two-thirds of the extra manpower, in fact, was made up of German men who had been demobilized because of their duty to the civilian war effort. At the same time, the share of women in the workforce rose to 19 percent. A further eight percent had been recruited from occupied countries, particularly from nearby Belgium. Some five percent of the employees were German youths below draft age and one percent were prisoners of war.

The chiefs of staff and a number of industrialists had proposed a universal labor draft with an obligation to remain with one job, but this failed against opposition from the unions. A compromise was worked out instead.

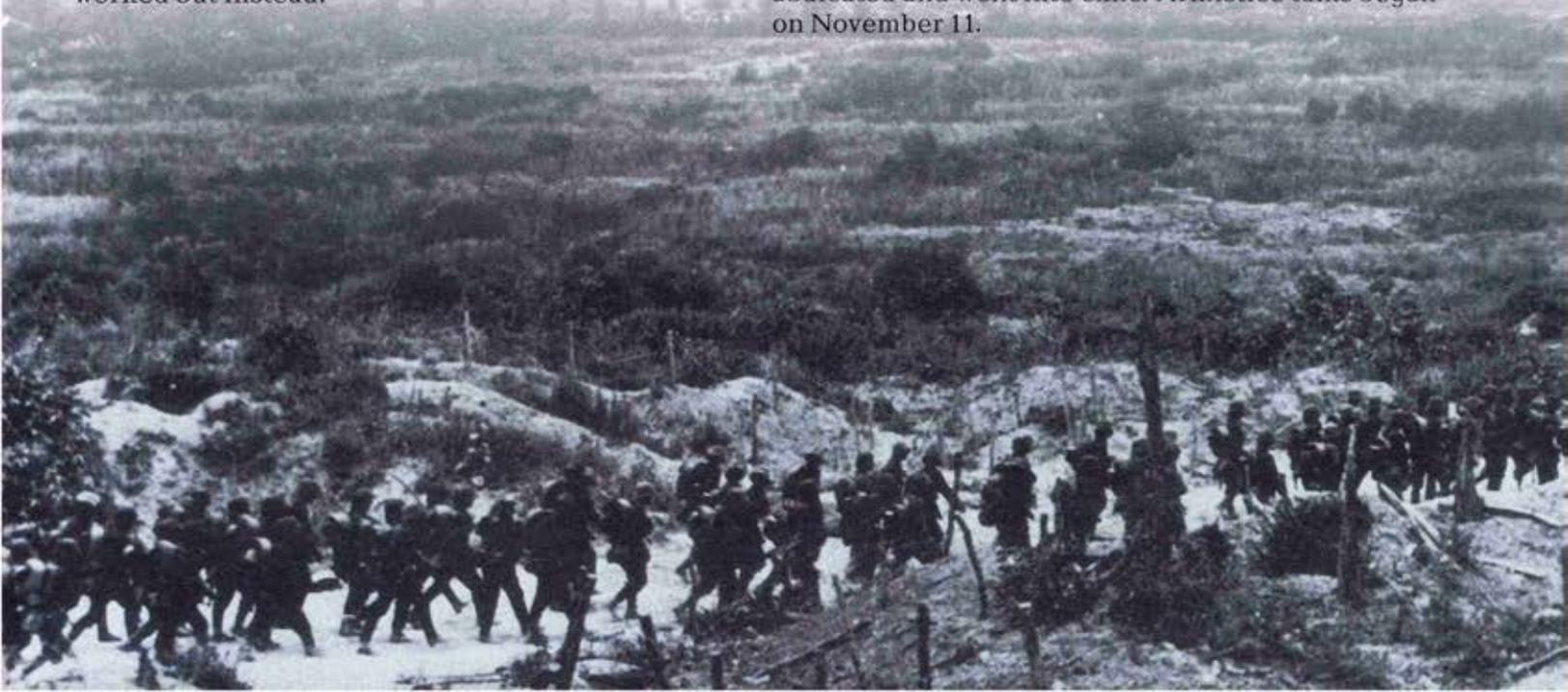
In December 1916, a so-called Patriotic Auxiliary Labor Act came into effect for all persons between the ages of 15 and 65. To meet organized labor half-way, this legislation included an important concession: for the first time, statutory worker representation came into force in the form of freely elected workers committees. This plan did not go down very well with some employers who saw the role of management being jeopardized as a result.

Duisberg himself had his misgivings but was flexible enough to recognize that it was possible not only to live with these committees but even to cooperate with them. The unexpected consequence of the then-emergency situation has turned out to be a fruitful collaboration.

There was no trouble with the Bayer workforce until the food situation got so bad that physical and mental exhaustion left the employees at their wits' end.

During the British sea blockade and the so-called "Turnip Winter" of 1916/1917, rations had been cut to only 1,000 calories per day. Wage increases did not help, since they could not buy more food. As a wave of strikes swept the country, Bayer employees also refused to work, demanding more food. This strike in February 1917 did not last long because the company actually managed to obtain food supplies.

The following winter it became clear that the German public could not survive another cold spell under wartime conditions. After the last major German offensive had failed in the spring of 1918, an Allied counterattack shook the German front. In August, the chiefs of staff admitted for the first time that continuing the war would be hopeless. The revolution broke out in November; the Emperor abdicated and went into exile. Armistice talks began on November 11.



Bayer chronicle 1914-18

In January 1914, Bayer buys a site for a new plant on the banks of the Rhine near Dormagen.

When the First World War breaks out in early August 1914, management calls on able-bodied male employees to enlist.

Nitric acid production unit based on a process developed by BASF opens in Leverkusen in March 1915.

An explosion on January 27, 1917, at a grenade-filling unit in the Leverkusen works kills eight and injures more than a hundred employees.

On August 25, 1917, Bayer opens its third major plant, when sulfuric acid production goes on stream in Dormagen.

British troops occupy the Leverkusen plant on December 8, 1918.

On December 12, 1918, the U.S. Alien Property Custodian sells the confiscated Bayer subsidiaries in the United States to Sterling Drug, Inc. for \$5.31 million.

World events 1914-18

On June 28, 1914, the heir to the Austrian throne is assassinated in Sarajevo, whereupon Austria-Hungary declares war on Serbia on July 23. On August 1, Germany declares war on Russia. After the German invasion of neutral Belgium and its declaration of war on France, the United Kingdom enters the war against Germany on August 4.

German war plans fail with the Battle of the Marne (September 5-12, 1914). Trench warfare begins on the Western front and continues until 1918.

In October 1914, the Ottoman Empire joins the war on the side of the Central Powers Germany and Austria-Hungary.

Starting in February 1915, British and French troops unsuccessfully attempt to occupy the Dardanelles, resulting in a great loss of lives.

Between February 22 and May 13, 1915, Germany launches an all-out submarine attack.

On April 22, 1915, German troops make the first use of poisonous chlorine gas, marking the start of chemical warfare.

Italy declares war on Austria-Hungary on May 23, 1915, and on Germany on August 28.

World events 1914-18

The Battle of Verdun, which costs a total of some 700,000 lives, begins on February 21, 1916. No decisive strategic gain is achieved.

Battle of the Somme, in which a million lives are lost, starts with a British offensive on June 24, 1916.

Germany resumes unlimited submarine warfare on February 1, 1917. This proves to be one of the decisive reasons for the United States to join the war against the Central Powers on April 6.

Russian Revolution begins in March 1917, leading initially to the formation of a provisional government. In November, the Bolsheviks carry out a coup d'état against the Kerensky Administration in Petrograd and take over power in the so-called October Revolution.

On December 15, 1917, the new Russian government concludes an armistice with Germany.

President Woodrow Wilson announces a 14-point peace program on January 8, 1918. It is based on self-determination for all peoples and the creation of an equitable and democratic peace settlement.

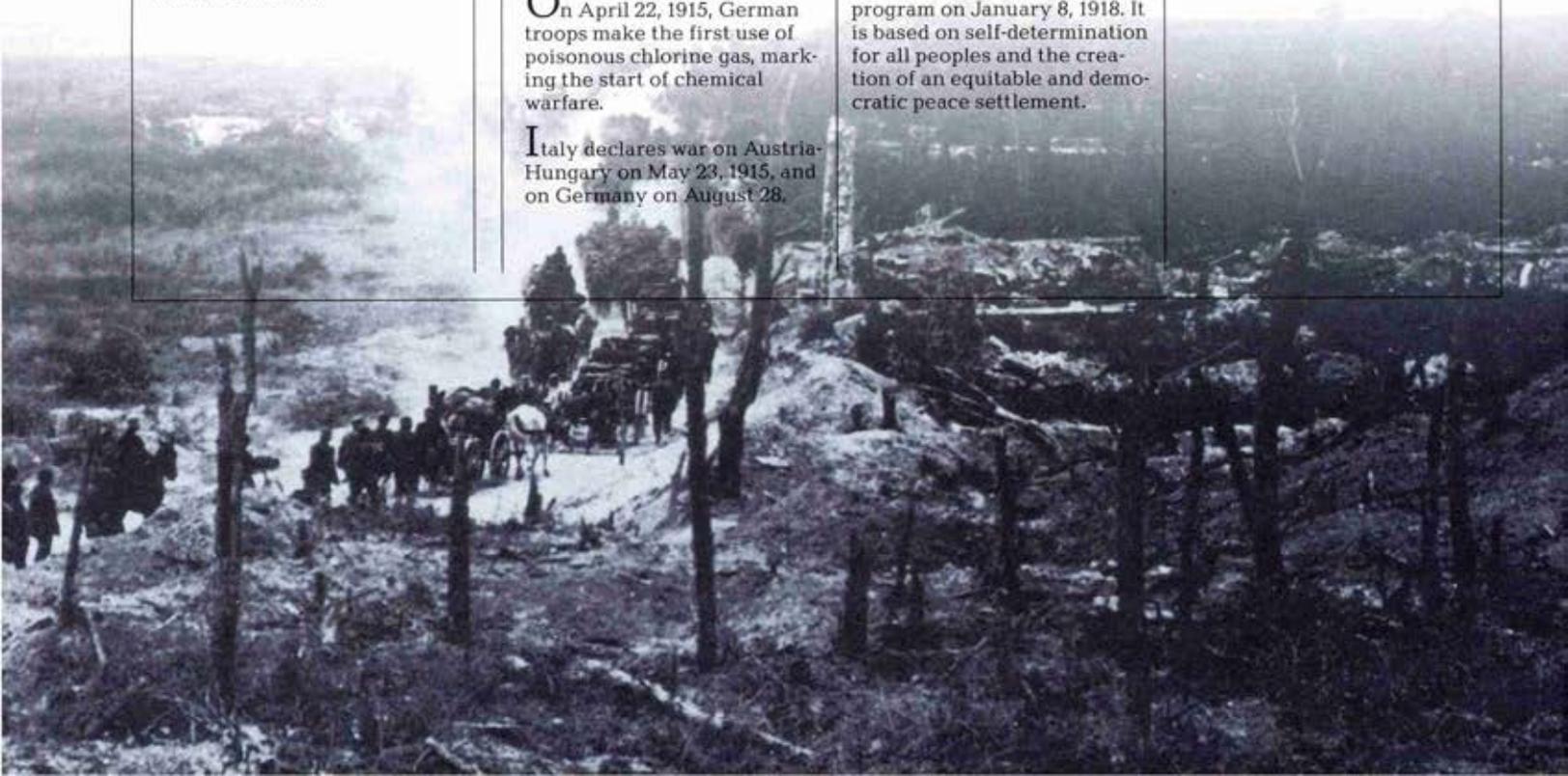
World events 1914-18

Russia and Germany sign a peace agreement in Brest-Litovsk on March 3, 1918. Soviet Russia waives its claims to Poland, the Baltic States and Finland.

Central Powers and Romania agree on a peace settlement on May 7, 1918.

Final German offensive on the Western Front fails in the spring of 1918. It is followed by major Allied victories in the summer. In order to avoid total collapse, Germany signs an armistice agreement in Compiègne on November 11, 1918.

Treaty of Versailles is signed by Germany and the victorious powers on June 28, 1919. This is followed by peace agreements with Austria on September 10, Bulgaria on November 27, Hungary on June 4, 1920, and finally with Turkey on August 10 of that year. Almost eight million died and over 19 million were wounded in the course of World War I.



The chemical industry faces a new world

The Great War had changed the face of the world. The formerly powerful Austro-Hungarian Empire had disappeared from the map. Russia was in the midst of a civil war. Germany, now a republic, was looking for a way to survive. The German dyestuffs industry, which had been the leader on the world market, found itself confronted by formidable foreign competitors.

The lost war and the accelerating inflation rate posed serious problems for the German I.G. members. Their nominal capital was misleading; the inexpert financing of the war effort halved the value of the mark long before superinflation broke out. Not only had important markets been lost, but foreign assets, patents and trademarks had been confiscated.

Since Bayer was far more active abroad than any other German chemical company, it was especially badly affected. The Russian subsidiary was lost as a result of the October Revolution. The Treaty of Versailles had ordered the confiscation of German assets in Belgium, France and the U.K. In the United States, the Alien Property Custodian (APC) had been appointed in 1917 and after the war sold confiscated assets to American buyers. To add to this, the so-called Chemical Foundation was set up in 1919 to acquire all of the German chemical patents held by the APC for the ridiculously low price of \$250,000. This would hinder the return of German firms to the American market for many years. The Chemical Foundation subsequently sold these patents to American companies.

Thus, the American company Sterling Drug, Inc. purchased not only the Bayer patents from the APC in 1918, but also the name Bayer and the company's trademarks, including "Aspirin." The same U.S. company also managed to buy these rights for the rest of the countries in the Americas and for the U.K. and Australia.

Trying to establish the Bayer name for its company outside the United States turned out to be an all too awesome task; Sterling started its first negotiations with Bayer on divestiture as early as 1919. But from the beginning, Sterling refused to include the United States in the bargaining. Although an understanding was reached on Latin American business in 1920 and a further agreement on other areas in 1923, Bayer Co., Inc. in New York—and along with it the rights to the trade names and trademarks in the United States—remained the property of Sterling.

One of the many results of the First World War was Bayer's loss of important markets because it was not allowed to export its products to certain countries. The year 1919 saw a number of prominent visitors to the Leverkusen works, among them Winston Churchill (right).

In 1970, Bayer was able to reestablish its rights to its name and trademarks worldwide. Only the United States and, in certain product applications, Canada were excluded from the agreement.

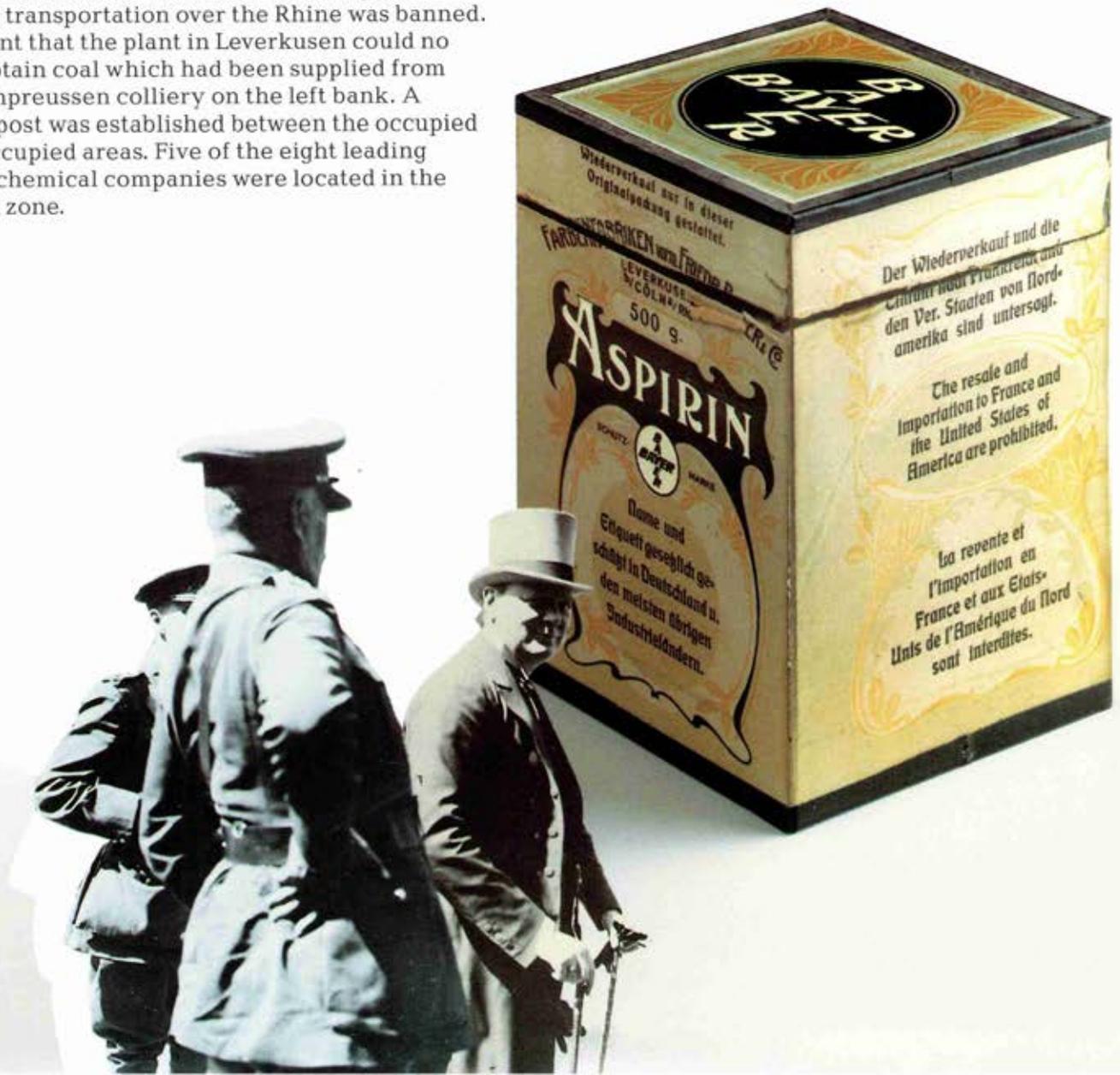
Sixteen years later, Bayer and Sterling Drug finally reached an accord on the use of the company name in the United States, however the Bayer cross and Aspirin were still excluded from the agreement. But more details on this subject will come later. Let's turn back to Germany in the late fall of 1918.

Under the Armistice Agreement, Allied troops occupied German territory on the left bank of the Rhine and a number of bridgeheads on the right bank. New Zealand troops occupied Leverkusen as early as December 8, 1918, setting up their headquarters in the administration building and the Kasino. They were followed by the British, whose staff moved into the Duisberg villa. The boss himself was left with two rooms and some cellar space.

Freight transportation over the Rhine was banned. This meant that the plant in Leverkusen could no longer obtain coal which had been supplied from the Rheinpreussen colliery on the left bank. A customs post was established between the occupied and unoccupied areas. Five of the eight leading German chemical companies were located in the occupied zone.

The occupation had positive effects as well. The British soldiers saw to law and order during a time of domestic unrest. It was a period of revolution after the Emperor had abdicated and gone into Dutch exile. All over the country, workers' and soldiers' councils were being formed. In Berlin, a Council of the People's Deputies was in power. The German army had been dissolved and millions of physically and mentally exhausted soldiers came home. Radical groups saw their chance and attempted to turn Germany into a soviet-ruled republic modeled after Russia. But in the National Assembly elections of February 1919, an overwhelming majority of Germans voted in favor of a democratic system.

In November 1918, employers and employees had already agreed to cooperate upon the basis of a famous agreement drawn up by industrialist Hugo Stinnes and labor union leader Karl Legien.



Carl Duisberg was all for this cooperation with unions, which is one important reason why the November Revolution passed without any serious incidents in Leverkusen. It also helped a great deal

Die heutige Lage läßt eine Wiederaufnahme unserer Friedensfabrikation in absehbarer Zeit erwarten. Deshalb geben wir schon heute bekannt:

1. Alle früheren, aus dem Felde zurückkehrenden Werksangehörigen, auch die Kriegsbeschädigten, sollen aus almslos wieder bei uns beschäftigt werden.

that the Bayer management posted an announcement that promised to reinstate all workers returning from the war.

In the absence of the conquered nations, the Peace Conference met on January 18, 1919, at Versailles in France. On May 7, the draft treaty was submitted to the German Armistice Commission. It contained 440 clauses. Germany had to give up its colonies and claims to 13 percent of what had been Imperial territory, together with ten percent of its inhabitants, 15 percent of its agricultural acreage and 75 percent of its iron ore reserves. A share of 60 percent of German coal production had to be supplied to the Allies. Germany also had to give up its merchant fleet and lost all foreign assets. Appendix 6 of the treaty concerned the German chemical industry, which was faced with surrendering one-half of all existing dyestuffs and pharmaceuticals and subsequently selling one-quarter of regular production to the Allies at discount prices for a period of five years.

Article 231 was of very special significance. According to this, Germany had to accept sole blame for the war. It was on this principle that the Allies based their claims for reparations, the extent and duration of which were not fixed until 1921.

The National Assembly empowered the government to sign the treaty by a majority of 237 to 138 on June 22. In the Hall of Mirrors in the chateau of Versailles, Secretary of State Hermann Müller of the Social Democratic Party and Johannes Bell of the "Zentrum" party signed the treaty

on June 28, 1919, exactly five years after the assassination in Sarajevo.

The German public was up in arms at the conditions laid down in the treaty. It had hoped for an acceptable peace agreement in keeping with Woodrow Wilson's famous "Fourteen Points." The Treaty of Versailles was perceived as being humiliating and discriminating. Political recognition of the treaty was written off as what was called "fulfillment policy," a reproach that was also leveled at the I.G. As Carl Duisberg said, "We have to fulfill the demands of the Treaty of Versailles in order to reduce it to absurdity."

There was no doubt that the German dyestuffs industry was greatly dependent on the world market. For this reason, the industry had to support the policy of rapprochement and therefore accept the conditions of the treaty. But many people agreed with the viewpoint of economist John M. Keynes: the fateful economic consequences of the treaty would in the end make it impossible to fulfill.

Despite the obvious contradictions, chemical companies had to get along with their former "foes." Their attempts met with approval from people in responsible positions abroad. Thus, negotiations between Carl Bosch and French General Patart led to a licensing agreement for the synthesis of ammonia in 1919. Carl Duisberg and Jose Frossard, President of "Compagnie Nationale des Matières Colorantes," agreed upon a cooperation in the dyestuffs sector in 1921.

On August 14, 1919, a telegram arrived in Leverkusen from the United States. Grasselli Chemical Corporation suggested a meeting with Duisberg or another representative as soon as possible in order to discuss "a matter of mutual interest." Grasselli had bought Bayer's former dyestuffs and chemical divisions in the United States from Sterling Drug. He knew Duisberg from the Bayer manager's visits to America and now offered the Germans a joint venture proposal; he hoped to obtain know-how that was lacking in the United States. A new start for these businesses had been made.

One of the reasons why there were no serious incidents in Leverkusen during the November Revolution is that Bayer promised to reinstate all workers returning from the war. An excerpt from the company's announcement is shown above.

Bayer chronicle 1919

Led by radical leftists, workers from other companies occupy the Bayer works in Elberfeld on February 18. In order to avoid violence, work is halted for one day. Bloody clashes with the police in the town of Elberfeld result in four deaths and nine persons injured.

A laboratory for the study of moths is opened for systematic research on textile pests.

Certan and Venetan (label below) are introduced to the market as Bayer's first pesticides against plant lice and bedbugs.



A "Volkshochschule" adult-education center is set up in Wiesdorf. The majority of founding members are Bayer managers.

World events 1919

On January 1, 1919, the German Communist Party (KPD) is formed under the leadership of Karl Liebknecht and Rosa Luxemburg as a successor to the former Spartakus-Bund. The occupation of the Berlin newspaper district



on January 5 marks the start of the so-called Spartakus Revolt. While this is brought under control by the military, both Liebknecht and Luxemburg are killed by members of the right-wing voluntary corps. When a general strike is called on February 25, Secretary of Defense Gustav Noske gives the army the order to fire.

The democratically elected constituent National Assembly meets in Weimar on February 6. On February 11, Friedrich Ebert is elected president. On July 31, the assembly ratifies the Weimar Constitution.

On February 24, the British government introduces import restrictions on dyestuffs which were tantamount to an embargo. However, a court shortly afterwards declares the action illegal and, consequently, null and void.

World events 1919

The Comintern (Third International) is formed in Moscow in early March and calls for the transformation of war into class conflict revolutions.

Benito Mussolini initiates the Fascist movement in Milan in late March under the name of "Fasci di combattimento."

The League of Nations is founded in the interest of world order. First members are the victors of World War I; the United States does not join.

With the help of the government, the British Dyestuffs Corporation Ltd. is founded by merging the two leading companies, Levinstein & Co. Ltd. and British Dyes Ltd.

After the Treaty of Versailles with Germany, peace is made with Austria-Hungary in St. Germain on September 10.

An economic blockade is imposed against Bolshevik Russia by the Allies, who also send an expeditionary force to support Lenin's opponents.

Prohibition is made law in the United States on October 28, thus banning the manufacture, transportation and sale of alcohol.

World events 1919

The Association of German Industry (RDI) and the General German Trade Union Federation (ADGB) are formed.

The antiscorbutic food factor Vitamin C is named by J. C. Drummond.

Sir Edward Mellanby and at the same time Elmer W. McCollum both are successful in inducing rickets in young rats which are still growing by giving them a one-sided diet. They subsequently cure the disease with the help of cod liver oil.



Hans Vogt, Joseph Massolle and Joseph Engl jointly develop the first recording and reproduction equipment for sound-track films. (The picture dating from 1922 shows the first sound-track projector, the so-called "iron box.")

Business supports the needs of science

After the war, public finances were totally disrupted. Universities and the scientific world were threatened with stagnation and decline. Help had to come from the business sector and so Bayer responded to the call.

The Emergency Association of German Science (Notgemeinschaft der deutschen Wissenschaft) was formed between 1917 and 1918 on the initiative of Friedrich Schmidt-Ott, the Prussian secretary of education. Its aims were to promote scientific efforts and to support young scientists. The association's work was financed by a committee of sponsors with representatives from top trade associations as members. As a result, the Notgemeinschaft was active in all fields of science.

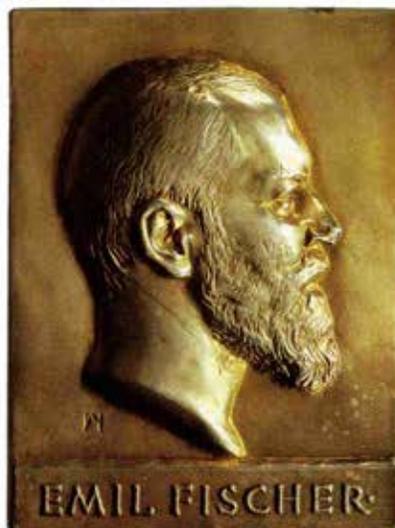
Also in 1917, Carl Duisberg supported the foundation of the Society of the Friends and Promoters of the Friedrich Wilhelms University in Bonn. This society became a model for similar organizations created to assist other German universities.

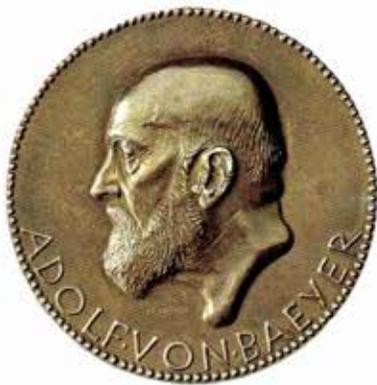
The relationship between Bayer and the university in Bonn was a particularly close one. Friedrich Bayer, Henry von Böttinger and Duisberg each donated 50,000 marks for a special Spanish, French and Italian library. In addition, the company gave 250,000 marks to sponsor a professorship. For its part, the university sent professors of chemistry to give lectures in Leverkusen to, in Duisberg's words, "*bring our chemists up to date with scientific knowledge.*" Duisberg went on a massive fund-raising drive to obtain 819,750 marks for the extension of the Bonn X-Ray Institute.

Duisberg was, in fact, a respected and even feared fundraiser. He not only wrote to potential donors, but personally met with them until they finally came up with their donation. This talent was to be of great value in the founding of further organizations.

The "Justus Liebig Society for the Promotion of Chemistry Teaching" was formed by the merger

of Emil Fischer's "German Association for Chemistry Teaching" and Duisberg's own "Liebig Scholarship Society." After Emil Fischer died in 1919,





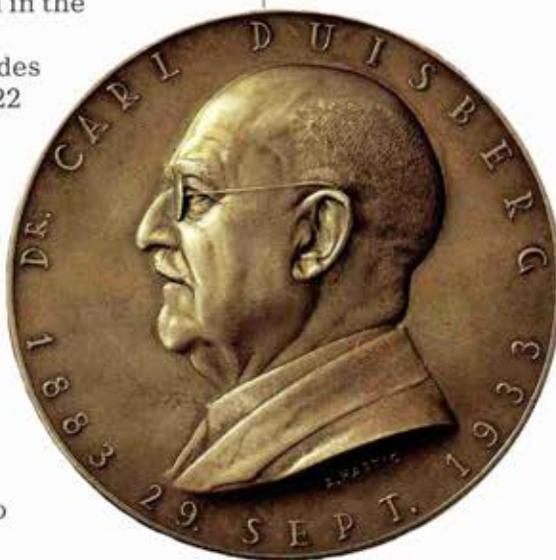
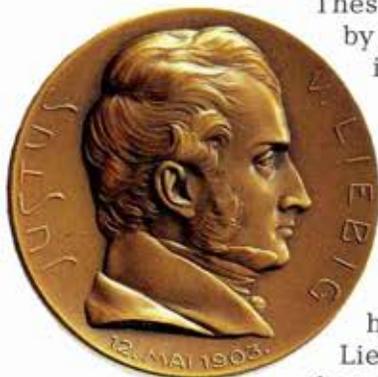
the "Emil Fischer Society for the Promotion of Chemical Research" was founded in his memory. The third of the organizations was the "Adolf Baeyer Society for the Promotion of Chemical Literature."

These three societies were financed by contributions from the chemical industry, each company paying 20 to 30 pfennigs per employee per year. The boards of the societies were manned by an equal number of representatives from industry and science.

Duisberg was offered the chairmanship of all three societies, but he accepted only that of the Justus Liebig Society. Apart from the fact

that even his energy would not have permitted him to head each organization, Duisberg chose to become active in this society because he had always been particularly interested in helping young people. He was instrumental in the formation of a loan association for German students ("Darlehnskasse des Deutschen Studentenwerks") in 1922 and a study foundation ("Studienstiftung des deutschen Volkes") in 1925.

When he was asked by a Dresden-based student aid organization to help set up a youth hostel in Marburg in 1926, he had the Carl Duisberg House built there. It was partially paid out of his own pocket, even though neither he nor the company had any special connection to the university in Marburg. And finally he went on to establish the Carl Duisberg Foundation in 1929, which made it possible for young scientists to gain experience abroad.



More than a thousand plaques, medallions and coins in the Bayer archives commemorate personalities and significant events. The silver-plated copper plaque from 1899 (left) marks the 25th anniversary of the date when Emil Fischer's doctorate was conferred. The silver Adolf

von Baeyer medallion above was issued in 1910 in honor of his services to organic chemistry. The bronze medallion (center) of 1903 commemorated Justus von Liebig's 100th birthday. The I.G. issued a bronze medallion in 1933 to mark Duisberg's 50th year of service to the company.

Bayer chronicle 1920

Henry von Böttinger dies on June 9, and Friedrich Bayer, the founder's son, twelve days later.

Introduction of pay-as-you-earn income tax of 10 percent leads to a strike and a lockout in late August. Employees return to work 12 days later. This is only the second strike in the 57 years of Bayer's history.

The long-service association, "Verein der Jubilare" is formed on November 28 with 627 members. Today, the association has more than 20,000 members.

World events 1920

The Weimar Coalition of Social Democrats, German People's Party and the Zentrum Party loses the majority at general elections. The Social Democrats become the opposition party.

Following the Peace of Trianon on June 4, Hungary has to cede Slovakia to Czechoslovakia; Croatia, Slovenia and the Banat to Yugoslavia and Transylvania to Romania.

After eight months of war, Poland and Russia agree to an armistice.

Mohandas Karamhad Gandhi, known as Mahatma ("he who possesses a great soul"), calls on his fellow Indians to protest against British rule with passive resistance.

Some 10 million Chinese have died to date as victims of the plague that has been rife since 1894.

Women obtain the right to vote in the United States.

Finland's Paavo Nurmi, the "Flying Finn," wins three gold and one silver medal in the Antwerp Olympics.

Allied Chemical & Dye Corporation is established in December. In terms of capital stock, it is the world's biggest chemical company.

Reparations and inflation : one dollar in exchange for 4.2 trillion marks

“Now that the South Sea islanders’ cowrie shell is worth more than the paper mark... we are no longer on the edge of a precipice as we were a year ago. We have long fallen off and are in a desperate state of affairs,” concluded Carl Duisberg in his report on 1921.

At the end of 1921, the exchange rate was running at 188 marks to the dollar and wages climbed 82 percent between July and December. In addition to these domestic problems, Germany also had to pay reparations to the Allies.

At a meeting in Paris in January of 1921, the Allies decided to set German reparation payments at 226 billion gold marks, payable in 42 annual installments. In early March, the Reparations Conference in London reduced the sum to 132 billion marks. Payments were to take the form of two billion gold marks per year plus 26 percent of German export value. The German government and business sectors rejected these reparation demands as unattainable.

The Allies subsequently decided to demonstrate that they meant what they said. French troops occupied the Rhine ports of Düsseldorf, Duisburg and Ruhrort in March. On May 4, the Commission issued an ultimatum demanding the acceptance of the reparations program. Otherwise, the Commission made clear, the entire Ruhr would be occupied. German parliament was constrained to accept their demand. As Duisberg said, *“In the end, the wish to avoid the worse always forced us to accept the bad.”*

When war broke out, the dollar had been equivalent to 4.20 marks. By the end of the war, its value had reached eight marks. By January of 1920, the U.S. currency was worth 49.10 marks; a year later 74.50; at the beginning of 1922, the 188 marks mentioned earlier. And a year later the dollar was traded at 49,000 marks.

In January 1923, Germany got behind in paying its reparations. As threatened, Belgian and French troops occupied the entire Ruhr. An attempt by the Germans to use passive resistance lasted only until September.

At first, Germany was able to live with inflation. It was naturally an advantage on the world market with low-priced German products in great demand abroad. Higher exports meant higher output and factories began to run at full capacity.

Kaufhaus der Farbenfabriken vorm. Friedr. Bayer & Co.,
WIESDORF und FLITTARD.

	per	M	3
Kindermehl, Nestles u. Kufekes	Dose	1	40
Kirchenlampenöl	Liter	—	78
Kleien	Pfund	—	08
Knorr's Sos, 2 Pfd.	Flasche	5	—
Korken	Stück	—	01
Kochsalz	Pfund	—	10
Konserven, siehe Conserven			
Kornbranntwein, alter	Flasche	1	40
Berg. Kornblume		1	90
Kräuterkäse	Stück	—	20
Kunstgelée	Pfund	—	28
Kunsthonig	"	—	50
Lackritzen	Stange	—	10
Lachs, geräuch. in Scheiben	1/2 Dose	—	90
"	1/1	1	70
Lebertran	Flasche	—	70
Lederfett	Dose	—	10
Ledercreme, Trommalin	"	—	15
Immalin	"	—	15
Guttalin	"	—	20
Leberwurst I	Pfund	—	90
II	"	—	60
III	"	—	40
Liebig's Fleischextrakt	1/8 Topf	1	25
"	1/4	2	10
"	1/2	4	25
Limburgerkäse	Pfund	—	52
Linsen	"	—	20
Linde's Caffeeessenz	Paket	—	—
Liköre, Anisette einfach			
Anisette			

Kaufhaus der Farbenfabriken vorm. Friedr. Bayer & Co.,
WIESDORF und FLITTARD.

	per	M	3
Liköre, Cherry brandy riche	1/1 Flasche	3	—
Cherry extra dry	1/1	4	—
Curraçao	1/1	3	—
Half u. Half	1/1	3	—
Orange Brandy	1/1	4	—
Pfeffermünz einfach	1/2	—	65
" doppel	1/2	1	20
" Pfeffermünz doppel	1/2	—	85
" Vanille einfach	1/1	1	50
" doppel	1/2	—	95
" doppel	1/2	1	10
" doppel	1/1	—	2
Lorbeerblätter	Beutel	—	05
Luhn's Waschextract	Paket	—	15
Salm.-Terpentinseife	Pfund	—	40
Mangbrot	Stück	—	50
Mandeln, süsse I	Pfund	1	60
II	"	1	20
bittere	"	1	50
Margarine, Vitello	"	—	85
Excelsior	"	—	75
Edelweiss	"	—	70
Special	"	—	60
Pflanzenmargar. Sanella u. Cobu	"	—	90
" Planta	"	—	70
" "	Paket	—	30
" "	"	—	60
" "	"	—	65
" nachgefüllt	1/8 Flasche	—	45
" nachgefüllt	1/4 Flasche	1	10
" nachgefüllt	"	—	70
" "	2 Pfd.-Fl.	6	—
" "	Stück	—	05
" in Dosen	Dose	—	50
" "	Stück	—	10
" "	"	—	15



Bei dem augenblicklichen Mangel an Zahlungsmitteln sind wir gezwungen, diese Gutscheine auszugeben. Die Einlösung erfolgt an unserer Hauptkassa, sobald der Mangel behoben ist, spätestens am 1. Dezember 1923. Für den Betrag des Gutscheines übernehmen wir volle Haftung.

Levertufen, den 25. Oktober 1923.

Das Direktorium
der Farbenfabriken vorm. Friedr. Bayer & Co.

H. D. Quisberg

...ten Zeit, soweit Vorrat vorhanden ist, Fett-
...ndigung gelangen, und zwar erstmalig in
...beiter und Arbeiterinnen je 2 Pfund und
...d Margarine. Die Gutscheine können von
...en 17. August vom Betriebe in Empfang
...en die Gutscheine gegen Vorausbezahlung
...stellten bei ihrem Bürovorsteher.
... nachmittag 4 Uhr an den Pfortnern.
... Samstag mittag ab 1 Uhr am Pfortner II.
... Uhr beenden, empfangen die Margarine ebenfalls an

...mäßig passieren.
...schaftsarbeitern werden die Fettwaren im Betriebe zugestellt.
Voraussetzung für die Ausgabe — auch nach Bezahlung der Gutscheine — sind ruhige Ver-
hältnisse auf dem Werke und an den Toren.
Der Preis der Margarine beträgt Mf. ~~390000,-~~ 390000,-
Levertufen, den 15. August 1923.

Das Direktorium

The price list of the Bayer department store in 1911 (above) is far removed from the realities of the inflationary period only 12 years later when the mark hit rock bottom. In August 1923, a pound of margarine cost 390,000 marks. By October of the same year, Bayer was forced

to issue coupons to employees, like the one shown above with a value of 500 billion marks, because the company lacked the means to pay them.

Reparations and inflation:
one dollar in exchange for
4.2 trillion marks

The firms accepted foreign currency from customers and met their commitments with paper marks.

Wages were paid every morning before work started. The employees' wives picked up the money at the



factory gate and went shopping immediately, as a new rate was fixed at noon, and their money would be worth even less. By October 22, 1923, a pound of bread cost 800 million marks and a pound of butter cost 20 billion.

No wonder Germany was again shaken with unrest. After Bayer had experienced a 30-day Communist-led strike in January and February of 1921, leftist elements assumed power over the workers for three days beginning on August 14, 1923. The company felt compelled to answer with a lockout.

In the meantime, inflation continued. The mark fell from 126 million per dollar in September to 72.5 billion at the end of October and finally to 4.2 trillion by November 20.

This 13-digit figure was virtually beyond the imagination. Bayer's financial statement for the year 1923 showed a balance sheet total of 20 digits in front of the decimal point: 29,088,608,402,638,262,551.56 marks. This could obviously not go on.

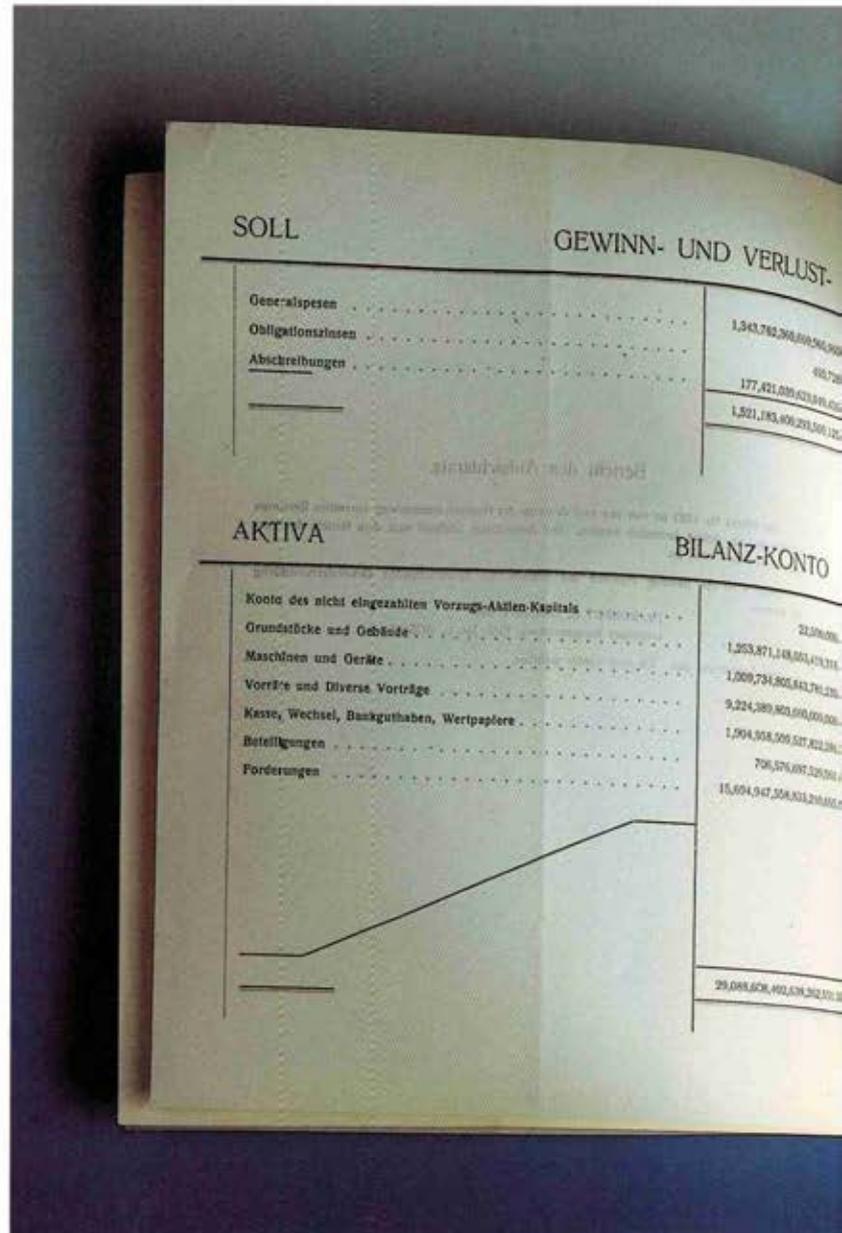
The solution came with the creation of the stabilized "Rentenmark." Agriculture and industry guaranteed 3.2 billion of the new currency unit with their real estate and assets. This amount was then brought into circulation. One Rentenmark was made equal to one trillion paper marks and thus stood at

4.20 against the dollar. In 1924, a new currency, the Reichsmark (RM), was created at the rate of 1:1 to the Rentenmark.

The Reparations Commission insisted that the Reichsmark be backed by gold and by foreign currency reserves. It also saw that its demands had to be adjusted to Germany's actual capability. The result was the Dawes Plan of 1924, named after American chairman of the committee of experts Charles G. Dawes. In the future, Germany was to pay one billion gold marks per year. This sum was to be raised to an annual 2.5 billion when the country was able to manage it. To get payments going, Germany received a loan of 800 million. The duration and extent of the final demands were not determined.

With the collapse of the currency, figures skyrocketed to astronomical amounts; the Bayer balance sheet as of December 31, 1923, shown on the right, closed with an amount of some 29,000 quintillion marks. The sum of 56 pfennigs after the 20-digit

total gives evidence of the exactness in bookkeeping. Dissatisfaction spread throughout the country. The picture above shows employees demonstrating in front of the main administration building.



In 1929, the Dawes Plan was eventually succeeded by the Young Plan. This agreement finally spelled out what Germany's commitments were to be. Between 1930 and 1988, reparations were set at two billion RM per year. Because of the Great Depression German payments were waived in 1931 as part of the Hoover Moratorium, and in the following year, the Lausanne Agreement dropped all further reparation demands.

The chemical industry was in favor of Germany meeting the various commitments, expecting that the Allies would permit German exports to finance reparations. The dyestuffs industry was, after all, dependent on exports.

RECHNUNG FÜR 1923		HABEN	
Gewinn-Vortrag aus 1922	.....	80,535,700.31	
Ueberschuss	.....	1,521,183,400,242,973,265.42	
		1,521,183,400,243,509,125.73	
AM 31. DEZEMBER 1923		PASSIVA	
Aktien-Kapital	.....	80,000,000.—	
Vorzugs-Aktien-Kapital	.....	60,000,000.—	
Gekündigte Schuldverschreibungen	.....	8,884,710.—	
Unerhobene ausgeloste Schuldverschreibungen	.....	323,573.65	
Zinsen aus	.....	354,471.94	
Dividenden	.....	246,919,310.—	
Schulden	.....	29,088,608,309,467,305,487.13	
Rücklage I	.....	843,232,500.—	
II	.....	20,000,000.—	
Rückstellung für gemeinnützige Anlagen	.....	275,036,623.20	
Beamten-Hilfsfonds	.....	276,462,962.33	
Arbeiter	.....	552,915,400.31	
Rücklage für Unterstützung der Kriegsinvaliden	.....	6,827,423.—	
		29,088,608,402,338,262,551.56	

Bayer chronicle 1921

A Franco-German dyestuffs agreement is reached between Bayer (for I.G. Farben) and "Compagnie Nationale des Matières Colorantes et des Produits Chimiques."

Bayer introduces its first inorganic color pigments to the market.

An African expedition fitted out by Bayer tests "Bayer 205" against the sleeping sickness.

Bayer's first agrochemical technical service unit starts operations in Munich.

The personnel registry is changed into the Personnel Department.

Bayer chronicle 1922

Bayer Bromitkontrast comes on the market as the world's first high-contrast silver bromide photographic paper.

A patent is obtained for Eulan, a substance to protect textiles from moths.

The I.G. Farbenindustrie sets up a Waste Water Commission.

Bayer employs students during their semester breaks for the first time.

World events 1921

The Dyestuffs Act comes into force on January 15, putting an end to the free import of dyestuffs into the United Kingdom.

Emergency Tariff Act regulates German dyestuffs shipments to the United States.

Peace agreement between Germany and the United States is signed on August 25.

Ireland gains independence from the United Kingdom.

Canadians Frederick G. Banting and Charles H. Best succeed in isolating the pancreas hormone insulin.

World events 1922

The Fordney-McCumber Tariff Act of September 21 introduces a U.S. import duty on dyestuffs.

On December 30, the Union of Socialist Soviet Republics (USSR) is formed.

Benito Mussolini is appointed prime minister in Italy.

British archaeologist Howard Carter discovers Tutankhamen's tomb on November 4.

Germanin triumphs over sleeping sickness

Members of the Nyanja, a Bantu tribe living in the then-German colony of Cameroon, numbered 12,000 in 1914. By 1922, only 609 of them were still alive. The tribe had almost been wiped out by sleeping sickness. Tens of thousands of other Africans died like the Nyanja until it became possible to cure this tropical disease by treatment with Germanin.

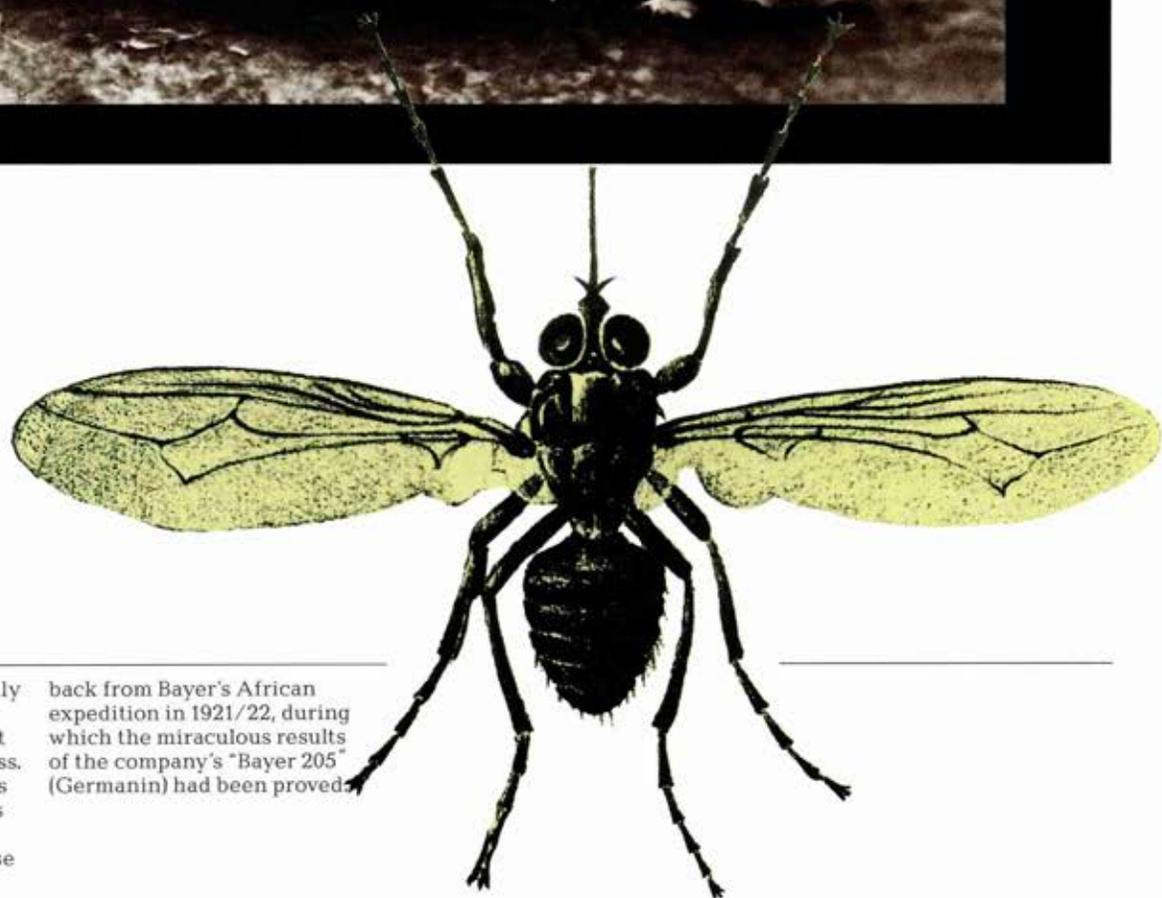
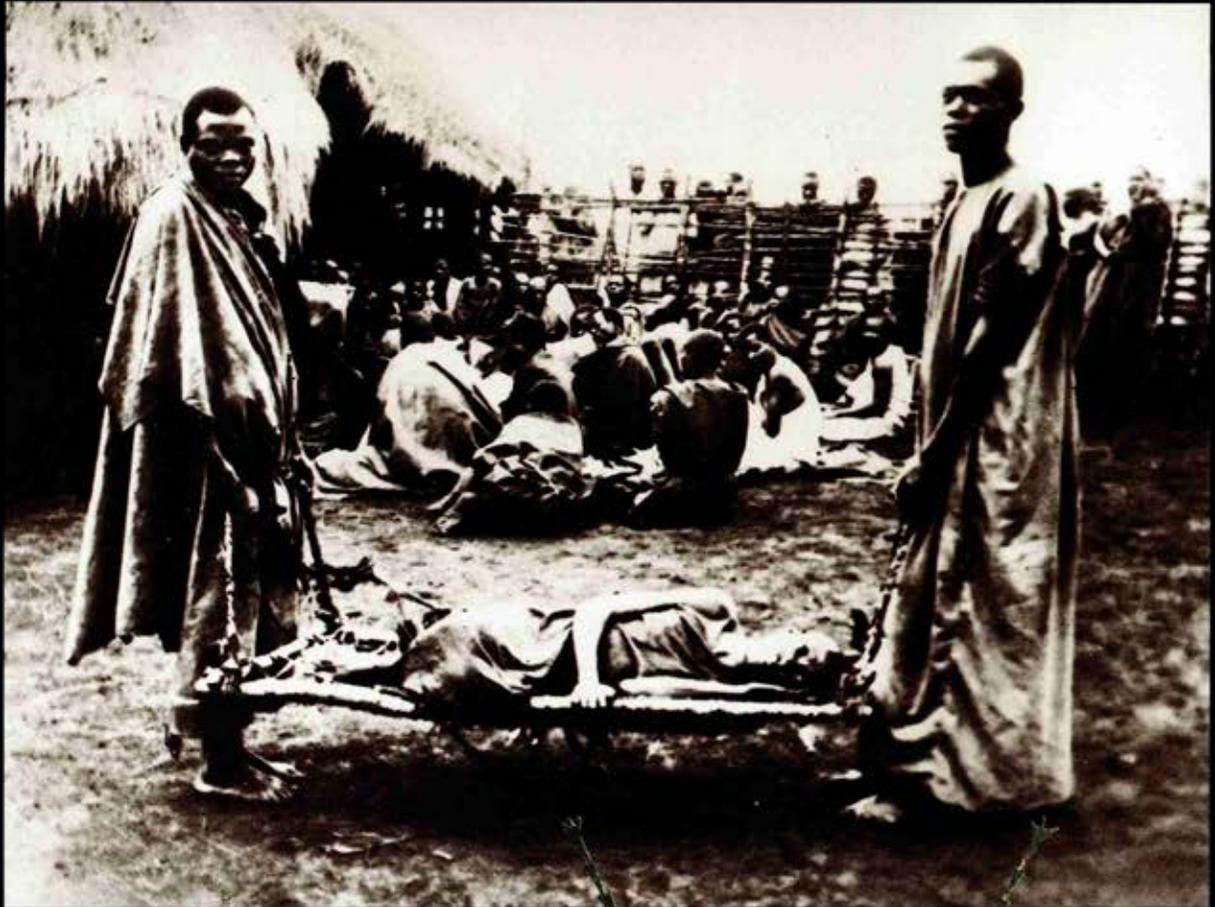
Modern pharmaceuticals can be developed with a specific purpose in mind, thanks to chemistry. The first major step in this direction was the more or less coincidental discovery of the pain-killing properties of such compounds as phenacetin or acetylsalicylic acid. However, these drugs countered the symptoms of an ailment rather than cured the actual causes.

The systematic development of medication to counteract specific pathogenic agents was the next move. Bacteria, singled out as the cause of many diseases, were targeted, but they had to be identified. Robert Koch was able to make bacteria visible by developing a method to color them with aniline dyes.

German scientist Paul Ehrlich is recognized as the founder of chemotherapy and also the man who gave this treatment its name. In 1904, he observed that a red aniline dyestuff healed mice infected with the pathogenic agent of the South American horsepox—the dye had not only colored the bacteria, but destroyed them as well.

Other researchers tried similar experiments. In 1906, Frenchmen Maurice Nicolle and Felix Mesnil of the Pasteur Institute had Bayer make special dyes for use in their investigations. They believed that the efficacy of Afrido Blue and Afrido Violet when used against trypanosomes, the parasites that cause sleeping sickness, was due to their dyeing properties. The two scientists published their findings in the journal of the institute. The consequence was an increased demand for azo dyestuffs from other researchers. *"It got to be an inconvenience for us,"* Bernhard Heymann, head of the Elberfeld chemical research laboratory, later said.

Nicolle and Mesnil made progress, but had no real success. Paul Ehrlich did. He defined the aim of chemotherapy with the following words: *"In order to apply chemotherapy successfully, we must discover substances whose affinities and destructive properties are so balanced as to kill the parasites without doing any serious harm to the organism. First and foremost, we want to attack the parasites in as great a degree of isolation as possible; in other words, we must learn*



The tsetse fly's sting can hardly be felt, but it is enough to transmit the pathogenic agent which causes sleeping sickness. Whole tribes fell victim to this epidemic, for which there was long no known antidote. The enlarged illustration of a tsetse fly to the right was brought

back from Bayer's African expedition in 1921/22, during which the miraculous results of the company's "Bayer 205" (Germanin) had been proved.

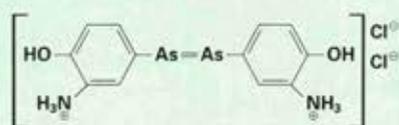
The birth of chemotherapy

The concept of fighting bacterial infections with dyestuffs is not as far-fetched as it may seem at first sight. Robert Koch had shown that there were dyes which only colored certain microorganisms but not the surrounding substances in the host organism. The actual dyeing process is proof that the dyestuff enters into a close connection with the microorganism. The assumption could therefore be made that a dyestuff of this kind had other properties, such as a degree of toxicity toward the organic substances to which it is bound. This concept fit in perfectly with what Paul Ehrlich saw as the most important criterion of chemotherapy, i.e. "taking aim" with chemicals showing specific properties.

Practice has shown that the fundamental idea is right,

though in this particular case the substance in question does not necessarily have to be a dyestuff. The development of Salvarsan and Germanin, as described in the main text, and the discovery of sulfonamides mentioned later all show, however, that the first positive research results with the aim of countering certain pathogenic agents were all reached with dyestuffs. After having determined which grouping within the dyestuff molecule had been responsible for killing the bacteria, scientists struck out in new directions in the development of therapeutically effective and more generally applicable pharmaceuticals.

Syphilis had hitherto been treated with the highly questionable "gray ointment," a trituration of mercury in fats. Paul Ehrlich subsequently developed Salvarsan:

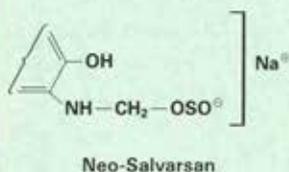


3,3'-diamino-4,4'-dihydroxyarsenobenzene dihydrochloride
Salvarsan

The similarity of this compound to an azo dyestuff is

obvious; Salvarsan simply has arsenic atoms instead of

two nitrogen atoms. The more compatible Neo-Salvarsan masked the amino groups with formaldehyde sulfoxylate:



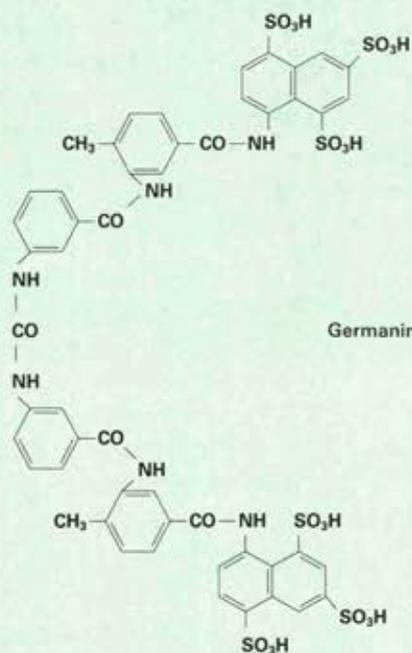
Neo-Salvarsan

Today, syphilis is treated with such antibiotics as penicillin.

Sleeping sickness (trypanosomiasis) is spread over large

areas of Africa. It begins with attacks of fever and leads to skin rashes, anemia and weight loss, subsequently to nervous and psychic disorders, paralysis, convulsions, motor disturbances, disorders of the senses and finally, with constant loss of weight, to morbid somnolence; after years of infirmity this disease frequently ends in death.

Bayer 205, or Germanin, is a complex aromatic urea derivative with the following formula. The two terminal aminonaphthyltrisulfonic acids make the molecule soluble in water despite its size.



Germanin

to aim—to aim chemically... This is what the theory is all about—the *magna sterilisans*.” In short, to hit the pathogenic agent and spare the organism.

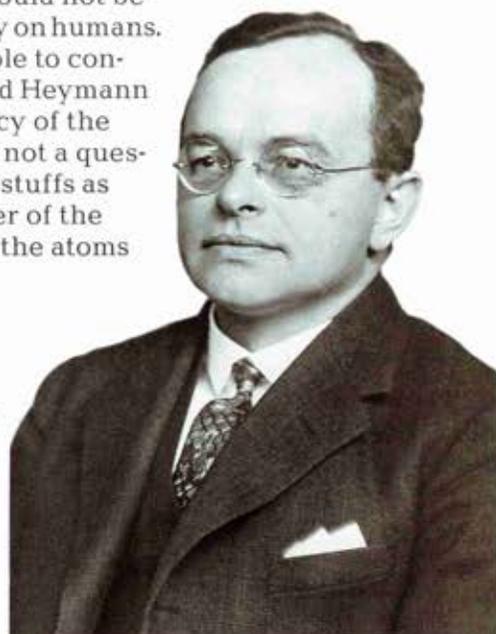
The first successful chemotherapeutical substance was Ehrlich's own Salvarsan, a product used in the treatment of syphilis. Hoechst put this on the market in 1910, but it did not quite live up to the discoverer's criteria. The arsenic compound did destroy the spirochaetae responsible for the disease, but it also led to baldness and other unpleasant side effects. But nevertheless, these were definitely the lesser evil compared to syphilis. Salvarsan was a resounding medical success—and big business. Later, in cooperation with Sahatshiro Hata, Ehrlich developed Neo-Salvarsan as a more tolerable and even more effective means to counter spirochaetae infections.

Wilhelm Roehl had been Ehrlich's close collaborator for three years before joining the Hygienic Institute of the university in Giessen. In 1909, he contacted Duisberg and asked for support for his animal experiments in the form of dyestuffs and money.

Heinrich Hörlein, who took over the Pharmaceutical Department in 1910, recognized the significance of this research direction and engaged Roehl to work for Bayer. A chemotherapy laboratory was installed in a former plumber's workshop. Hörlein had complete confidence in this new facility.

The azo dyestuffs made available to Roehl proved not only to have a good absorption rate when used to color cotton, but they also were very suitable for tagging living cells. Since they were effective against trypanosomes, they were given the name of trypan dyestuffs. Unfortunately, they also colored human skin, so they could not be used in therapy on humans.

Roehl was able to convince Bernhard Heymann that the efficacy of the substance was not a question of the dyestuffs as such, but rather of the positioning of the atoms



in the molecule. Heymann gave chemists Oscar Dressel and Richard Kothe instructions to produce substances with a similar configuration.

The first results were disappointing. A substance called Asypin for combating syphilis was discovered, but this failed to prove its usefulness in clinical trials. Roehl then turned to the field of tropical medicine.

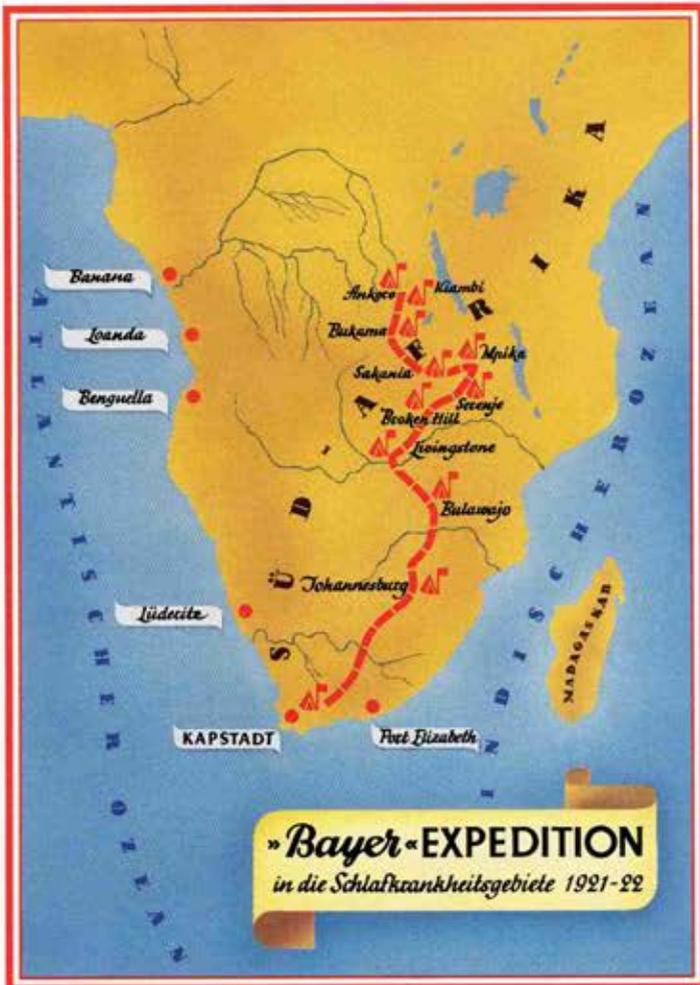
There were good reasons for this decision. The cultural and economic development of tropical regions seemed impossible without steps being taken to counter the most dangerous infectious diseases. In 1908, Bayer had initial success in this field with its Antileprol. As a treatment for sleeping sickness, there was still only Atoxyl, a French product with strong side effects. Sleeping sickness is a disease characterized by fever, weakness, tremors and lethargy, and usually ends in prolonged coma and death.



Dressel and Kothe made a decisive discovery in the fall of 1916: a colorless, odorless, slightly bitter and water-soluble urea derivative. After his return from the war, Roehl tested this substance in animal experiments and found it to be effective against trypanosomes. It was given the name Bayer 205 and

The three fathers of Germanin: Oscar Dressel and Richard Kothe, seen in the background of the above picture, discovered the compound while Wilhelm Roehl (left), the head of the chemotherapeutical laboratory, carried out the necessary animal tests and developed the

product up to its introduction to the market.

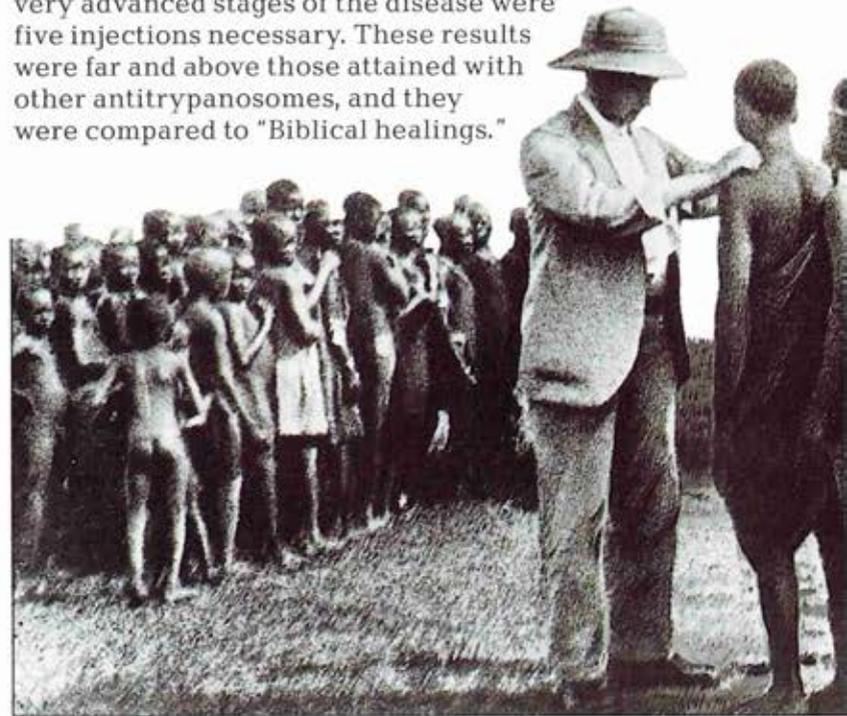


was passed on for further study to the Bacteriological Department of the National Health Office in Berlin and the Hamburg Institute for Tropical Medicine.

British engineer Christopher G. James had been in a Hamburg hospital since January 1921, after contracting sleeping sickness in Rhodesia. He had been treated unsuccessfully with antimony and arsenic substances for eight and a half months. His chances for survival seemed slight. After a few injections of Bayer 205, he was back on his feet and soon able to return to Africa.

Despite the difficult conditions in the wake of the war, Bayer was able to dispatch an expedition to South Africa to carry out the necessary field tests. It was led by Friedrich-Karl Kleine of the Prussian Institute for Infectious Diseases. Kleine had accompanied Robert Koch on his research visit to East Africa in 1906 and 1907 to examine the causes of sleeping sickness. The expedition, bearing 30 kilograms of Bayer 205, left Capetown for Rhodesia in November of 1921. Scientific investigations began there in January of the following year.

Oral applications showed only a temporary effect, but subcutaneous injections proved highly successful. Indeed, they were so convincing that the governor-general of the Belgian Congo invited them to continue their work in the southern part of his country. The scientists then tested intravenous injections. Three one-gram doses of Bayer 205 in ten cubic centimeters of rainwater on the first, third and thirteenth day cured the patients. Only at very advanced stages of the disease were five injections necessary. These results were far and above those attained with other antitypanosomes, and they were compared to "Biblical healings."

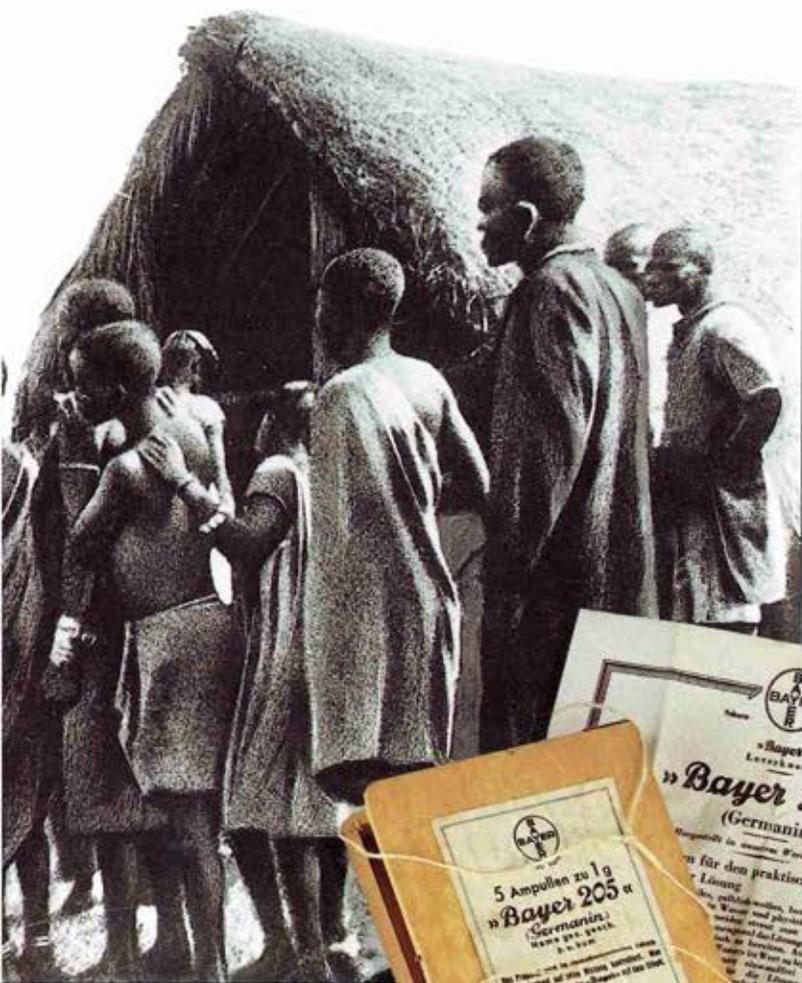


Deep in the heart of the African continent, the Bayer expedition carried out tests with the new drug "Bayer 205." These field experiments were under the supervision of Friedrich-Karl Kleine of the Prussian Institute for Infectious Diseases. In the above picture he is examining

a patient for signs of sleeping sickness. Treatment was so successful that contemporary observers compared the results to "Biblical healings."

Bayer 205 was registered in Germany on January 6, 1923, as Germanin, a remedy for tropical diseases. To this day, no better remedy has been found in the fight against trypanosomes.

In 1940, it was discovered that Germanin was also effective against river blindness (onchocerciasis). Today, there are a total of 250 various Germanin derivatives in use throughout the world.



Bayer chronicle 1923

World events 1923

Thallium compounds are patented for use as rodenticides. They are later to be introduced to the market as the Zelio line.

On April 9, Bayer reaches an agreement with Sterling Drug, Inc. that recognizes Sterling's use of the Bayer name in the United States. The situation is regularized in all other parts of the world other than South and Central America. Following this arrangement, Bayer acquires a stake in Winthrop Chemical Co. in the United States.

Agfa Products Inc. is set up in New York.

The Walsrode-based company Wolff & Co., today a Bayer subsidiary, markets the first fully transparent packaging foil.

On September 29, Carl Duisberg is made an honorary citizen of Wiesdorf, today part of Leverkusen.

On January 11 Belgian and French troops occupy the Ruhr. The so-called "Battle of the Ruhr," a form of passive resistance, begins. On October 21, separatists in Koblenz set up the "Independent Republic of the Rhine." On October 23, the German army marches into Saxony to depose the Communist government there. On November 9, the Hitler putsch fails in Munich.

General Miguel Primo de Rivera sets up a military dictatorship in Spain.

Mustafa Kemal Pasha, otherwise known as Atatürk (the Father of the Turks), proclaims the Turkish Republic on October 29.

Japanese capital Tokyo is destroyed by an earthquake. The quake is followed by hurricane-like fire storms. Some 100,000 people die, an estimated 70,000 of them in fires.

Germany's first radio program is broadcast from Berlin on October 29.

The chemical companies finally get together

The painting by Hermann Groeber in the Kasino in Leverkusen shows a historic meeting of the “Interessengemeinschaft” (I.G.) on November 14, 1924.

Two personalities dominate the portrait of this group, which was generally known at the time by its nickname “Council of the Gods.” These two — Carl Bosch and Carl Duisberg — are in marked disagreement.

The “Interessengemeinschaft der deutschen Teerfarbenindustrie” (literally, the Community of Interests of the German Coal-Tar Dyestuffs Industry) had been set up in 1916. This pooling agreement had worked well during the war and in 1920, the I.G. members renewed it until 1999. The date was hardly meant to be taken literally. It was instead to symbolize cooperation for all time.

The I.G. of the wartime years was, however, not up to tackling the quite different conditions of the postwar era. The industry was suffering from high taxes and levies, low prices resulting from the reparations agreement and high wages. If the dyestuffs industry wanted to regain its competitive position abroad, it could no longer afford overblown bureaucratic organizations, duplication of production, separate inventories or competing sales operations in a single country or even a single location. The eight firms which made up the I.G. had long since realized this predicament but had not drawn up any practical solutions.

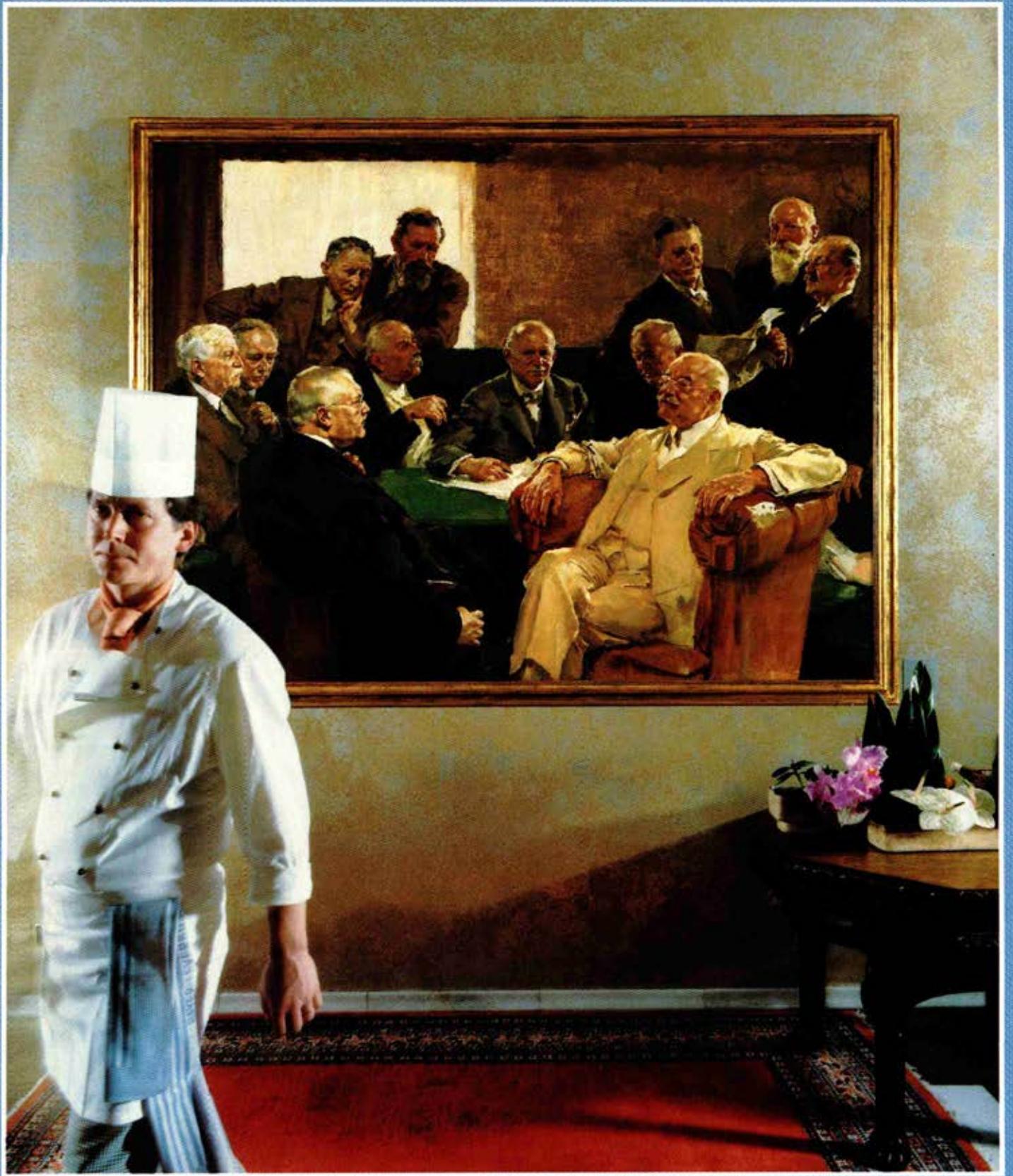
In a memorandum dated December 1923, Duisberg summarized the criticisms that had been leveled against the I.G. and proposed a number of improvements. These suggestions reached the individual company heads at a very unfavorable moment. The period of inflation was over and each firm had to decide how to adjust to the new state of affairs.

The meeting of the “Council of the Gods” in June of that year achieved nothing except to prolong the period from two to four years in which a given member company chaired the pool, which Bayer had done since April 1. In August, Duisberg was then asked to formulate another memorandum on a possible reorganization of the I.G. He came up with three alternatives that were to be used as the basis for negotiations:

1. An amendment of the I.G. charter which aimed at bringing the members closer together. To achieve this goal, a standardization, or rather a centralization, of sales was crucial. This solution called for a genuine “I.G. spirit,” which Duisberg claimed did not exist.

Visitors to the Bayer Kasino in Leverkusen have most likely seen this portrait in which the artist Hermann Groeber depicts the founders of the I.G. trust after the decisive meeting in 1924. In the foreground are the two main protagonists, Carl Bosch

to the left and Carl Duisberg to the right. Their differences of opinion concerning the organization of the “Interessengemeinschaft” seem to be reflected in their attitudes and gestures.



2. A merger. This would mean that all member companies would either be absorbed into a single new joint stock company or that one of them, which could only be BASF as the largest company, would take over the others. In both cases, the great names of the German chemical industry would disappear. The Board of Management and the Supervisory Board of the amalgamated company would be very large and the merger would cost between 45 and 56 million Reichsmark.

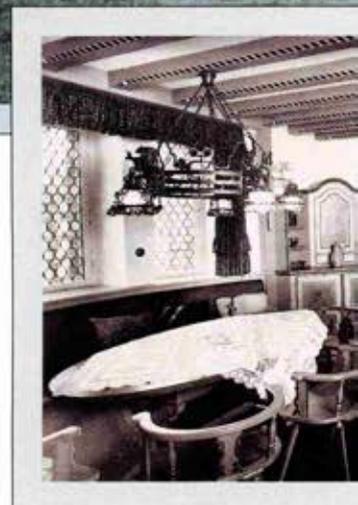
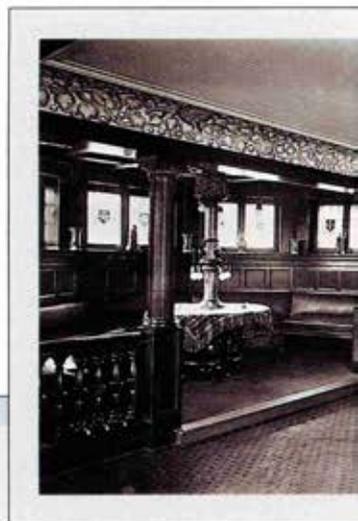
3. A holding company. All firms would be obliged to sign a contract with a holding company, which would take over *"everything—all operations and their management, purchasing and sales. It would thus have the right to make dispositions on behalf of the members—and would also assume responsibility for the whole."* The names of the companies, rich as they were in tradition, would be retained, as would the character of the individual firms and thus the incentive for competition.

The remarkable feature of this memorandum was that Duisberg, who had championed a merger in 1904 and again in 1916, now abandoned this idea and came out strongly in favor of a holding company as the solution.

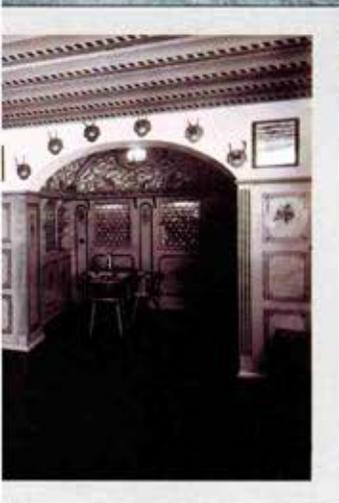
The next session of the council was planned for November 13. Duisberg thought it best to initially talk the matter over with his counterparts at the other companies in question. They met in Frankfurt in October. To Duisberg's surprise, the amendment of the I.G. agreement was not a matter for discussion. Everyone rejected the idea of a holding company and, with the exception of Cassella and Griesheim, the other companies were in favor of an immediate and direct merger.

For the present, however, the interested parties agreed on a compromise proposed by Hoechst. This laid down an immediate merger in the case of a unanimous decision by the council. Should a majority be in favor, the merger would begin in two years at the earliest and be completed within four.

A disagreement ensued as to the form of organization. Duisberg wanted an organization program with



Company history was made in this house: negotiations for the amalgamation of leading German chemical companies into the I.G. Farbenindustrie took place in Duisberg's villa on November 13 and 14, 1924.



Duisberg withdrew to the billiard room (shown above) with his allies, while the supporters of Bosch met in the bar (below).

every detail laid down in advance. Carl Bosch, however, was for improvisation: the companies should just get started and then more or less play it by ear.

The decision to merge was passed at the council meetings in Leverkusen on November 13 and 14. Fritz ter Meer later summed up the reasons: *"No board of management of a member firm could have justified to its shareholders a situation in which it would let production capacities and sales organizations be reduced with the danger of the company losing ground should the agreement be scrapped for some important reason or another."* The only answer was a merger from which there could be no withdrawal.

These two days were filled with hot debate. It is impossible today to reconstruct exactly what was said since the companies agreed to record only resolutions in the minutes and not points of discussion. Duisberg's son Curt later recalled the tension at the dinner given in Duisberg's home. After the meal, the executives split up into two groups; Duisberg and his few allies retired to the billiard room and Carl Bosch and his supporters to the bar, while a mediator constantly ran between them.

The merger was resolved the following day. Duisberg made no secret of his disappointment. He had never been faced with such a personal defeat before. After a brief meeting with the Bayer board, he gave up the chair of the council to Bosch on his and the company's behalf. This was an embarrassment to Bosch, who gave a personal vote of thanks to Leverkusen's management for its work at the head of the I.G. Before they parted, Bosch approached Curt Duisberg and said to him, *"Now that we have taken over the presidency of the I.G., I would like you to set up and head the office in Ludwigshafen."*

This conciliatory gesture was not in vain. On December 16, Duisberg Sr. and Bosch met in Ludwigshafen. The "hostile gods" settled their differences and began to work together toward a common goal.

The first products for the farming business

In the spring of 1924, the Biological Institute of the Crop Protection Experimental Unit was completed adjacent to the Leverkusen plant. This new laboratory underscored Bayer's interest in expanding agrochemical research in the wake of its first major successes with seed dressings.

Surrounded by the tall trees of what had been Leverkusen's extensive park, the Biological Institute looks like a converted villa or a small private sanitarium in the old photographs found in Bayer's archives. After the addition of a new wing and because it has become somewhat of an island among parking lots, train tracks, the Japanese Garden and the high-rise office building, today's institute has lost some of its erstwhile charm.

During the period in the twenties between inflation and the pending I.G. merger, the opening of this well-equipped building was considered something very special. It marked the start of large-scale chemical research in the important field of "agriculture and chemistry."

The dramatic food shortage during World War I had shown just how vital it was to protect the already diminished supplies from pests and microorganisms. In 1915, Bayer had put a seed dressing on the market whose significance was to outlast the emergency conditions of wartime. Marketed under the trade name of Uspulun, this product was the result of research work that Georg Wesenberg, one of the company's first agrochemical research scientists, had begun four years before it was ready to be introduced to the market.

Up until then, the normal practice had been to "treat" seeds with copper vitriol or mercuric chloride. But copper became scarce shortly after the war broke out, and the use of mercuric chloride frequently hindered germination of treated cereals. Uspulun also contained mercury, but its excellent properties as a fungicide did no harm to the germination process.

Even that long ago, a great deal of attention was paid to the question whether the mercury contained in the dressings might be penetrating into the seed corn and consequently into the foodstuffs. In the 1920s, this question was already the subject of investigations on the part of Bayer and a number of leading universities. But even their most sensitive analytical methods and devices were unable to substantiate any such danger.

Seeds have always been a great draw for microorganisms. In order to ward off fungus and retain germination ability, the seed corn is treated with a chemical disinfectant. The picture on the right shows an advertisement for Bayer's seed

dressing "Uspulun," which had been developed by the company in 1915.



USPULUN

Wirksamste Saatbeize

zur Vernichtung aller dem Saatgut äußerlich anhaftenden
schädlichen Pilzkeime:

Erprobt gegen: Stein- (Stink- oder Schmier)brand d Weizens, Fusarium (Schneeschimmel) d Roggens u Weizens, Roggenstengelbrand, Streifenkrankheit d Gerste beide Arten v Haferflugbrand Wurzelbrand d Rüben, Brennfleckenkrankheit der Bohnen u Erbsen usw

Erhältlich in allen üblichen Verkaufsstellen.

Farbenfabriken vorm. Friedr. Bayer & Co., Leverkusen b. Köln^o 3011.

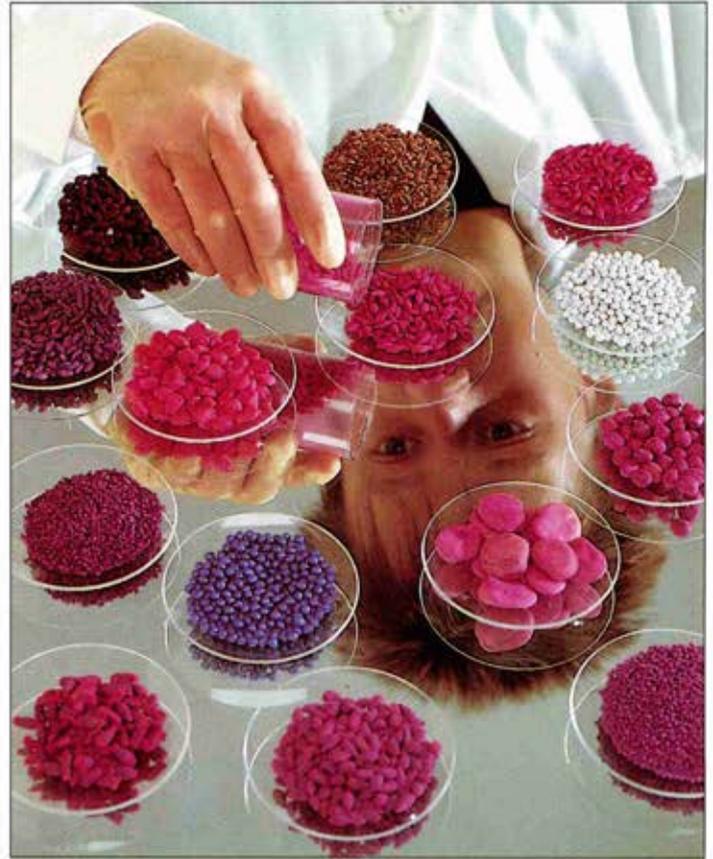
Abt. für Pflanzenschutz

The use of mercuric treatments is still considered safe as long as they are properly applied, but over the years scientists have endeavored to develop mercury-free products as a matter of principle, and they are now available.

Agrochemical research had initially been located in Elberfeld. It very soon became clear, however, that this sort of work not only called for laboratories, but also for greenhouses and acres of open fields where the efficacy of the new chemicals could be tested under close-to-normal operating conditions. Therefore, a much better location was in the southwestern part of the Leverkusen plant, where the Horticultural Department already had greenhouses for experimental purposes. There was also the nearby Paulinenhof farm that Bayer had bought in 1917. It was consequently considered quite logical to locate the Biological Institute next to the Horticultural Department on the edge of the Leverkusen park.

Wartime, the turbulent postwar conditions and inflation held up building plans, but in 1923, the Board of Management resolved that the agricultural laboratory should be completed; it was finished the following year. For the time being, however, the company's research activities nonetheless remained in Elberfeld.

The history of crop protection and pest control at Bayer is closely linked with the names of Curt Gropengiesser and Wilhelm Bonrath. Of the two scientists, particularly the former earned special recognition for his publication of the bulletin "Nachrichten der Landwirtschaftlichen Abteilung" (Agricultural Department News). This department had been set up in 1920 by combining the crop protection and veterinary divisions. The bulletin, which was launched in 1922, became very popular. It had the dual benefit of explaining both the function and the methods of crop protection to the various target groups of the farming community as well as helping to prevent serious misuse of the products in question. The institute came up with improved dressing techniques, replacing the time-



consuming "wet" method that had previously been used with a dry Uspulun treatment. Centralized seed dressing stations were set up in the rural areas. The farmers could considerably ease their load by having the treating done for them months before sowing season.

Additional products were also developed, among them the active agent phenyl-mercuryacetate. This worked very well despite its low mercury content and was put on the market under the name Ceresan. It, too, was available in numerous variants. One type, for example, contained a special kind of anthraquinone, which scared off crows.

But Bayer's agrochemical research of the twenties and thirties did not only concentrate on seed



The Paulinenhof farm was bought by Bayer in 1917 for use as an agrochemical research station. Those are not candies in the picture shown above but dressed seeds. The brilliant colors are intended as a warning that the seed corns have been treated with a disinfectant.

dressings. In 1920, Solbar, which contained sulfur, was introduced to fight against fungal infestation of host plants. Certan, Venetan and Ustin served as new insecticides, and the resurgent rat population prevalent in many areas was the target of Zelio granules and paste.

During the era of the I.G. Farbenindustrie, research in the field of agricultural chemicals was split up among the various plants. The strong position of the trust's Lower Rhine Division with its works in Elberfeld and Leverkusen gave the newly formed Farbenfabriken Bayer a good start in this field after World War II.

The Biological Institute, in fact, soon became even too small for these increasing responsibilities and thus had to be expanded once again in 1952. Thirty years thereafter, this enlarged facility had also reached its limit. The space problem was finally solved when the Agricultural Chemicals Center was constructed in Monheim. This complex will be discussed in detail in a subsequent chapter.



Research means giving a great deal of attention to a few tiny details. The picture above shows an employee at the Monheim Agrochemicals Center scrutinizing the growth of a broad bean (*Vicia faba*) seedling.

Bayer chronicle 1924

Antimalarial drug Plasmochin is discovered but not introduced to the market until 1927.

Economic situation forces the company to dismiss 3,000 workers; at the same time, however, the number of chemists is increased by 60 to 340.

Bayer photographic factory starts production of film rolls.

Construction of a new Biological Institute is completed for the Agrochemical Research Department.

Doitsu Senryo is set up in Japan as a joint I.G. Farben sales company.

On June 17, Bayer, acting for I.G. Farben, concludes an agreement with Grasselli Chemical Co. on the establishment of a joint venture in the United States to be known as Grasselli Dyestuffs Corporation.

World events 1924

Following the death of Lenin, a "Troika" consisting of Grigory Zinoviev, Leon Trotsky and Joseph Stalin takes control in the Soviet Union. Shortly thereafter, Stalin makes himself sole ruler.

A radio message is broadcast from England to the United States.

Bell Corporation engineers transmit pictures over the telephone wires from Cleveland to New York. Max Dieckmann receives a German patent "for a process for the electrical transmission of moving pictures."

The hydrogenation of coal for the production of synthetic mineral oil is introduced at BASF.

The 10-millionth car leaves the Ford conveyor belt in Detroit.

On June 7, Japan introduces a licensing system, modeled on those of Britain and the United States, to limit imports of German dyestuffs and promote its own industry.

The bob, created in the United States in 1920, becomes the most popular hairdo for European women.

A new company is born : I.G. Farbenindustrie AG

At the end of the 1924 business year, Farbenfabriken vorm. Friedr. Bayer & Co. ceased to exist as a legal entity. For the next 26 years, it was to be known as the Lower Rhine Operating Division of I.G. Farbenindustrie Aktiengesellschaft. The Bayer name remained in existence, however, and became the overall trademark for I.G. Farben's pharmaceuticals.

By December 9, 1925, all pooling agreements had been completed. For accounting purposes, the formation of the I.G. Farben was backdated to January 1, 1925. As of January 1, 1926, all correspondence had to be carried out under the name of the new, amalgamated group "I.G. Farbenindustrie Aktiengesellschaft," which was officially translated into English as the "Community of Interests of the Dye Industry Corporation."

The merger naturally took more time to realize in operational terms than on paper. Few people had lukewarm emotions about the merger. While some were very enthusiastic, others strongly opposed giving up the old order.

The corporate organization was a combination of Duisberg's theoretical considerations and Bosch's practical demands. Of the two alternatives proposed by Duisberg, the cheaper and simpler one was chosen: BASF took over the other firms, i.e. Farbenfabriken Bayer, Farbwerke Hoechst, Agfa, Chemische Fabriken vorm. Weiler-ter Meer and the Frankfurt-based Chemische Fabrik Griesheim-Elektron. The merger excluded Cassella & Co. and Kalle & Co.; these subsidiaries technically remained autonomous but transferred management responsibility to the I.G. Farbenindustrie organization.

The new trust had its headquarters in Frankfurt on the Main. Its capital amounted to 646 million Reichsmarks and was double that of Germany's ten next largest chemical companies combined.

Members of the boards of management of the former companies were transferred to the I.G. Farben Board, which thus had 83 members. All 50 supervisory board members joined the corresponding organ of the I.G. Both boards were clearly oversized and obviously too large to function successfully.

As Chairman of the Board of Management, Carl Bosch formed an executive committee from the board members.

Carl Duisberg was appointed Chairman of the Supervisory Board, which he set about turning into an administrative organ. As important as this new union undoubtedly was, it meant a sacrifice in

This sculpture of fighting Pekinese was brought back to Germany from China by Carl Duisberg. He had an eloquent inscription carved in the pedestal: "The I.G. before the merger."



"Interessengemeinschaft"

When the term "Interessengemeinschaft" (literally, "community of interests") appears in German economic history, it is almost invariably referring to the German coal tar dyestuffs industry. In fact, this kind of corporate pooling agreement was by no means uncommon in Germany in the first decades of the 20th century and the dyestuffs community of interests was initially not even the most famous trust.

The "Interessengemeinschaft," or I.G. in its more commonly used abbreviated form, was one of the ways in which companies could join forces to attain a common goal. Its organization could be categorized somewhere between that of a cartel and a concern, whereas the legal form was simply that of a corporation with certain civil rights provided under the Code of Civil Law dating from the year 1900. It was based on a contract between natural or legal persons.

In the case of the German dyestuffs industry, the companies which had committed themselves to the idea of the I.G. entered into a contractual agreement in 1904 and then once again in 1916; they remained legally independent organizations but transferred a number of powers to such common organs as the Council of Delegates in the so-called "little I.G." of 1904 or the Community Council or I.G. Council in the "big I.G." of 1916.

As provided by the law governing public companies,



the fundamental characteristic of the "Interessengemeinschaft" was the pooling of each company's profits and their subsequent distribution to all parties concerned, whereby the amount to be received was calculated according to a system of quotas. Thus, for example, Bayer had a share in the profits of about 46 percent under the "little I.G." agreement of 1904 and 24.82 percent within the "big I.G." from 1917 onwards.

The I.G. Farbenindustrie, as set up in 1925, was actually not an "Interessengemeinschaft" in the true sense of the word, but rather a joint-stock corporation that had absorbed the formerly independent I.G. member firms. Thus, its use of the term after 1925 was as a part of the company name and not as a description of its legal status; this is why "Interessengemeinschaft" was no longer written out in full but only as the abbreviation I.G. It was unprecedented in German history for a joint-stock company to call itself I.G., but in a legal battle, which went as far as the German Supreme Court in Leipzig, the corporation won the exclusive right to the use of the abbreviation.

In addition to being a legal entity in itself, I.G. Farben was—as the parent company of the directly controlled subsidiaries Kalle, Cassella, Ammoniakwerk Merseburg, Riebeck'sche Montan etc.—a corporate group in which the I.G. organization was the dominating factor.

Duisberg's own eyes. At a reception for Bayer's long-service employees on October 31, 1925, he admitted: *"I would personally have preferred the former pooling agreement to have lasted until my retirement, but we must keep up with the times. There can be no other way but to follow a new course, so let us do this bravely and confidently!"*

I.G. Farben was structured both horizontally and vertically. The horizontal breakdown was into five Operating Divisions ("Betriebsgemeinschaften"). These included Upper Rhine, based in Ludwigshafen but also taking in the Oppau plant and the Leunawerke near Merseburg, Central Rhine in which the Hoechst works played the leading role, Central Germany with its Bitterfeld and Wolfen plants, and the Berlin Division, including the photographic and artificial silk facilities.

The Lower Rhine Division was made up of the Bayer works in Elberfeld, Leverkusen and Dormagen and the Weiler-ter Meer plant in Uerdingen. Nobody could have foreseen that this group of production units was to form the core for the reincorporated Bayer AG after World War II.

Technical integration remained incomplete at first. The following divisions were not created until 1929:

Division I: nitrogen, methanol, mineral oils and mining;

Division II: chemicals, dyestuffs, pharmaceuticals and pesticides;

Division III: photographic products and artificial silk.

During the course of time, these divisions became the real management units, representing profit centers within I.G. Farben as a whole. In technical and personnel matters, the major works remained largely independent.

At the center of all planning in 1924 and 1925 was the rationalization of sales. Large new marketing units were set up for pharmaceuticals and agrochemicals in Leverkusen; for artificial silk and oils in Berlin; and for chemi-

cals and dyestuffs in Frankfurt. A number of central administrative functions were subsequently located in Berlin, including finance, legal and patent affairs, purchasing and transportation. This demanded mobility and flexibility on the part of the staff.

Hundreds of employees had to relocate their families, work for new bosses and change working conditions.

The standardization of sales programs led to considerable difficulties. In the field of dyestuffs alone, there were some 50,000 different designations, often for products that were chemically identical. A top-secret "identity list" was drawn up, and salesmen who had been promoting their former firms' products as the best now had the embarrassing task of convincing their clients that they would be getting the same thing as before, but under a different name.

I.G. Farben was eager to profit from well-known trademarks, which were particularly important in the pharmaceutical sectors. Five of the I.G. firms were producing pharmaceuticals—Bayer, Hoechst, Kalle, Cassella and Agfa. Production was initially concentrated in Elberfeld and Hoechst, and extended later to the Behring-Werke plants in Marburg and Eystrup. The first joint trademark was a very clumsy "totem pole" combining all of the existing corporate logos. First Agfa and Kalle decided to drop their signs, and then Cassella followed suit. That left only the Bayer cross and the Hoechst bridge. In 1934, six years after the Pharmaceutical Sales Unit had moved to Leverkusen, I.G. pharmaceuticals simply bore the Bayer cross. The sales function itself took the official name of »Bayer« I.G. Farben-industrie AG, Leverkusen.

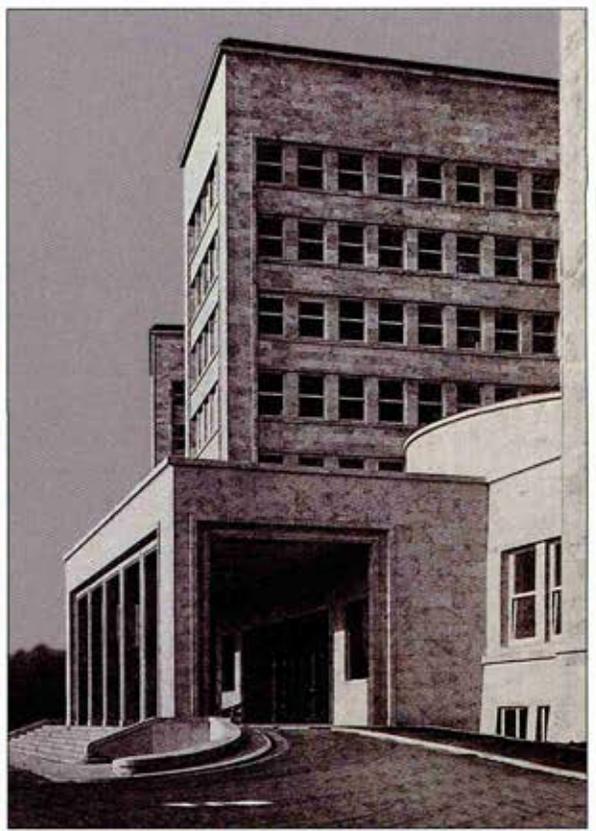
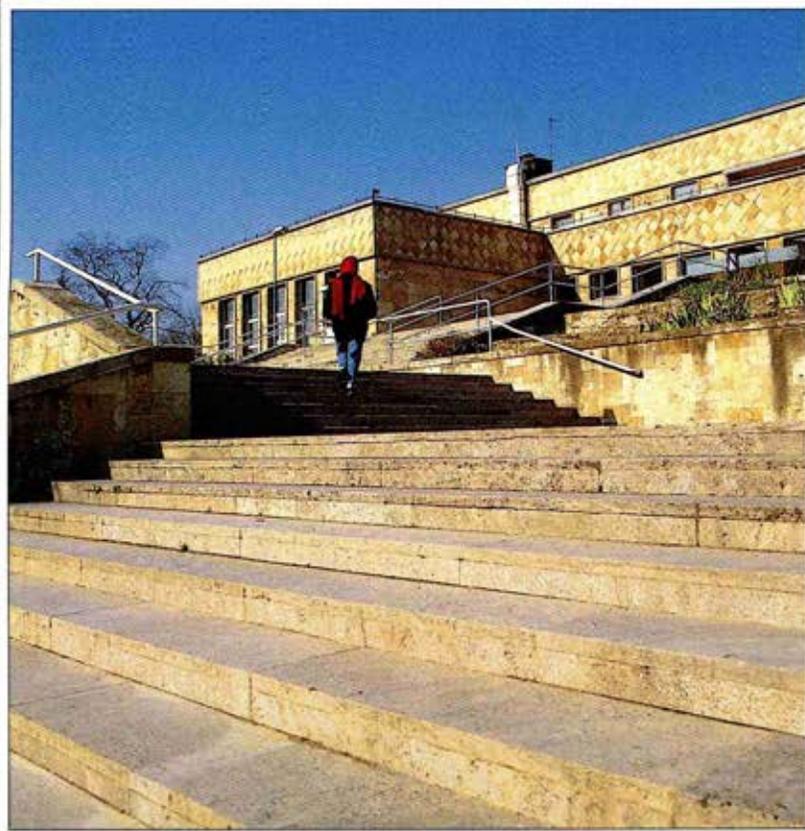
The construction of a central administrative headquarters began in Frankfurt in 1929. Designed by architect Hans Poelzig, it was considered one of the most impressive examples of contemporary architecture.

In Germany and abroad, the chemical industry was going through a consolidation period.



Five I.G. companies produced pharmaceuticals: Bayer, Hoechst, Kalle, Cassella and Agfa. Their joint trademark was a sort of totem pole bearing the individual corporate logos, here to be seen in the form of a letter-opener once owned by Carl Duisberg.

A new company is born:
I.G. Farbenindustrie AG



Similar corporate trusts were formed elsewhere, too. For example, Imperial Chemical Industries (ICI) was set up in the U.K. in 1926 by the merger of the former chemical companies Brunner, Mond & Co., Nobel Industries Ltd., United Alkali and British Dyestuffs Corporation. ICI consisted of 54 firms, with a total of 93 plants in the U.K. and other countries. Its share capital amounted to £56.8 million, or the equivalent of RM 1.2 billion, which was much bigger than that of I.G. Farben.

In France, a group of big concerns—St. Gobain, Péchiney, Ets. Kuhlmann and Rhône-Poulenc—controlled the industry, and the situation was similar in Italy. The American chemical industry was dominated by Du Pont de Nemours, Allied Chemical & Dye and Union Carbide & Carbon.

Despite their substantial sizes, the major foreign chemical trusts had not yet caught up with I.G. Farben in the field of organic synthesis and were thus willing to cooperate with the German company. For its part, I.G. Farben was dependent on links to foreign firms because this was the only way it could win back a position on the important markets of the industrialized nations. As time went by, this led to a series of increasingly closer cooperations.



I.G. Farben set up its headquarters in Frankfurt on the Main. The massive "Grüneburg" complex (left) has been used by the Americans since the end of World War II.

Decorative little stickers like the one shown above adorned the cans of I.G. Farben's dyestuffs, which were exported all over the world.

Bayer chronicle 1925

Monthly wage accounts are introduced with payments of weekly installments.

Due to streamlining efforts, the number of workers in Leverkusen falls from some 10,000 in 1923 to 5,400.

Soporific Phanodorm is introduced to the market as well as Theominal and Jodisan, drugs for vascular regulation in the treatment of arteriosclerosis, angina pectoris and hypertension.

Block G power station goes on stream in the Leverkusen works. (The picture shows the control room.)



An entry in the commercial registry on December 4 marks the disappearance of the name Farbenfabriken vorm. Friedr. Bayer et Co.

World events 1925

Following the death in February of Friedrich Ebert, Field Marshal Paul von Hindenburg is elected as his successor to the presi-



dency of the German Reich by 48.3 percent of the votes in the second ballot on April 26.

After having been released from military detention, Adolf Hitler re-groups the NSDAP and publishes his ideological work "Mein Kampf."

Leading politicians from France, the United Kingdom, Italy, Belgium and Czechoslovakia meet the German Foreign Minister Gustav Stresemann in the Swiss resort of Locarno in October and sign the Locarno Pact. It guarantees France and Belgium's eastern frontier, lays down the principle of non-violence and leads to the end of the occupation of the Rhineland. Subsequently, Germany becomes a member of the League of Nations in 1926. Gustav Stresemann and Aristide Briand are awarded the Nobel Peace Prize.

Benito Mussolini establishes a Fascist dictatorship in Italy.

Bayer's first synthetic fiber—rayon from Dormagen

Bayer's fibers production is concentrated in the Dormagen plant. It was here that the company, as part of the I.G. Farben, started producing cuprammonium rayon in 1926.

The history of artificial silk literally began with a bang. In 1846, chemist Christian Schönbein dropped a flask containing nitric and sulfuric acid in his Basel laboratory. He wiped the floor with his apron, which he then hung to dry on the hot stove. The apron exploded—Schönbein had discovered guncotton. He examined the substance and found out that it could be dissolved in alcohol and ether to a sticky liquid called collodion.

Forty years passed before British electrical technician Sir Joseph Wilson Swan stumbled upon Schönbein's guncotton for use as a filament in the light bulb he invented. In order to make it nonexplosive, Swan dissolved the substance in glacial acetic acid, pressed it through a fine jet in alcohol and thus obtained a shiny, silky fiber.

His wife liked the way the threads looked and used them in some of her needlework. That gave Swan the idea of showing what he called artificial silk at the London Inventors' Exhibition of 1885. The name was born—and stuck.

At about the same time, the French silk industry had been badly hurt by the silkworm disease. Count Hilaire de Chardonnet, a leader in the country's industrialization process, dissolved nitrated cellulose in a mixture of alcohol and ether and forced the solution through fine glass tubes. The resultant silky fibers were patented in his name in France and Germany in 1885.

Like Swan, Germany's Max Fremerey and Johann Urban discovered a way to make a form of guncotton for use as an electric lightbulb filament that was less dangerous. This process involved the dissolving of cellulose in ammoniacal copper oxide to yield a lustrous fiber.

The real breakthrough, however, came with the viscose process developed in 1891 by Britons Charles F. Cross, Edward J. Bewan and Clayton Beadle. They discovered that cellulose was soluble in alkali lye and carbon disulfide and could then be spun into fine threads. Artificial silk was, therefore, the result of the common labors of British, French and German scientists. The first factories for the production of



I. G. FARBENINDUSTRIE AKTIENGESELLSCHAFT		
0,5% Siriusrosa G		10
0,5% Siriusrosa BB		11
1,5% Siriusrubin B		12
1,5% Siruscharlach B		13
1,5% Siriusrot BB		14
1,5% Siriusrot 4B		15
2 % Siriusrubin R		16
3 % Siriusbordo 5B		17
1 % Siriusrotviolett BBL		18
I. G. FARBENINDUSTRIE AKTIENGESELLSCHAFT		
1 % Siriusrotviolett R		19
1 % Siriusrotviolett B		20
1 % Siruskorinth B		21
1 % Sirusviolett 8L		22
0,5% Sirusviolett BB		23
1 % Sirusviolett 3B		24
1,5% Sirusblau BRR		25
1,5% Sirusblau BR		26
1,5% Sirusblau B		27



With the invention of Cupresa in the mid 1920s, Bayer entered the important field of textile fibers. Similar to the silkworm spinning what seems like an endless filament from its cocoon, artificial silk was also produced as an endless fiber.

The sorters in the photograph on the left are carefully inspecting the filaments for flaws. Sample cards (center) showed customers dyed and printed swatches of the new artificial silk fiber.

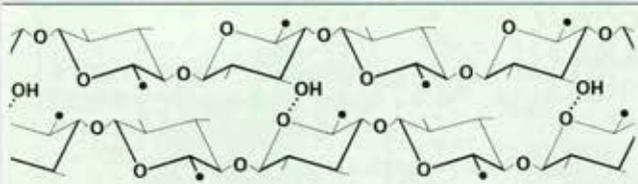
Silk from cellulose

Wool and natural silk are close chemical relatives of protein, while cotton consists of cellulose, the basis for almost all members of the plant family. However, the threads can only be spun from the seed hairs of the cotton boll, the stalk of flax and hemp and of a limited number of other species. The processes mentioned below are aimed at making use of the cellulose

contained, for example, in the wood of trees as a raw material for semisynthetic textile fibers.

Cellulose, like starch, is a macromolecular derivative of glucose, which is a member of the saccharide family.

A large number of such glucose rings join up in cellulose to form long chains:



Simplified representation of the structure of cellulose

All production processes for textile fibers based on cellulose involve methods of making the otherwise insoluble macromolecule soluble in suitable solvents. This is achieved by chemical manipulation of the free hydroxyl groups and then pressing the solution through a sieve-like arrangement of numerous fine jets to yield filament yarn. There are three spinning processes for all synthetic fibers:

1.) Wet spinning:

The spinning solution is passed into a precipitating bath and the resultant filaments withdrawn. Example: viscose fibers.

2.) Dry spinning:

The spinning solution emerges into heated shafts. The solvent then evaporates rapidly and

the solidified filaments are withdrawn. Example: acetate fibers.

3.) Melt spinning:

The melted, solvent-free spinning substance is pressed through the spinnerets, and the filaments solidify as they cool in the air of the shaft. Examples: polyamide, polyester and other synthetic fibers but not cellulose fibers.

The bundles of fibers obtained from one of these processes are either in the form of filament threads or yarn such as artificial silk (Cupresa, acetate) or, after cutting, in the form of staple fiber for respinning (Cuprama).

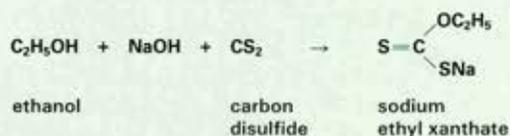
Apart from the manufacture of nitrocellulose, the text describes the following processes:

1.) Cuprammonium process: When an aqueous solution of copper sulfate (CuSO_4) is treated with concentrated ammonia solution, the color changes from sky-blue to a deep dark-blue. This shows the formation of the very stable tetrammine copper

complex. Cellulose is soluble in this mixture. The solution is spun into an acid precipitating bath where, as the complex is destroyed, the cellulose is regenerated and obtained in the form of a fiber.

2.) Viscose process:

Alcohols react with alkali lye and carbon disulfide to form xanthates, e.g.:



The same reaction takes place with the hydroxyl groups of cellulose, thus forming a viscous solution of cellulose xanthate. This substance is spun into a precipitating bath and the remaining xanthate groups are removed from the viscose rayon filaments.

3.) Acetylation:

The hydroxy groups of the cellulose are esterified with acetic acid. Cellulose acetate can be processed into a number of different materials, including plastics, foils, coating raw materials and fibers.

The discovery of Eichengrün and Becker was instrumental in the invention of acetate rayon. It offered much easier spinning procedures because products with a low

acetylation rate of about 2.5 could be worked with instead of cellulose triacetate, which is a difficult base due to the fact that all three hydroxy groups of the glucose component are esterified with acetic acid. Low acetylation rates permit, for example, dry spinning.

artificial silk began to appear. Around the turn of the century, Bayer had also started to look at the potentialities of cellulose. Two of its Elberfeld chemists, Arthur Eichengrün and Theodor Becker, succeeded in obtaining the known substance cellulose triacetate by direct acetylation of cellulose. This product only became technically feasible in 1905, when the two men, in cooperation with Hugo Guntrum, were able to produce an acetone-soluble cellulose acetate. Under the tradename Cellit, it was to form the basis for a number of products.

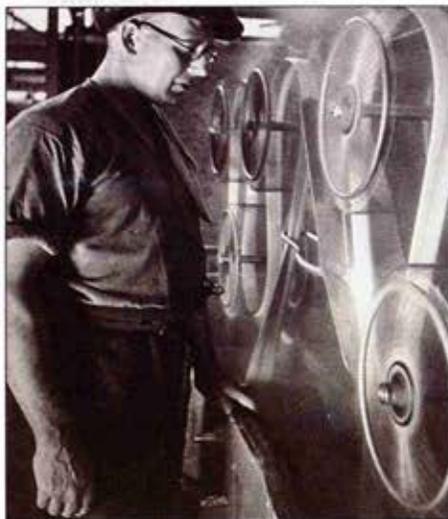
The first of these new introductions was a range of Cellit films for the rapidly growing photographic and cinematographic industries; they were intended to replace celluloid. Cellon coatings soon became important for fuselage coverings, and later on Cellit led to the development of Cellidor, the first product in Bayer's plastics program.

In 1904, Eichengrün and his team registered the patent for the first dry spinning process for acetate rayon fibers on behalf of Bayer. The company did not, however, make use of this process itself but licensed it out to a textiles company. In 1907, the "Kunstseidenfabrik Jülich" started making acetate silk by the Bayer process. But the promising beginnings ended with the First World War.

In the mid 1920s, Bayer took the decisive step in the manufacture of textile fibers. In the search for diversification possibilities, production of cuprammonium rayon began in 1926 at the Dormagen works, which had practically been desolated since the end of the war. Production was based on the cuprammonium cellulose stretch spinning process of J. P. Bemberg AG. But output was modest by today's standards, with 2,000 workers, most of them women, turning out only some two metric tons per day.

In fact, "Bemberg silk," which later sold under the name Cupresa, brought about a near revolution in the consumer goods sector.

Fabrics from the silky fiber Cupresa were already being made into light, softly draping and colorful garments when Cuprama was introduced as a new variant in 1934. Like wool,



"Silk" stockings were suddenly affordable. Cuprammonium rayon acquired a legendary reputation outside Germany as well, where it was used under the name "Lavable"

for linings and other garments. The fine, silky and flowing fabric was a hit with consumers all over the world.

In 1934, Dormagen added "artificial wool" to its artificial silk production. This wool-type chemical fiber was sold under the trade name Cuprama. It was not easy to find a place in the market for this staple rayon because natural wool and cotton were relatively inexpensive as compared with natural silk.

The Third Reich's self-sufficiency policy helped rayon become viable and even after the war, production continued for a considerable time. Bayer did not cease Cuprama until 1970, and Cupresa held on until 1974. They were then succeeded by synthetic fibers no longer based on the natural product cellulose.

But back to cellulose acetate. It was produced by Bayer under the Cellit trademark from 1905 onwards, though initially not for use in acetate rayon. However, Cellit produced in the Elberfeld works, and after 1927 in Dormagen, was sold to the Berlin company Aceta, which used it to manufacture acetate rayon.

It was not until after the war that the Bayer plant in Dormagen began producing acetate rayon. Production started in 1952 and with it, the real beginnings of Bayer's fibers business. The extensive experience gained by chemists, chemical engineers and sales personnel gave the company the wherewithal to become a leading synthetic fibers manufacturer. And this is where the story of Dralon begins (see the chapter beginning on page 334).



this product consisted of short stretches of filament and had to be spun. The picture at the top of the page shows an operator at a Cuprama spinning machine.

A successful product evolves from waste

Not so very long ago the predominant shade of European cities was gray. Today, cities are much more colorful. The development which began in 1926 would culminate in Bayer becoming the world's largest manufacturer of inorganic pigments.

Since the beginning of the century, the Uerdingen works, then still "Chemische Fabriken vorm. Weilert-ter Meer," had been making aniline from nitrobenzene by reduction with iron filings. A dark-brown iron oxide sludge—a nuisance in both economic and environmental terms—resulted as a by-product. Chemist Julius Laux decided to take a closer look at the sludge to see whether it could be of any use and found that a modification of the production process would yield colored pigments. He took out a number of corresponding patents, and the manufacture of iron oxide pigments began in Uerdingen in 1926.

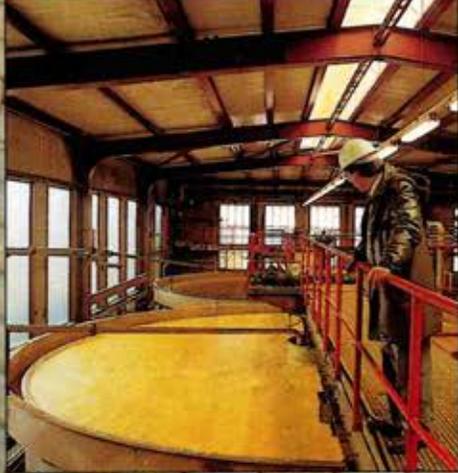
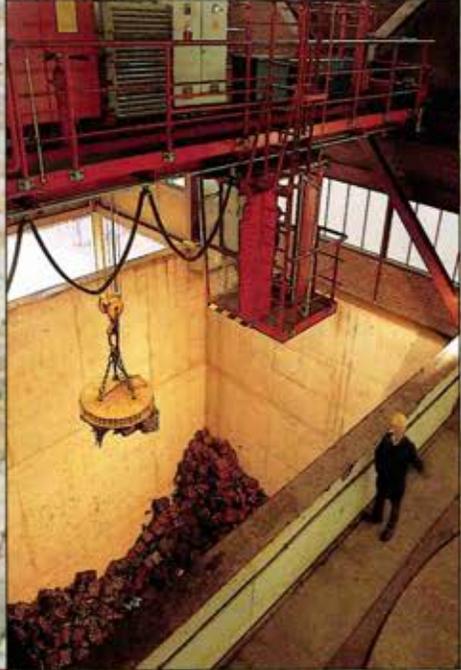
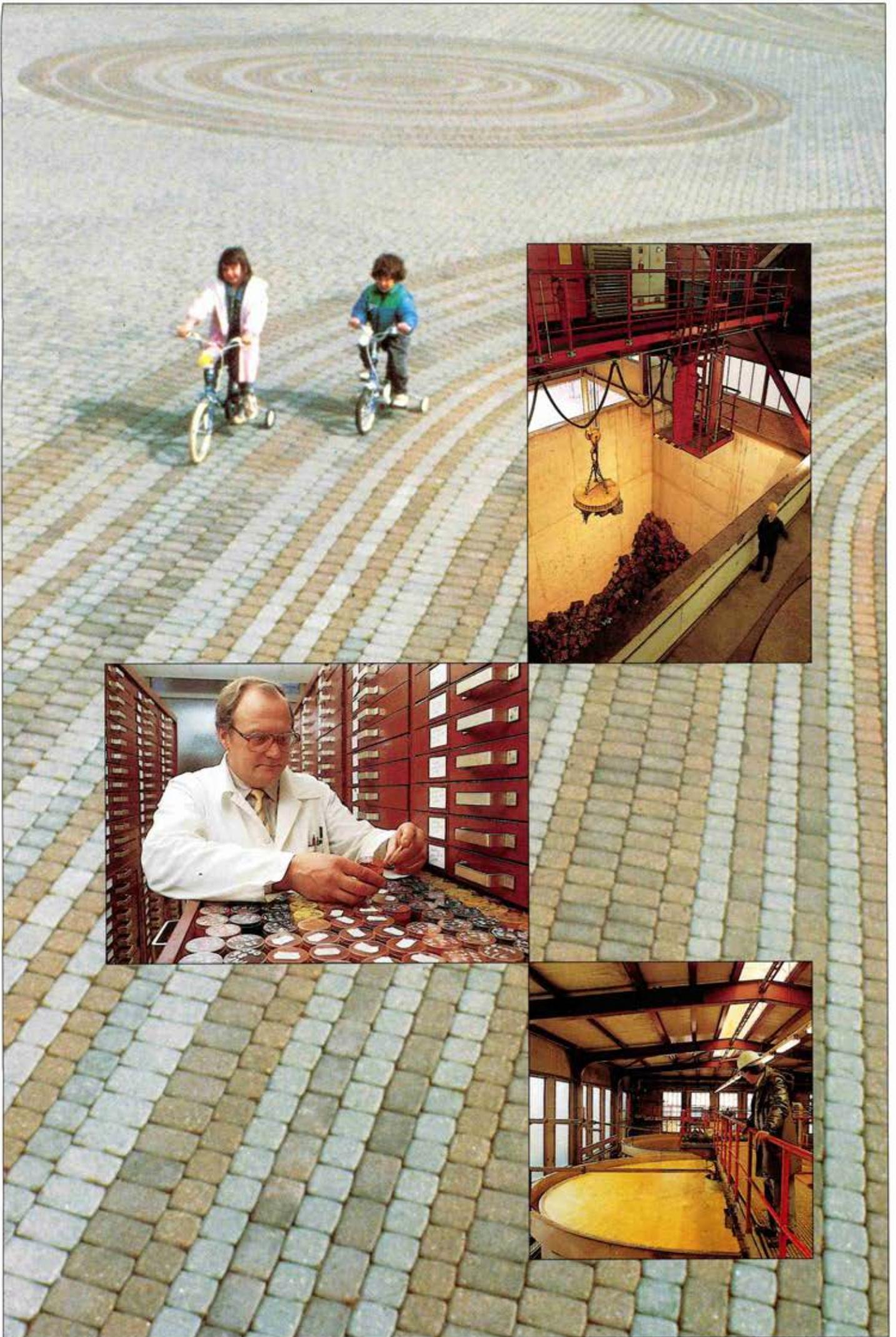
These patents were extended by Ulrich Haberland, later to be chairman of Bayer's Board of Management, and other chemists. They discovered red, brown, yellow and black pigments. After a few years, the aniline process was altered when it was found that aniline could be made better without iron. But in the meantime, iron oxide pigments had become a product group in their own right. To this day, Bayer has continued to use the old process as well as the new one in order to obtain raw materials for pigments.

Iron oxides obtained by the aniline process are not the only basis for inorganic colors; certain pigments are also produced by precipitating iron salt solutions. What was once a question of waste utilization is now a complex manufacturing operation.

Inorganic pigments have over the years become important materials for the coloring of such construction materials as limestone, paving and roofing tiles and concrete because they are insoluble in water and resistant against light and weather. An admixture containing as little as five percent of iron oxide pigments is enough to add an attractive shading to the gray or white of conventional building materials. The color intensity depends on the degree of the pigment's fineness; granular sizes can vary between one-thousandth to one ten-thousandth of a millimeter. The characteristics of the base—cement, concrete or bitumen—also play an important role. The company's iron oxide pigments have become widely known under the trade name of Bayferrox and are

What was once useless waste now beautifies our cities. Julius Laux discovered a way to produce pigments from dark-brown iron oxide sludge. Scrap iron, which is required in large quantities, constitutes an important basis for this process.

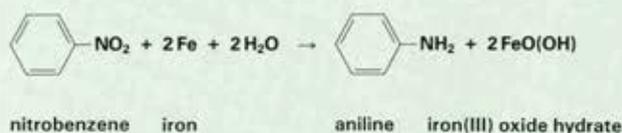
Samples are taken of every batch of pigments produced and are "filed away" while the next batch is waiting in large tanks for the drying treatment.



Inorganic variegated pigments

The origins of industrial-scale manufacture of iron oxide pigments are found in the use of iron as a reducing agent in the production of aniline from nitrobenzene:

In the yellow FeO(OH) on the right side of the formula, the iron is trivalent. However, iron can also occur as a pure oxide, Fe_2O_3 .



It is then red-brown, which gives rust its characteristic color. In black Fe_3O_4 , which occurs in nature as magnetite, both bivalent and trivalent iron atoms are present, a reason for the dark color.

The iron oxide resulting from the production of aniline can form either as FeO(OH) or as Fe_3O_4 , depending on the process.

Variations in the processes were worked out in order to obtain different kinds of color pigments. Thus, the composition, water content and particle size of the resultant iron oxides could be modified. The different shades are attained after filtering-off and subsequent drying or calcination.

When iron(II) salt solutions are treated with alkaline reagents, initially colorless Fe(OH)_2 is produced, which is then rapidly converted by air oxidation into hydroxides with iron of a higher valence. This is the principle behind a process for the production of yellow pigments of the type FeO(OH) .

Chromium is used in the pigment range in the form of green chromium oxide, Cr_2O_3 .

Bayer's brilliant cadmium pigments were based on cadmium sulfide, CdS , and cadmium selenide, CdSe , or mixtures of the two.

Manganese blue consists of mixed crystals of barium sulfate, BaSO_4 , and barium manganate, BaMnO_4 .



available today in a range of 250 different shades. The idea of the "colorful city" took some time to be accepted, but now it is highly unlikely that developers would disregard this aesthetic potential. Road surfaces and sidewalks, for example, can be designed in a plain color or an attractive pattern. Paving stones can be colored to match the surroundings, or to delineate traffic control signs. Sports tracks can be laid out with weatherproof, colored material instead of ash or brick dust.

The unexpected success of its oxide pigments encouraged the company to try to introduce colors other than the existing shades of black, brown, red, beige or yellow obtainable from an iron base. By the end of the 1920s, Bayer had already expanded the program to include green chromium oxide pigments. For a while, bright orange and red cadmium pigments also belonged to the company's colorful product range, and manganese blue was subsequently added.

Color pigments became an essential additive not only for applications in building materials, paints and lacquers, but also for the plastics industry. The range was further enlarged by specially developed

Samples from the production unit are sent to the application technology laboratory where their composition and quality are analyzed.





pigments for the coloring of enamel and ceramic products.

But even the most colorful of programs would be incomplete without a good topcoat white. In this case, production began as early as 1908 with the processing of waste zinc lye, first into carbonate and then zinc sulfide lithopones—yet another example of putting a waste product to good use. In 1957, titanium dioxide was introduced as “the whitest of whites” and was practically an immediate success; its story can be found beginning on page 362.

The Uerdingen plant alone has reached a leading position in the field of pigment colors. Since large-scale production also began at its subsidiary Mobay in the United States, Bayer has become one of the world’s biggest manufacturers of inorganic pigments. And it all started with an annoying by-product.



Bayer chronicle 1926

Synthetic rubber research is resumed.

In China, Bayer starts publication of a medical journal with a circulation of 19,000.

In downtown Milan, the Bayer agency Cofa is opened as a cooperation with an Italian partner.

An annual bonus for all employees is introduced.

World events 1926

Crown Prince Hirohito becomes Emperor of Japan.

Seven heavy industrial firms in Rhineland-Westphalia set up the Vereinigten Stahlwerke AG with a total of 200,000 employees. Daimler and Benz merge. Deutsche Lufthansa is formed by the amalgamation of Junkers Luftverkehrs AG and Aero Lloyd AG.

Construction begins of a major I.G. Farben facility in Leuna for the hydrogenation of coal.

The I.G. Farbenindustrie merges with Köln-Rottweil AG and signs a common-interest agreement with Dynamit Nobel AG.

Physicist Robert Goddard launches the first liquid-fuel rocket in Auburn, Mass., on March 16.

Walt Disney’s Mickey Mouse captivates the world and the black dancer Josephine Baker takes Europe by storm.

Baron Jakob Johann von Uexküll sets up the first Institute for Environmental Research at the university in Hamburg.

Germany’s industrial standard specifications are introduced under the acronym DIN.

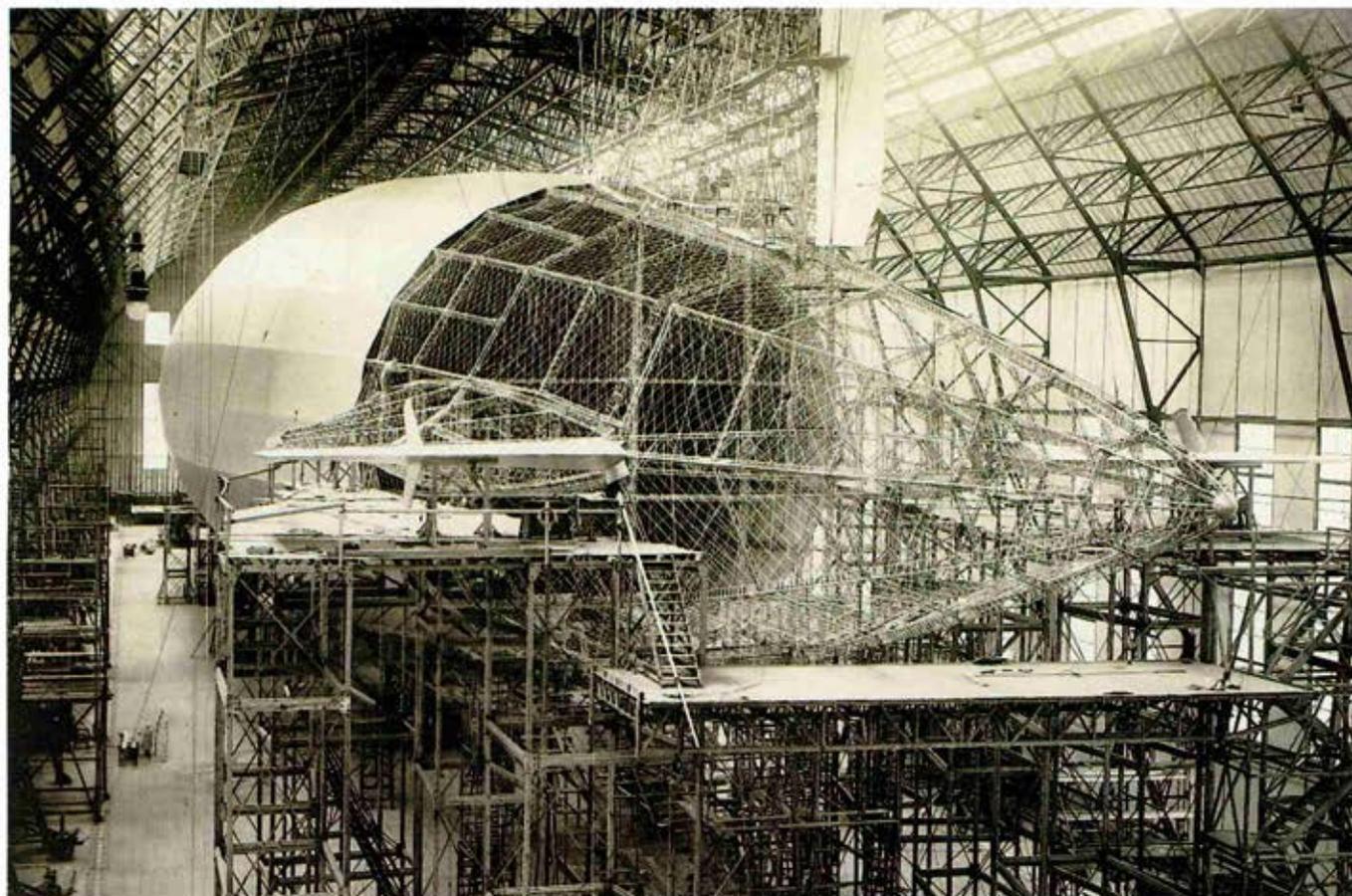
A new chapter opens in the development of coating raw materials

On April 26, 1927, the Uerdingen unit of I.G. Farben registered its so-called “transesterification” patent. This marked a new chapter in the history of coating raw materials, which today form a Business Group of their own within Bayer.

Man has used coatings for thousands of years. As was the case with silk and porcelain, lacquers for artistic applications first showed up in China. In the second millennium B.C., religious and household utensils, such as teacups and boxes, were varnished with the resin of the *Rhus vernicifera* tree. When dried in the air, this coating was heat-, acid- and alkali-resistant and had a lasting shine. Applied in several layers of different colors, the varnish was used as a base for japanning. The lacquers were so durable that 2,000-year-old objects have been found which have totally rotted from within but whose coatings have remained intact. In the 17th and 18th centuries, varnished objects d’art from China and Japan became popular imports into Europe.

Lacquers and paints, wherever they are used, have two purposes: to ornament and to preserve. How well they perform the latter job is shown by the fact that ancient Egyptian and Greek temples have still kept some of their original colors, while mummies have also remained unimpaired—thanks to the saturation of their bandages with resin solutions. We can even read in the Gilgamesh epic or the Book of Genesis how a ship (Noah’s Ark in the Bible) was protected against the Deluge by a triple layer of bitumen.

Since the varnish resin itself could not be transported from East Asia to Europe—it would have become hard as a rock during the journey—people began to consider how lacquers could be made. The use of drying oils and the addition of agents to speed up the drying process were discovered quite early. As long ago as 1685, a vessel was mentioned in which such resins as colophonium (pine resin), gum mastic or amber could be melted out or linseed oil could be boiled down to a more viscous bodied oil. In 1730, the Martin brothers in Paris developed their “vernish Martin,” which was to go down in art history. During the rococo period, Europeans had a craze for varnishing just about everything from furniture and coaches to snuff boxes and walking sticks. But the varnish itself remained a luxury because its raw material was so expensive.



At the turn of this century, scientists of the chemical industry were finally able to produce resins equal in quality to the natural product from Asia—and at the same time, cheaper and easier to process. Bayer started producing coating raw materials before World War I under the name Cellit, a product which has already been mentioned. It had turned out that cellulose esters could not only be used for making films and, later, acetate rayon, they also proved serviceable raw materials for such coatings as those used to paint airplane fuselages.

In 1910, the Albatros-Werke launched a line of varnishes for aircraft and airships on the basis of Bayer's Cellit. In 1917, Bayer itself hired a chemist whose sole task was to adapt Cellit as a coating material.

The company did not stop at Cellit. In 1926, the Uerdingen plant noticed that certain quantities of benzoic acid, long known as a food preservative, were being purchased by the coatings industry. Looking for the reason, they stumbled across the patent of a varnish manufacturer in Godesberg who had discovered that benzoic acid, used together with zinc oxide in oil varnishes, had the surprising

property of working as a flow improver; the result was that oil paints could be applied without the brush strokes being visible.

I.G. Farben tried in vain to buy the patent rights and in the end, set out to reach the same goal by different means. In Ludwigshafen, it was discovered that certain semiesters of phthalic acid had almost the same effect when used in coatings. However, these solidified too rapidly and tended to form crystals.

At the same time, phthalic acid was the subject of different experiments in Uerdingen, where chemists were trying to find faster-drying oil paints. The answer lay in the transesterification of linseed oil with glycerol and phthalic anhydride. A new group of coating raw materials had been created: the alkyd resins. Air-drying coatings of this type dried much faster than existing products.

The first of these resins came on the market in 1929 with the trade name of Alkydal. In a wide range of variations, alkyd resins became the base material for numerous varnishing systems: air-drying, heat-drying, for industrial and later also for many do-it-yourself purposes, for lacquering or re-spraying

The above picture shows what today would seem an unusual use for Bayer's Cellit coatings: in the heyday of airships, they were applied to seal and finish the fuselage of the blimps. As it dried, the coating contracted to form a water-tight, protective film over the fabric.

in the automobile industry, for furniture varnishing and for anticorrosion coatings.

But first Uerdingen was faced with an unpleasant surprise; only six weeks before its patent application had been registered, the American company General Electric had registered a similar one for a product called Glyptal. It turned out that the patents were complementary rather than identical and the two companies agreed to a mutual licensing arrangement.

In 1930, Uerdingen produced only a few tons of Alkydal per month. This rose to 80 metric tons by 1932 and reached the 1,000-ton per month level by 1939. Today, Uerdingen is the biggest manufacturer of alkyd resins on the European continent and has a sales program of 50 basic types.

But the chemists did not just rest on their laurels once they had modified natural oils. They soon started to consider possible chemical transformations of other natural substances and in the 1930s succeeded in chlorinating natural rubber. A chlorinated rubber was put on the market under the trade name Pergut in 1932, and it is still an important product in Bayer's range of coating raw materials. The heavy-duty protective coatings made from Pergut soon proved so good that in 1936, Hercules Powder of Wilmington, Delaware, acquired a license for the manufacture of chlorinated rubber in the United States.



New compounds are constantly being put to the test in the Leverkusen pilot plant for coatings. In this picture an expert is using a magnifying glass to examine the surface of a freshly lacquered car body.

Bayer chronicle 1927

Plasmochin, the first synthetic antimalarial drug, is introduced to the market after having been discovered in 1924. Vigantol is marketed as a treatment for rickets.

The I.G. Farbenindustrie sets up the Titangesellschaft mbH in Leverkusen as a joint venture with the National Lead Company of the United States.

Agrochemical sales are centralized in Leverkusen; technical service units for the agricultural industry are set up in Münster, Frankfurt on the Main and Munich.

The various Japanese sales companies of I.G. Farben are amalgamated to form "Bayer" Yakuhi Gomei Kaisha.

Bayer chronicle 1928

Every six months a waste water analysis comprising 29 components is performed on behalf of the Cologne water authority.

Supranol, which makes wool dyestuffs resistant against seawater, is introduced to the market.

On November 15, I.G. Farben signs a dyestuff sales agreement with the French dyestuffs industry.

World events 1927

On May 20 and 21, 25-year-old American mail pilot Charles Lindbergh flies the Atlantic solo and without radio in the single-engined "Spirit of St. Louis."

Statutory unemployment insurance is introduced in Germany.

On April 1, the world's first major pilot plant for coal hydrogenation opens in Leuna.

Werner Heisenberg, the so-called Father of Quantum Mechanics, formulates the uncertainty relations theory, which states that it is impossible to measure the position and the momentum of a subatomic particle simultaneously.

World events 1928

New election law is introduced in Italy with a single list of candidates representing the Fascist Party.

On August 27, fifteen nations meet in Paris to denounce war as a means of realizing politics. The agreement is named the Briand-Kellogg Pact after the foreign secretaries of France and the United States.

Alexander Fleming discovers penicillin.

Buna is a triumph of chemical research

Buna was originally nothing but a simple trade name, formed from the first two letters each of butadiene and "Natrium" (the German word for sodium). Ultimately, it came to symbolize chemical innovation at its best. But the road to success was filled with many obstacles and setbacks.

In 1919, the production of synthetic rubber in Leverkusen had been given up "for good." Neither its quality nor its price could compete with the natural product. After the First World War, a glut of natural rubber on the world market led to a dramatic fall in its price. This prompted the United Kingdom, the Netherlands and France to develop a restrictive policy to protect the interests of their colonial rubber planters. Limitations were imposed on latex tapping, no new plantations were to be established and existing ones were not to be expanded. In fact, this so-called "Stevenson Plan" soon proved unnecessary. With rapid motorization, demand skyrocketed; by 1926, the price had bounced back from originally less than three Reichsmarks to six per kilogram.

In the meantime, chemists in Hoechst and Ludwigshafen had discovered new and cheaper ways to produce butadiene, a key raw material for synthetic rubber. For this reason, I.G. Farben resumed its research work on synthetic rubber in May of 1926.

For the polymerization of butadiene, the company first turned to a discovery patented by F.E. Matthews and E.H. Strange back in 1910. They had shown that sodium metal was an effective catalyst.

I.G. Farben did manage to polymerize butadiene with sodium to obtain a product similar to rubber, but when processed, it proved to have properties that were far from satisfactory.

In Leverkusen, development work was first made the responsibility of Eduard Tschunkur and his assistant Walter Bock from the "A" plant. The initial step of the two chemists was to alter the polymerization conditions of the butadiene by perfecting a process, already developed both there and in Ludwigshafen, for working with different catalysts in aqueous emulsions.

The second step towards a technological breakthrough, in which Walter Bock was particularly instrumental, was the copolymerization of butadiene and styrene. This process resulted in a rubber which seemed equally suitable for use in tires and technical rubber goods and, in some respects, was

superior to the natural product. On June 21, 1929, the copolymerization of butadiene and styrene was patented. On July 5 of the following year, "Buna" was registered in Germany as a trademark of the I.G. Farbenindustrie.

This discovery was far from being a solution to all outstanding problems. Polymerization had to be speeded up, processing had to be simplified and quality had to be improved. After all, if styrene worked as a polymerization component, other unsaturated compounds could be tried out, too. Once again, Ludwigshafen and Leverkusen were the centers for the most significant research work.

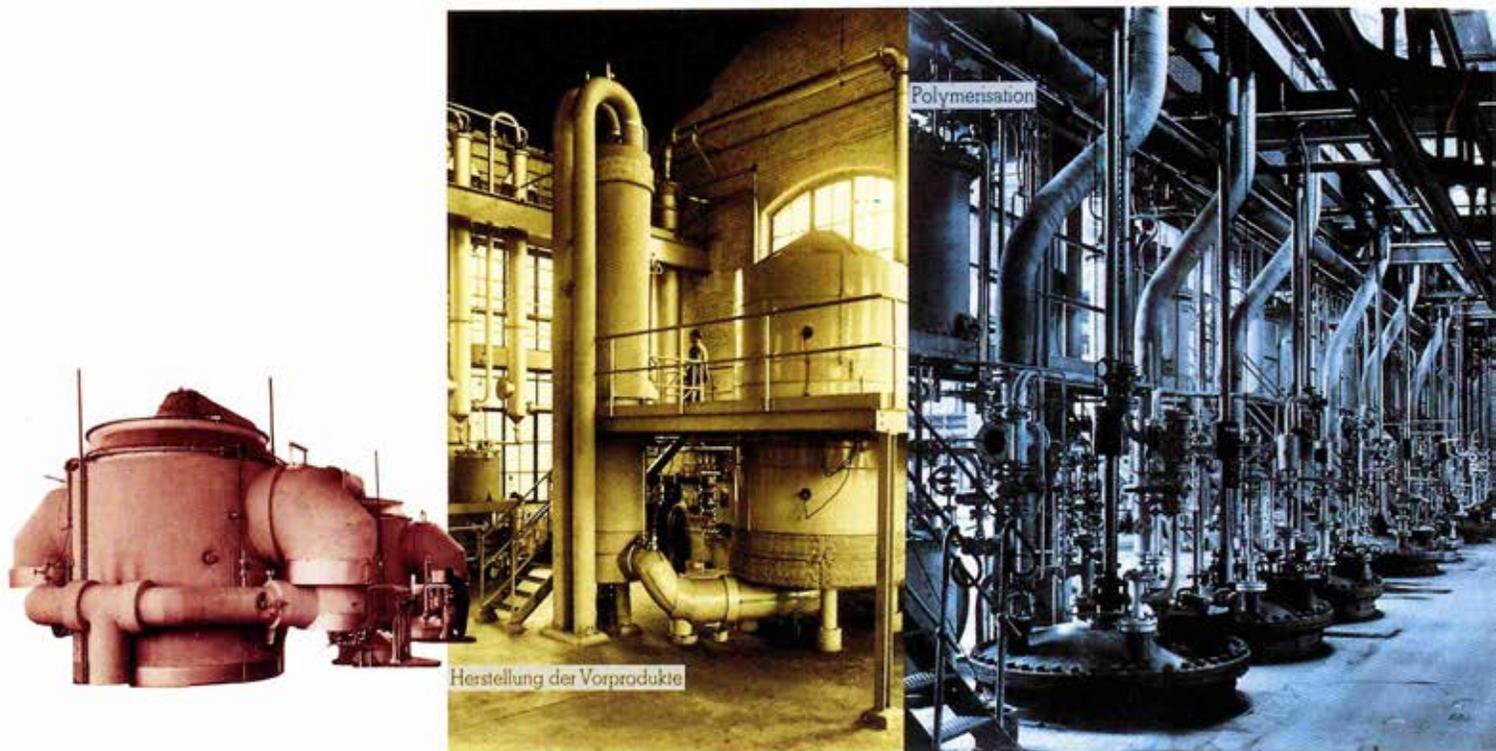
In Leverkusen, the research team was headed by Helmut Kleiner and included Tschunkur and Erich Konrad, who was to become the head of I.G. Farben's Central Rubber Laboratory and was largely responsible for the resumption and development of Farbenfabriken Bayer's postwar activities in the field of synthetic rubber.

Kleiner's team tested a number of possible polymerization components, including acrylic derivatives,

and hit the jackpot with acrylonitrile. Their work led to the invention of nitrile rubber, which was patented on April 26, 1930.

This product had the particular advantage of being resistant to both oil and gasoline, which enabled it to carve out a market despite its high price. Under the name of "Buna N," it was not only the first of the so-called "letter Bunas," as copolymers were known, but also the first commercial synthetic rubber. In 1938, it was renamed "Perbunan N." Incorporating types which have been improved again and again over the years, this particular variety is still one of the most important specialty product lines in Bayer's Rubber Group.

Unfortunately, severe economic difficulties followed the technological triumph. The restrictions of 1926 had been dropped, the Depression started and the price for natural rubber hit rock bottom. By 1932, it was selling for no more than 30 pfennig per kilogram. It was quite understandable that there was very little interest in the much more expensive synthetic product.



It took them a long time to get there, but in 1929, Bayer chemists finally succeeded in producing a synthetic rubber suitable for automobile tires and technical rubber goods: Buna.

An album of photographs prepared for the International Automobile Exhibition of 1936 shows the phases of production.

It begins with the copolymerization of butadiene and styrene to yield a substance with long, elastic chain molecules.

In 1929, I.G. Farben had intended to build a large pilot plant in Knapsack, near Cologne, at a cost of RM 2.8 million. Although this was only a modest sum compared with most of I.G. Farben's investments, it had to be scrapped.

In the following year development work on synthetic rubber was stopped for the second time. Unfortunately, this decision came at a time when it seemed like things were really moving. Only a small group of researchers continued work, and their job was simply to keep track of other scientific developments in this field. Saving money was the most important priority of the day.

The political circumstances of 1933 changed the situation completely. Germany now wanted to be independent of important raw materials; therefore, synthetic rubber was needed once more. Research and development work received a new boost.

Erich Konrad was in charge of work in the field of "letter Buna" in Leverkusen. In 1935, scientists recognized that the copolymer "Buna S" made out of styrene and butadiene was the most promising

synthetic rubber type for tire manufacturers. Tests proved that Buna tires could run for 35,000 kilometers, as compared with a life of 28,000 kilometers for tires made of natural rubber. "Buna S" was therefore specifically developed for use by the automobile industry. At the 1936 Berlin Motor Show, its initial triumphs were greeted with a fanfare; the press hailed "Buna, Germany's synthetic rubber" as a technical sensation. In fact, this reaction turned out to be slightly overenthusiastic, since it was not until the following year that a pilot plant opened at Schkopau near Halle.

Schkopau had been chosen as a location since I.G. Farben already had an integrated raw material and energy network in central Germany. Even with all of the advantages for the production side of operations, it was still not smooth sailing. Processing of "Buna S" took eight times longer than that of natural rubber. Obviously, something had to be done to counteract this disadvantage. An important step in this direction was the discovery in 1937 that the processibility of "Buna S" could be significantly improved.



The raw material for synthetic rubber is pulverized and rolled into so-called rough sheets. They are the starting materials for the processing industry. In former times, these sheets used to be wrapped in jute sacks for shipment.

To this day, the mechanical properties and dynamic behavior of the raw materials are examined in Bayer's testing laboratories. Over the years, various kinds of Buna products have been developed, all of which are based on

In 1938, the Central Rubber Laboratory was opened in Leverkusen to coordinate all I.G. Farben research and development work in the field of synthetic rubber and rubber chemicals. With its rubber testing unit, experimental section for tires and excellent equipment, Konrad's laboratory was for those days scientifically and technically unique.

The expansion of the synthetic rubber industry resulted from the influence of political as well as economic factors. The German government demanded the accelerated construction of high-capacity plants as part of its self-sufficiency policy.

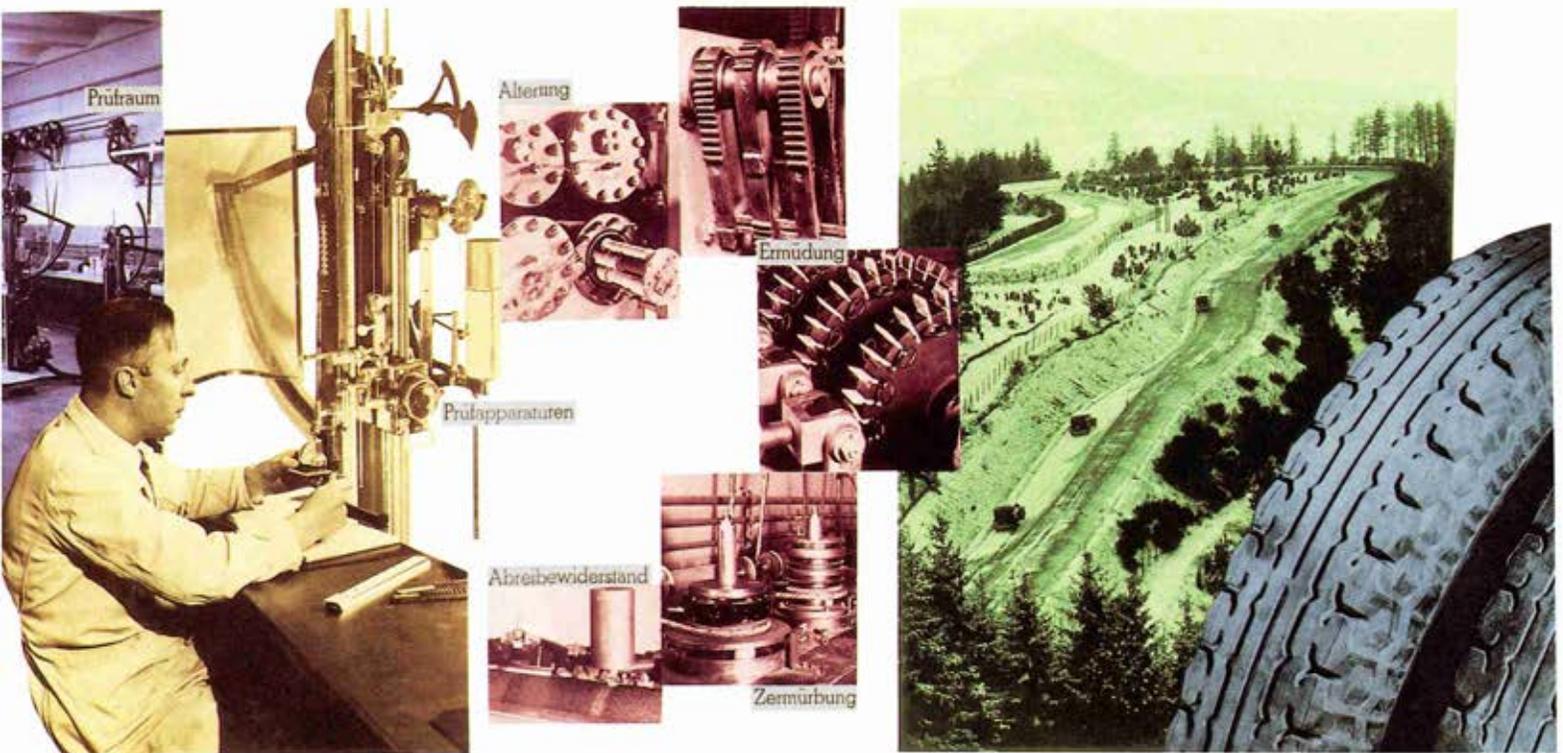
The Four-Year Plan which Germany launched in 1936 provided for the building of four major synthetic rubber facilities, whereby the goal of 170,000 annual metric tons was never reached because of the exigencies of war. Production peaked at some 119,000 tons in 1943.

When the war in the Pacific cut the Allies off from the most important suppliers of natural rubber in 1941, the U.S. government decided to spend \$750 million on its own rubber plants. By 1945, output had

reached 820,000 metric tons—or seven times that of I.G. Farben. Most of this was in the form of "Government Rubber Styrene," a modification of "Buna S." The American rubber program was thus indirectly based on the 1929 invention in Leverkusen, which finally established the synthetic product as the leading raw material for tire production.

At the end of the war, the Allies banned synthetic rubber production and research in Germany. This ban was subsequently eased in 1951. More details about the development of Buna will be given in a chapter later on in this book.

In recognition of his role in the development of Buna, Leverkusen chemist Walter Bock has been included since 1979 among those scientists honored in the Hall of Fame of one of the leading rubber processing companies, General Tire, with its headquarters in Akron, Ohio.



butadiene-styrene copolymerization. With new and improved types constantly being introduced, this range still belongs to the most important group of specialty products within the Rubber Business Group.

Tires were made with the new Buna material and tested for robustness on the Nürburgring racing course in Germany. When it was shown that Buna had proved itself in tire applications, the company was finally convinced of its future success.

The Great Depression and its disastrous consequences

Thursday, October 25, 1929, has gone down in German history as "Black Friday." On this day, the prices on the New York Stock Exchange fell as much as 90 percent. Within five days losses totaled 50 billion dollars. The world plunged into an economic crisis.

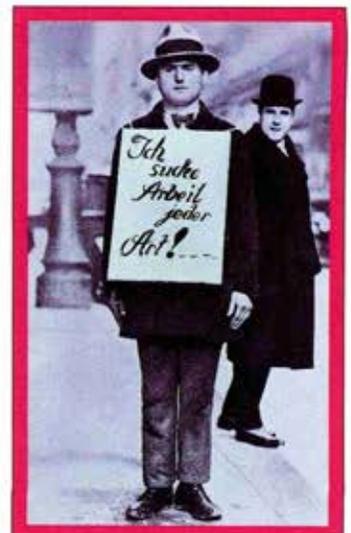
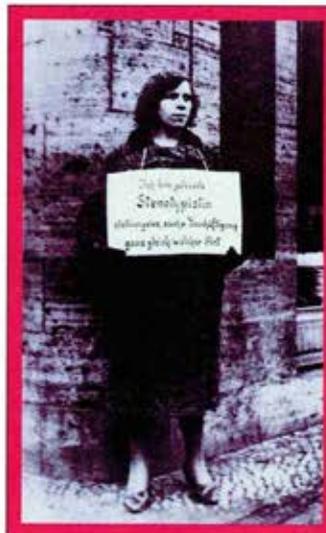
The economic sunshine in which the world had been bathing in 1929 had long been a delusion. Agriculture and industry had suddenly realized that the postwar boom which had led to years of prosperity was over. Many of the profit forecasts turned out to be grossly exaggerated. Large and small companies alike were faced with difficulties.

I.G. Farben tried to help matters by instituting a ban on recruitment and introducing a five-day workweek, in addition to early retirement programs. It was hoped that these measures would at least keep the existing personnel at work. In spite of this effort, the labor force of the Lower Rhine Division shrank by about one-fourth, from 16,600 to 12,500, between 1929 and the end of 1932. This figure must be compared with the 45-percent decline for I.G. Farben as a whole.

The former Bayer organization had already been streamlined before the merger took place and therefore was not faced with the same number of crisis dismissals. Cuts in investment and research budgets also caused serious repercussions on the company as a whole, affecting not only the synthetic rubber division but also synthetic fibers and the mineral oil synthesis project.

The crash led to massive worldwide unemployment. Even in the so-called "golden twenties," there had been about a million jobless in Germany, but now the unemployment figure shot up to 5,966,000 by the end of 1932. And this showed only part of the picture; a further 2.8 million welfare recipients who no longer received unemployment insurance had to be added to this amount. In fact, almost one-half of the active population was without paid employment.

Short-time work was common, and only a minority of the workforce took home regular wages.



This meant the second economic and social disaster for the country after the inflation crisis of 1922 and 1923.

The Depression reached its lowest point in the summer of 1932. By then, industrial output had fallen worldwide by 28 percent in comparison with 1929; this rate of decline reached 46 percent in the United States and 42 percent in Germany. German exports had dropped by 57 percent over the same period. Because of its strong position on world markets, I.G. Farben did not suffer as badly as most. Losses in such businesses as nitrogen fertilizers, fibers and mineral oil products were offset by profits from other operations.

The Great Depression also had far-reaching political consequences. The economic chaos and the despair of millions of people spurred the rise of radicalism. Within just a few years, the National Socialist Party of Germany was able to become the strongest party in parliament.

In 1928, the Nazis had obtained only 810,000 votes, or 2.6 percent of the whole, and a total of 12 parliamentary seats. On September 14, 1930, this jumped to 6.4 million votes and 107 seats. In the July elections two years later, the Nazis received 13.7 million votes, entitling them to 230 seats; thus they surpassed the Social Democrats as the biggest single party in Germany.

I.G. Farben had serious misgivings about the Nazis and their "Führer." As Chairman of the Supervisory Board, Carl Duisberg organized support in German business circles for the re-election of President Hindenburg in the spring of 1932. He not only supported the Weimar Republic, but openly opposed Hitler.

Carl Bosch, I.G. Farben's Chairman of the Board of Management, criticized the self-sufficiency policy because he saw it as a threat to the company's commitment to a world market presence. At the Shareholder's General Meeting in May 1932, Bosch argued that the urgently needed recovery of the world economy could only be achieved by re-establishing confidence in international politics.

The international Depression brought with it a rapid rise in the number of unemployed. Destitution meant that many of the jobless went into the streets to look for at least temporary work (left).

Bayer chronicle 1929

Dry seed dressing Ceresan is put on the market. Despite a relatively low mercury content, it is more effective than any other mercury compound tested up until this time.

A Bayer treatment for bilharziosis is successfully tested in Egypt. It is named Fuadin in honor of King Fuad.

Neostibosan is introduced to the market as a treatment for tropical diseases transmitted by flagellates, such as black fever.

The I.G. Farbenindustrie enters the field of synthetic detergents with its Igepon A.

Behring-Werke in Marburg on the Lahn, a producer of high-quality low-protein vaccines against diphtheria and tetanus, becomes part of I.G. Farben's Central Rhine Division.

Agfa and Gevaert develop the necessary negative materials for talking pictures.

World events 1929

The I.G. Farbenindustrie AG receives RM 21.1 million as compensation for confiscation on the basis of a law freeing German property in the United States.

The Vatican is created as a sovereign state by the Lateran Treaty signed between Pope Pius XI and the Italian government.

The airship "Graf Zeppelin" (photo) flies around the world (25,000 miles).



Hermann Knaus and Kiusako Ogino independently and simultaneously discover the female fertility cycle and give their names jointly to the Knaus-Ogino birth-control method.

The first "Oscars" are awarded in Hollywood.

Herbert Hoover receives the White House's first desk telephone on March 27. Until now, the president had had to make calls from a booth outside the Oval Office.

A new way of tanning for the leather industry

With its Tanigan supra LL, Bayer's chemists created the first synthetic light-proof tanning agent in 1930. It not only had the properties of conventional natural tannins, but also produced a pure-white leather that was stable to light. So began the steady expansion of leather chemicals in Leverkusen.



Leather is animal skin, but animal skin is not leather. Leather is supple, durable and water repellent; it "breathes" and has various other desirable attributes, all of which have been chemically enhanced in one way or another.

Up until the beginning of the 18th century, tanning was done almost exclusively in small craft businesses. In later years, leather factories emerged as a result of the growth in population and the rising demand for saddlers' goods and leather shoes. In the tanning process, skins were treated with natural tannins found in tree bark, wood, plants and fruit.

An adequate supply of leather could only be attained if ways could be found to speed up the tanning process. Two inventions were of great importance in achieving this goal: the rotary tanning vat and the chrome tanning process. In 1858, German Friedrich Knapp had discovered the tanning properties of chromium salt solutions on animal skin. There was certainly no lack of the necessary chromium salts. The dyestuff manufacturers needed bichromates for a large number of oxidation processes, such as those used in the production of anthraquinone from anthracene. Chromium salt solutions were an unwelcome by-product which was not easily disposed of. The introduction of the new tanning method meant that the waste lye could be used as a base for curing salts.

A small leather dyeing unit had been set up in Elberfeld back in 1911, and it eventually became the company's Leather Department. After the First World War, Bayer added chrome tanning agents to the dyestuffs it had already been selling to the leather industry.

As yet a method had not been found to replace the time-consuming process of treating heavier leathers with vegetable tannins. The chemical industry had looked for alternatives to tanner's bark, chestnut extract and quebracho but still had not discovered a synthetic substitute.

In 1930, Bayer solved the problem with its Tanigan supra LL. Apart from its basic tanning properties, this agent produced a white, light-resistant leather.

Scientists in Elberfeld started working on the production of leather dyestuffs as early as 1911. Tanners were soon offered a wide range of dyestuffs and finishing materials. The picture shows a brochure aimed at the Dutch leather industry.



The whiteness was an important advantage because leathers tanned with vegetable extracts or chromium salts had a color of their own that could be turned into white only through secondary treatment with a finishing lacquer.

Bayer went on to add products derived from other chemical bases to its program of synthetic replacement tannins. At the same time, the firm rounded off its assortment of finishing agents, such as the Eukanol and Baykanol range of primers and dyestuffs. After *Farbenfabriken Bayer* was reestablished in 1951, the company was thus able to offer a wide program of chemicals to meet all the needs of the resurgent leather industry. Exports also got started again.

In the early 1950s, the tanners found themselves with a number of new processes and products at their disposal. Bayer was ready to move with the changing market. Its first step was to adopt the American principle of secondary resin tanning; the *Retingan* range was the result. Secondary curing allows the color of plant- or chrome-tanned leathers to be lightened while, at the same time, influencing the properties of their texture.

Chrome tanning was to develop into the predominant process and today accounts for more than

90 percent of all leather production. The former replacement or integral tannins have become secondary treatment agents, so that the most diverse types of leather can now be made with the help of an unprecedented choice of products and processes.

At the end of the 1950s, Bayer's Leather Department developed a new form of chrome tanning that was to simplify tannery operations considerably. In this process the undissolved tanning salts were fed straight into the tanning drum. By doing away with the time-consuming dissolving process and the subsequent "maturing" of the batch liquor, this process—made possible by the spray-drying of the chromium salt solutions to very fine and easily soluble powders—represented a substantial advantage for users.

Bayer also solved another serious problem that plagued tanners: how to get rid of liquid waste containing chromium because not all the chrome in the tanning batch had been absorbed by the hide. The necessary, additional treatment is difficult and costly. New *Baychrom* products, however, improved the efficiency of the process so much that less than 0.1 percent of chromium remained in the waste.

More recently, new developments have enabled the manufacture of totally new types of leather.

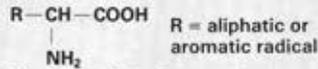
Raw leather needs intensive treatment before its valuable qualities come to light. The picture in the bottom left-hand corner above shows an old-fashioned paring-bench on which the tanners worked laboriously to remove hair roots and sebaceous glands with scrapers.

The large picture above shows the so-called "tanners' island" in Bayer's leather applications unit, where the completely depilated skins are tanned or dyed and dubbed. The tanner is removing a piece of leather from the open drum in order to judge its quality.

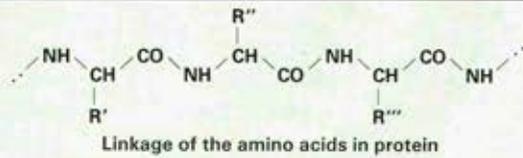
Synthetic tannins

Animal hide consists primarily of collagen. During water treatment other components, such as hair and epidermis, are removed. The fibrous collagen left is made up of albumen (protein).

Proteins are themselves composed of alpha-amino acids,



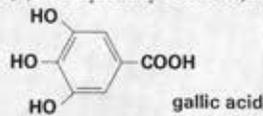
They are linked together in the form of acid amides:



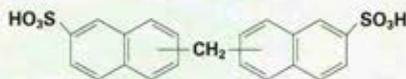
In collagen the protein chains are coiled up like corkscrews. The collagen mesh, no longer subject to the animal's metabolism, would soon rot due to biological decay if it were not chemically modified by the tannin molecules, which form bonds with its reactive groups.

Natural tannins are generally made up of polyphenols

such as condensates of gallic (3,4,5-trihydroxybenzoic) acid.



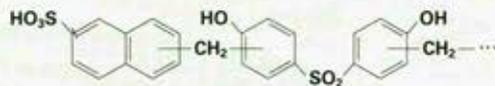
Auxiliary tannins, used to disperse the sludge formed by vegetable tanning liquors, are mainly condensates of beta-naphthalenesulfonic acid and formaldehyde.



Structural principle of an auxiliary tannin

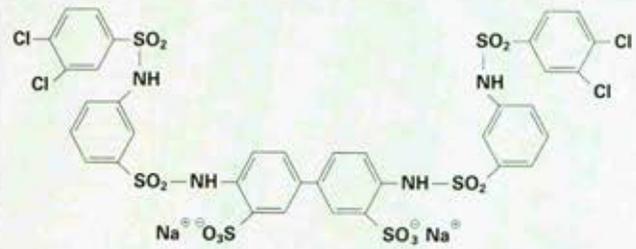
Synthetic replacement or integral tannins can be made by such processes as the co-condensation of 4,4'-dihydroxy-

diphenyl sulfone and beta-naphthalenesulfonic acid with formaldehyde.



Structural principle of a synthetic replacement tannin

Tanigan supra LL was a chemical exception. The product had the following exactly defined, complex formula:



Tanigan supra LL

Chrome tanning is based on the ability of chromium(III) ions to form very stable complex compounds. Some of the R radicals of the collagen's amino acids still contain active groups, for example, the carboxyl acid radical, $-\text{COO}^-$, which can join up with the Cr^{3+} .

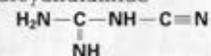
Neutral chromium salts like chromium sulfate show acid reaction in aqueous solution because the base $\text{Cr}(\text{OH})_3$ is very weak and sulfuric acid very strong. Hydrolysis leads to the formation of both basic salts and free acid, for example:



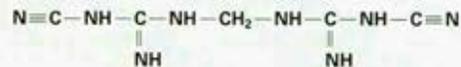
Hardly any tanning takes place in the acid phase, however, so the free acid has to be neutralized by alkaline agents. This normally involves the danger that insoluble $\text{Cr}(\text{OH})_3$ will be precipitated, a development which can be countered by the addition of suitable chelating agents. Not only is this the basis for conven-

tional chrome tanning but also for the improvements described in the text.

The secondary tanning with Retingan uses water-soluble condensates of dicyandiamide



and formaldehyde, as shown in the formula:



Structural principle of Retingan

One example is when natural leather is applied in polyurethane technology.

Natural hides are too thick for most applications and therefore have to be split. The resultant leather, so-called skiver, used to be employed primarily for the production of velour types. Bayer's Levacast process enables a much greater range of materials to be made from split leather. Using the company's silicone rubber, the natural grain of a leather is reproduced on a matrix. The components of a polyurethane substance are then sprayed on this reproduced surface bearing a negative of the leather grain.

The reaction mixture is initially liquid enough to spread over the silicone matrix before turning into a sort of gelatine consistency. The split leather itself is now pressed onto this viscous mass to join with it in a firm composition. After the silicone matrix is pulled off, a material is obtained whose outward appearance is similar to grain leather. This can be used for shoes, belts, bags and other consumer items.

The chemical industry has truly transformed tanning. It provides the wherewithal to turn animal hides into durable and attractive products—not only to be worn as our "second skins" but also to be used in a wide range of applications in modern, everyday life.



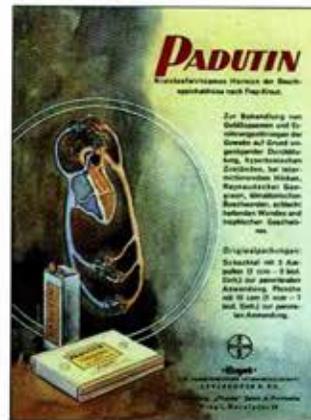
The Levacast process developed by Bayer gives a characteristic leather surface to the basically less attractive skiver. A tough and very durable material is obtained, which can be made into a wide range of products.



Bayer chronicle 1930

On April 1 the town of Wiesdorf is amalgamated with the townships of Bürrig, Rheindorf, Schlebusch and Steinbüchel to form Leverkusen. The new municipality has a population of 33,366.

First Rapidogen dyestuffs mark a step forward in cellulose-fiber printing. They reduce operational procedures, lower dyestuff consumption and have improved fastness.



Padutin, a pancreas hormone for treatment of circulatory disorders, is introduced by the Pharmaceutical Department.

Despite cost-cutting measures due to the Depression, I.G. Farben's Ludwigshafen unit starts the commercial-scale development of modern plastics, polyvinyl chloride and polystyrene.

World events 1930

General Primo de Riveras' military dictatorship in Spain is usurped. In Brazil, Gétulio Vargas seizes power with the help of the army and heads the government until 1945. In Austria, Prince Rüdiger von Starhemberg forms the Catholic-Fascist "Home Guards." During a court case involving the German military, Adolf Hitler swears to respect the Weimar Constitution.

The Allies end the occupation of the Rhineland. France begins with the construction of the Maginot Line on its eastern frontiers.

Norddeutsche Lloyd's "SS Europa" wins the blue ribbon, by crossing the North Atlantic in four days, 17 hours and six minutes.

First World Soccer Championship takes place in Montevideo; Uruguay beats Argentina in the final by four goals to two.

Max Schmeling becomes the first non-American world boxing champion in New York on June 12, after the disqualification of his opponent, Jack Sharkey.

Some 250 million people are now going to the cinema every week, 115 million of them in the United States alone. In Germany, the top filmstar is the English-born Lilian Harvey, known as the "Blonde Dream."

Plop, plop, fizz, fizz: the Alka-Seltzer story

In 1931, Dr. Miles Medical Company, Elkhart, Indiana, introduced a new product to the American market: Alka-Seltzer. In the meantime, this brand name has become well-known throughout the world—thanks not only to its efficacy, but also to a remarkable marketing effort.

Miles Inc., today a 100-percent subsidiary of Bayer, is a world leader in such important Business Groups of the Health Care Sector as diagnostics and biotechnology products. Miles itself is the subject of another chapter (see page 514). This is the story of the company's best-known product: Alka-Seltzer.

During the influenza epidemic that swept the United States in 1928 and 1929, Miles Chairman Andrew Hubble ("Hub") Beardsley went to see his friend, the editor-in-chief of the "Elkhart Truth." He was curious about the fact that at a time when a quarter of the Miles workforce was off sick and some U.S. firms had had to close down altogether, the newspaper was working at full strength. Editor Tom Keene explained to Beardsley that at the first symptoms of a cold, he gave his employees a dose of aspirin and bicarbonate of soda.

English chemist J. Maurice Treener had been working on a project to give Miles pharmaceuticals the form of water-soluble effervescent tablets since 1927. He was given the job of using this process to make a commercial product out of the newspaperman's household remedy. Treener succeeded. The resulting tablets were given the name "Alka-Seltzer" to illustrate their alkaline effect and the seltzer-like fizz. They provided relief in the case of colds, heartburn, stomachaches and various other aches and pains.

From the start, Alka-Seltzer was marketed as an over-the-counter product that needed no doctor's prescription. This meant that if the public was to choose the new product from the shelves, they had to know what it was and what it did.

Advertising and marketing were nothing new for Miles, which was already spending large sums on publicity campaigns. One of its most successful marketing ideas was the Miles Almanac, a useful booklet filled with a host of general-knowledge facts. These brochures appeared in English with a circulation in the millions—and also in the languages of immigrants to the United States—and were distributed through drugstores. Almost a billion almanacs were published between 1902 and

Alka-Seltzer, a product of Bayer's American subsidiary Miles in Elkhart, Indiana, originated as a household remedy of the former editor of the local newspaper "Elkhart Truth." When an influenza epidemic swept the area, he supplied his staff with a combi-

nation of aspirin and bicarbonate of soda. His people remained healthy. A chemist employed by Miles turned this recipe into what is still a highly successful product.



1942 when the publication fell victim to a wartime paper shortage. Newspaper, magazine and movie advertising also belonged to Miles' marketing program.

The company was now faced with the problem of how to publicize a completely new product. One method Miles chose was to advertise in newspapers that a free Alka-Seltzer drink was available at the neighborhood drugstore. Another approach was by the new medium of radio; not only did it reach even the most isolated areas, but also commercials could be presented in such a way that they couldn't be overlooked, as was frequently the case with newspaper ads.

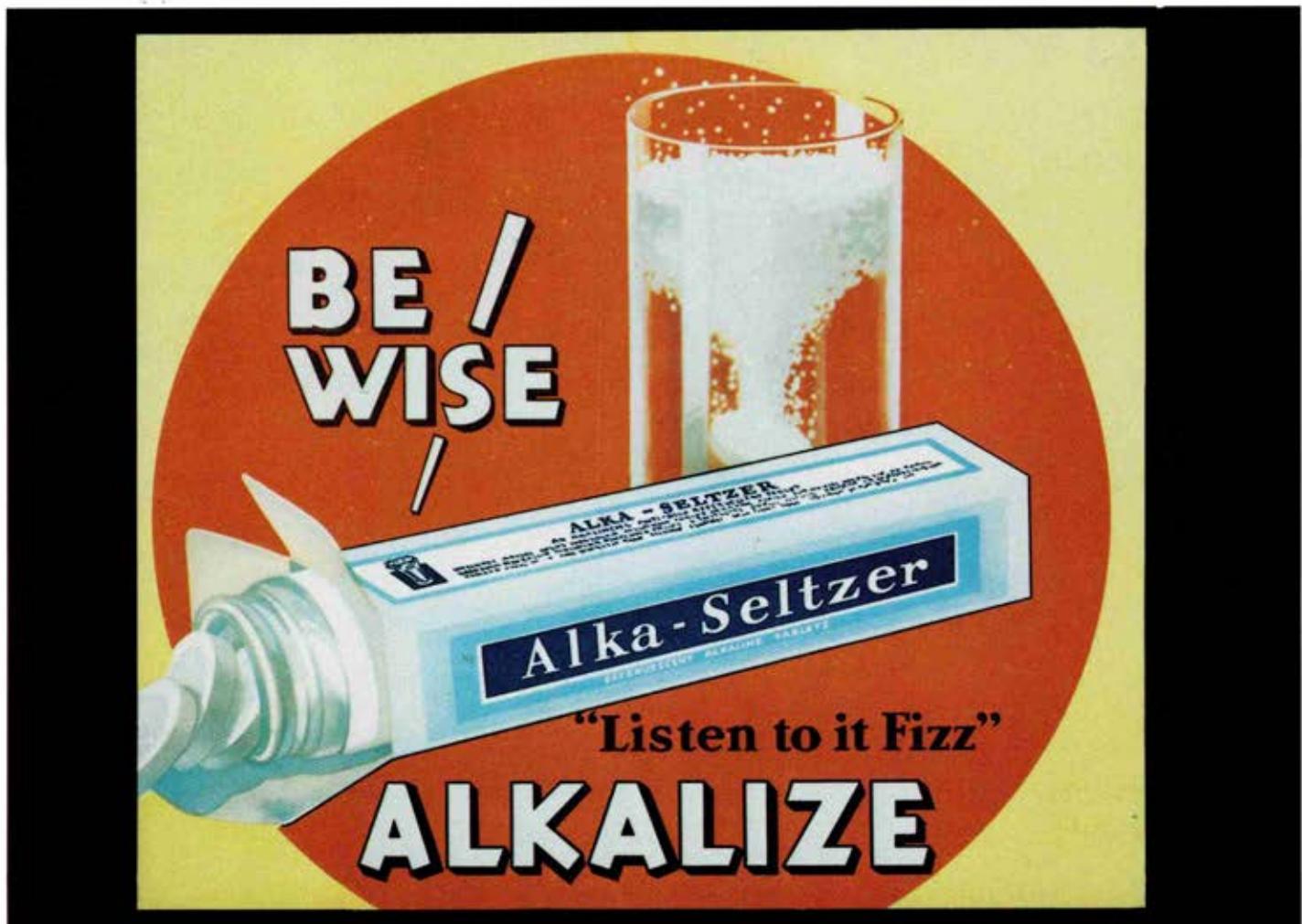
Miles sponsored the program "The Songs of Home Sweet Home," and the first broadcast led to 33,000 requests for Alka-Seltzer samples. Unfortunately, free samples were not much help to get the product moving, and actual sales showed little progress.

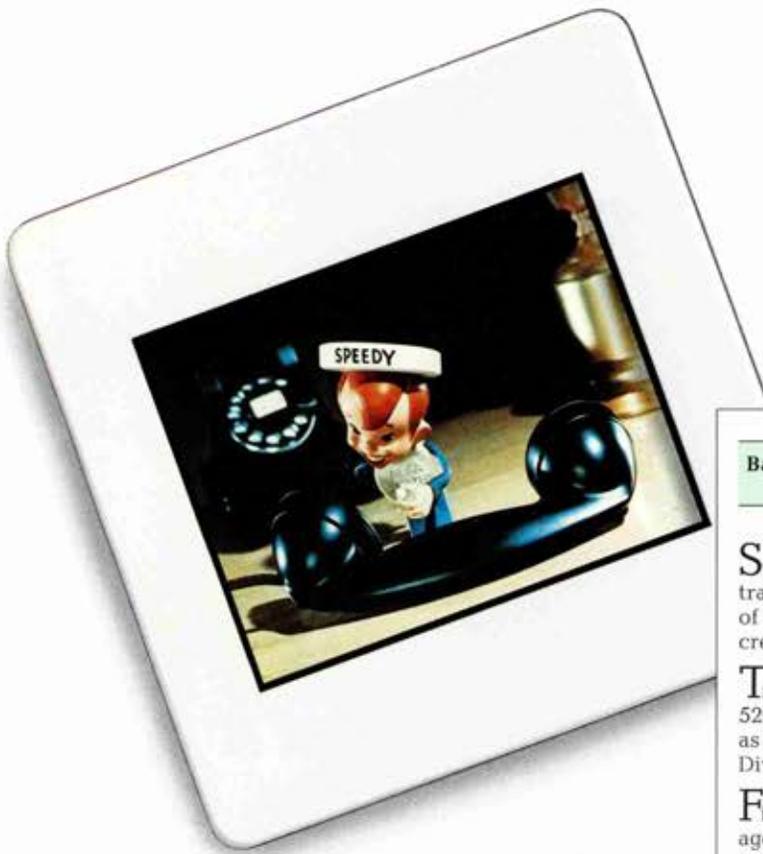
By the time the Depression had reached its depths, the company decided that if Alka-Seltzer did not

establish itself very quickly, the advertising budget would have to be cut. Marketing genius Charles S. Beardsley's answer was to halve the price of the tablets and double the advertising budget. Publicity costs rose to no less than 63 percent of sales.

The breakthrough came with a program on a Chicago station called "Saturday Night Barn Dance." The first of the series was broadcast on February 4, 1933. During the commercials between country music hits, the radio audience could hear the sound of Alka-Seltzer tablets effervescing in water. The announcer accompanied this gimmick with the exhortation "Listen to it Fizz!"

After the first 13-week contract, the program was subsequently also broadcast by Detroit and Pittsburgh stations. That September, it went nationwide via the 200 stations of the NBC network. The result was that sales of Alka-Seltzer increased from \$168,000 in 1932 to \$397,000 the following year and then skyrocketed to \$2.1 million in 1934, \$5 million in 1935 and \$7.5 million in 1936.





Alka-Seltzer advertising also made use of the growing popularity of soap operas and eventually even accompanied such current affairs programs as "News of the World."

The product was also among the pioneers of television advertising in 1949. By 1952, the Wade advertising agency had come up with an Alka-Seltzer mascot—a manikin whose body and hat were each made of an Alka-Seltzer tablet and who waved his wand to promise rapid relief from aches and pains. "Speedy Alka-Seltzer" soon became a favorite of listeners and viewers.

After 50 years of fruitful cooperation with Wade, Miles moved from this agency in 1963 in a search for new ideas. It found them by changing its ad agencies in rapid succession over a number of years and benefiting from numerous campaigns deemed the best of their year or decade. The advertising concept based on a short, simple and catchy slogan always remained the same. These have ranged from "Try it, you'll like it" to the "Plop, plop, fizz, fizz" conceived as a piece of convincing onomatopoeia by Wells, Rich, Greene.

Charles Beardsley, Hub's brother, once said, "If you have the right commercial, you can wait three weeks, go out on the loading dock and see the constructive results." The Alka-Seltzer story proved him right.

The advertising for Alka-Seltzer set standards for marketing techniques in the United States; slogans like "Be Wise, Alkalize" and "Listen to it Fizz" were recognized all over the country. The radio was particularly effective in spreading the message, and the little tablet-

manikin "Speedy Alka-Seltzer" became one of the most popular advertising figures in the early days of television.

Bayer chronicle 1931

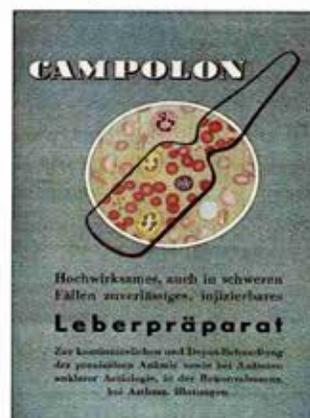
Special department to centralize activities in the field of veterinary medicine is created.

Transport Department with 526 employees is set up as part of the Engineering Division.

First non-coloring anti-aging agent is discovered in rubber research.

In order to keep dismissals to a minimum, the workweek is cut from 48 to 45 hours.

Pharmaceutical Department introduces the liver extract Campolon in the form of an injection. It is marketed to fight against the blood ailment pernicious anemia.



The I.G. Farbenindustrie spins the first synthetic textile fiber (PeCe) from polyvinyl chloride.

World events 1931

Carl Bosch and Friedrich Bergius are jointly awarded the Nobel Prize in chemistry for their services in the discovery and development of the high-pressure process for the hydrogenation of coal.

Ernst August Ruska and others begin developing an electron microscope. Ruska is awarded the Nobel Prize in physics in 1986.

The huge flying ship "Do X" of the German Dornier concern crosses the South Atlantic. With room for 158 passengers and eleven crew members, it is the biggest airplane of the day.

With 102 stories and a height of 1,250 feet, the Empire State Building is completed in New York as the world's highest structure.

In light of the worldwide economic and banking crisis, President Herbert Hoover recommends a one-year moratorium on all international payments due. The United Kingdom is the first country to leave the gold standard. A number of industrialized nations devalue their currencies, and there is an end to fixed exchange rates.

On April 14, a republic is declared in Spain.

Pope Pius XI announces his "social encyclical" against growing totalitarianism and fascism.

The battle against the worldwide epidemic of malaria

In 1930, some 700 million people were infected with malaria. Every year between two and four million died from this tropical disease. Since the disease occurs in swampy areas, it used to be known as marsh fever; another name was intermittent fever because it struck in the form of "attacks."

In 323 B.C. it killed Alexander the Great in Babylon at the age of 33. Visigoth King Alaric in Calabria died at 40 in 410 A.D., when *"his shoulders were still covered by the blond locks of youth."* Other prominent victims included German Emperor Otto II at the age of only 22 in 983 in Apulia, and Heinrich VI in 1197, who died in Sicily at 32.

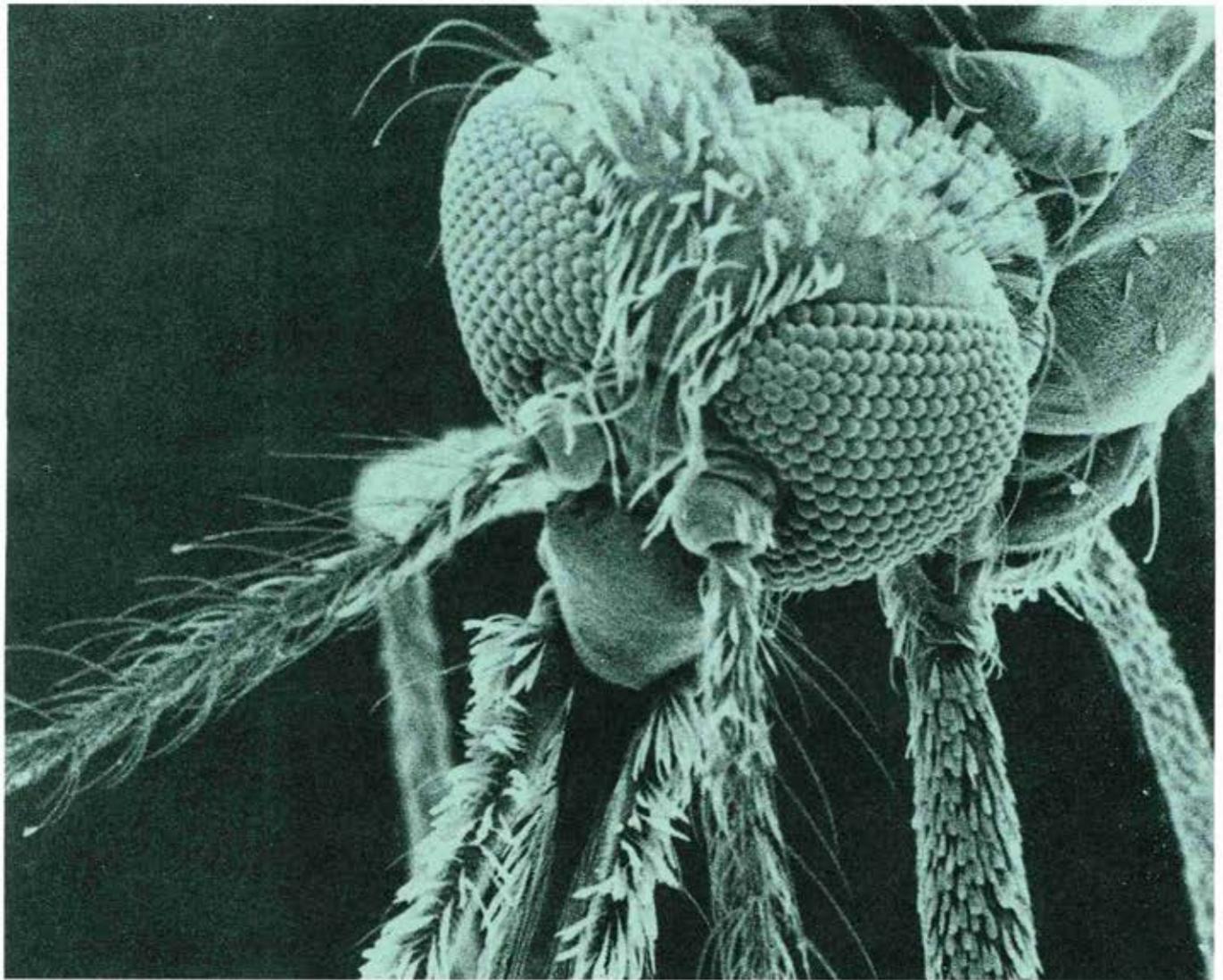
In those days, scientists did not know what caused the disease. The best bet seemed to be "evil vapors" which came from the swamps or, as they were called in Italian "mala aria." There was certainly no known remedy.

While physician Dr. de Vega was tending Countess Cinchon at her sickbed in Peru in 1638, he remembered having heard of a reddish bark that the Indios claimed brought down fevers. He was, in fact, able to save his noble patient with an extract of this bark, which he named "cinchona" in her honor.

As the news spread of this discovery, Peru was soon unable to meet the growing demand for cinchona bark, and the Dutch started to lay out plantations of the Peruvian tree in the East Indies. In 1820, the active agent in the bark was identified and named quinine.

The complex mechanisms behind the cause and transmission of malaria did not become clear until the end of the century. It was Sir Ronald Ross, Professor of Tropical Medicine in Liverpool, who determined in 1896 that the disease was carried by mosquitos. Two years later, he found the plasmodia of malaria in the body of the anopheles mosquito. This discovery put malaria research on solid footing—and earned Ross the Nobel Prize in medicine and physiology.

Quinine had been the only known treatment for malaria for a long time. However, it is neither completely satisfactory nor absolutely harmless as a remedy. During his work with Germanin (see the chapter beginning on page 216), Elberfeld chemotherapist Wilhelm Roehl had already tested all of the active agents on malaria parasites, though initially without success. Biological testing methods were lacking because human malaria could not be transmitted to animals. However, there is a form of



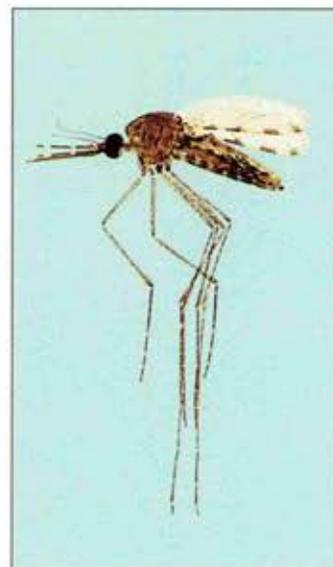
the disease that affects birds and is also similar to the human variety. Based on this fact, Roehl developed the canary test.

With a team of young chemists, including Fritz Schönhöfer and August Winkler, and pharmacologist Werner Schulemann, he started testing hundreds of substances on canaries. In December 1924, they found an active agent that was 30 times as efficient and also more compatible than all of those synthesized to date. They called it Plasmochin.

Clinical trials at the Institute for Tropical Diseases in Hamburg showed convincing results when used on humans. For the treatment of the particularly dangerous malaria tropica, Plasmochin still had to be combined with quinine. The new product was tested in a number of malaria-infected areas and was shown to work well in the field. In 1927, Plasmochin came on the market.

Although Plasmochin was effective on the sexual form of the pathogenic agent in the complicated reproduction system of the plasmodia, it was insufficient in fighting the asexual schizont that is responsible for the clinical manifestations of malaria. Roehl was determined to find the solution to this drawback, and so he continued his search. Unfortunately, he died in the middle of his efforts in 1929 from a *Streptococcus sepsis* that only a few years later could have been easily cleared up with sulfonamides.

Roehl's successor in this work was Walter Kikuth from the Hamburg Institute. An improved canary test enabled the researchers to make a better judgment on the effect of a substance on the asexual schizont.

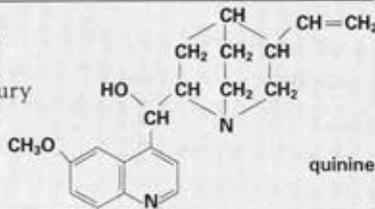


In 1896, Sir Ronald Ross, Professor of Tropical Medicine in Liverpool, discovered the causative agent of the dreaded "marsh fever," malaria. The anopheles mosquito, whose head is shown above as seen through an electron microscope, introduces plasmodia

into the skin with its sting. These organisms then enter the bloodstream to cause the dreaded disease.

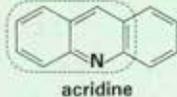
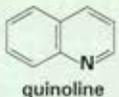
Antimalarial remedies

Quinine, which has been the classic treatment for malaria from the 17th century until modern time, has the following complicated formula:



The structures of Plasmochin, Atebrin and Resochin clearly show how research has systematically modified the basic structure of quinine.

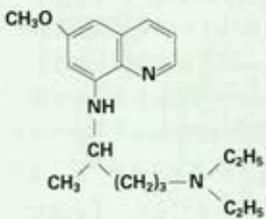
In the case of Atebrin, which has an acridine structure as its basis, the characteristic quinoline nucleus remains.



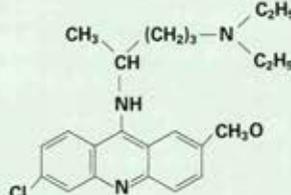
To replace the complicated quinuclidine base, another basic residue had been introduced at various points of the quinoline nucleus.

Three products—Plasmochin, Atebrin and Resochin—were

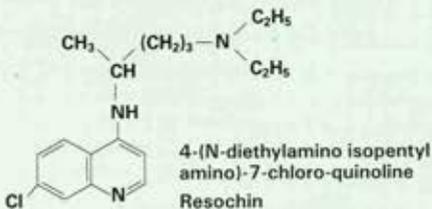
the final results of many hundreds of tests of similarly structured substances. They offered a considerably greater efficacy than quinine and with much fewer side effects.



6-methoxy-8-(N-diethylamino isopentyl amino)-quinoline
Plasmochin



2-methoxy-6-chloro-9-(N-diethylamino isopentyl amino)-acridine
Atebrin



4-(N-diethylamino isopentyl amino)-7-chloro-quinoline
Resochin

In 1930, Fritz Mietzsch and Hans Mauss finally discovered the right active agent to counter the schizont after hundreds of experiments. They called it Atebrin. After it was put on the market in 1932, good prophylactic and therapeutical properties soon led to its use in all malarial areas. It entered the U.S. market as a result of I.G. Farben's agreement with Winthrop Chemical Corporation.

Atebrin is highly effective but often has the unpleasant side-effect of turning a patient's skin and eyes yellow. In cooperation with British tropical disease specialist S. P. James and Elberfeld biologist Lily Mudrow-Reichenow, Kikuth started looking for a "white" Atebrin as early as 1931. In order to perform serial experiments, he even set up a mosquito farm. In 1934, his work resulted in the synthesis of 4-(N-diethylamino isopentyl amino)-7-chloro-quinoline.

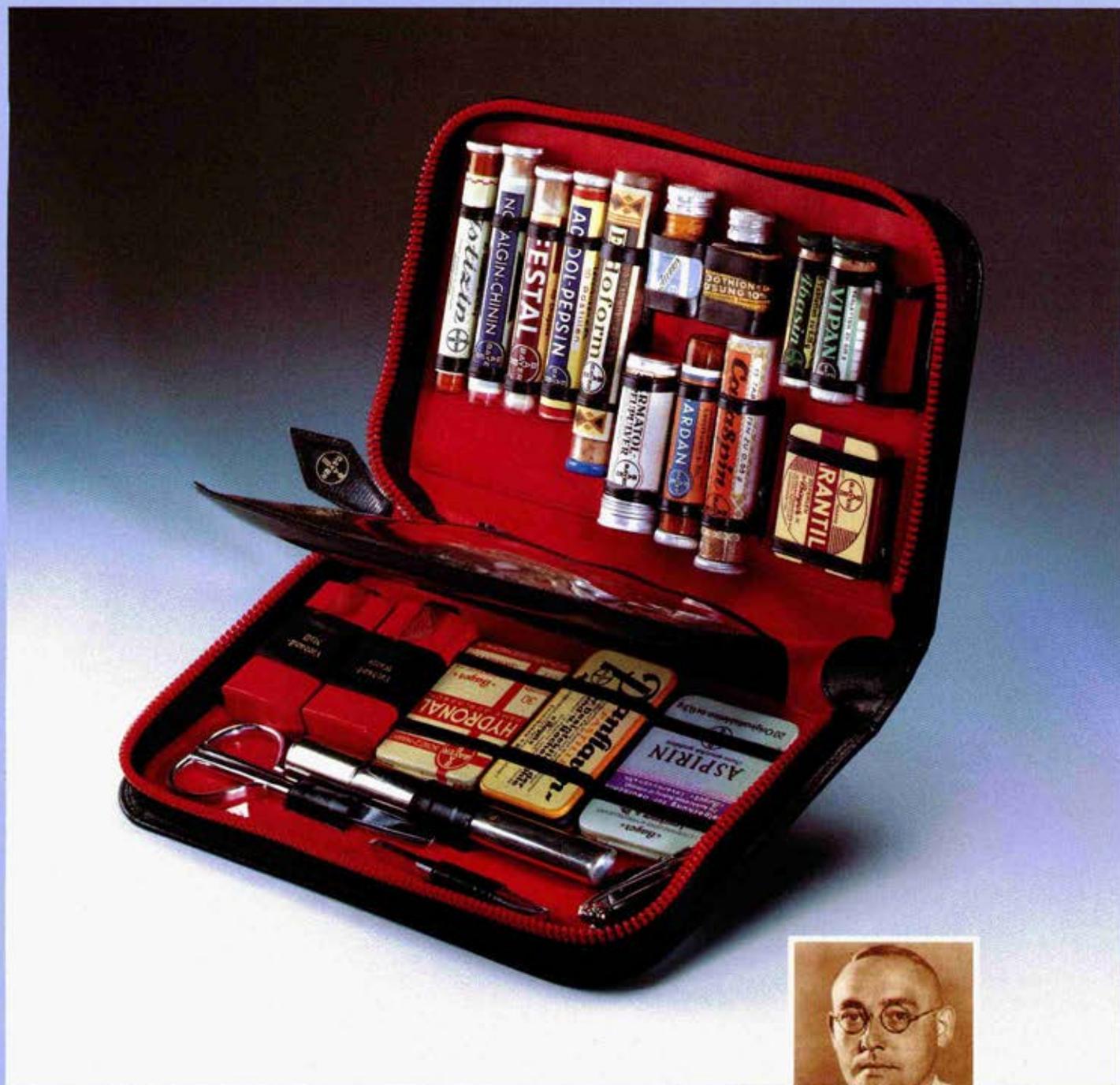
This substance was the basis for the antimalarial drug Resochin, today known internationally as chloroquin. Resochin is not only colorless, but its tolerability has now been improved so much that two tablets twice a week represent a sufficient dose for prophylaxis. A short-term, high-dose tablet taken for only one or two days cures the disease. Resochin also serves in the treatment of rheumatism of the joints and certain skin diseases.

In 1937, Resochin was the subject of a patent application. However, due to the war—which resulted in the confiscation of German patents abroad—it was 1950 before it could come on the German market as a Bayer product. By 1947, and with the help of government aid, a total of 14,000 compounds had been synthesized and tested against malaria in the United States, but none was found to be better than chloroquin, or in other words, Bayer's Resochin.

Guarding against infection with malaria and curing the infected are not the only ways to counter this plague. Another way is to destroy the carriers. The

most obvious move here would be to lay dry the swamps where the anopheles mosquito breeds.





Hans Mauss
1901–1953



Fritz Mietzsch
1896–1958

Two Bayer chemists Fritz Mietzsch and Hans Mauss (right) discovered an active agent that was introduced to the market in 1932 under the trade name of Atebrin. This drug was highly effective against malaria, but had the unpleasant side effect of leaving behind a yellow tinge

to skin and eyes. Bayer's portable medicine case of 1938 (above) still included Atebrin, here in the middle of the top row. Soon thereafter the colorless and highly efficacious Resochin was developed.

The battle against
the worldwide epidemic
of malaria



Hans Andersag
1902–1955



Walter Kikuth
1896–1968

The two men on the right, Walter Kikuth and Hans Andersag, were the inventors of Resochin. The breeding farm for malaria-carrying mosquitos installed by Kikuth in the early 1930s is still in use today (above).

Indeed, this has been done in many parts of the world, including the Magadino Plain in Ticino, Switzerland, and the Pontine Marshes near Rome. But it is impossible to dry out every malarial bog in the world. One could, however, kill off the mosquitos responsible.

In 1955, the World Health Organization (WHO) launched an international program aimed at eradicating malaria by 1962. The most effective weapon in this battle was seen as the pesticide DDT. With its help, the number of malaria victims in Sri Lanka had dropped from two million in 1950 to only 17 in 1963.

But then the figure rose to 3,000 in 1967 and was back to two million by 1969. The reason was that Sri Lanka had decided not to continue with the program for financial reasons. In other countries the use of DDT was stopped because of environmental disadvantages; it decomposes only very slowly and accumulates in the organism.

A growing movement to achieve a total ban on DDT put a brake on the eradication program, and a WHO warning in 1971 that a ban could mean a "disaster for world health" went unheard. In the meantime, mosquitos had time to develop resistance. Today, there are believed to be between 250 and 400 million malaria victims in 140 different countries and an annual death rate of over two million.

Resochin has remained the best prophylaxis against malaria, but in parts of Southeast Asia, South America and East Africa, the carriers have now become chloroquin-resistant. In cases of acute disease, it is therefore now necessary to prescribe a combination of various remedies.

The eradication of malaria has not been successful to date. But chemistry provides the means to counter it effectively. With the aid of genetic engineering techniques, it may even be possible to find a malarial vaccine within the next decade.

Bayer chronicle 1932

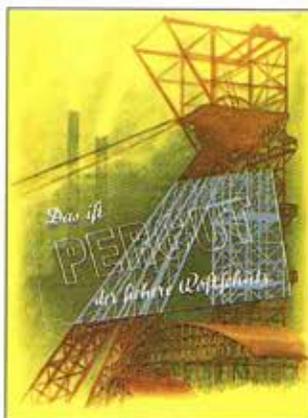
The "Grüneburg," corporate headquarters building of the I.G. Farbenindustrie AG, is opened in Frankfurt.

Five-day workweek is introduced by I.G. Farben.

The Occupational Health Department of I.G. Farben is moved from Ludwigshafen to Elberfeld.

Anti-epilepsy product Prominal is introduced to the market.

Production begins of the chlorinated rubber Pergut. (A contemporary advertisement is shown below.)



Gerhard Domagk discovers a new class of disinfectants.

Bayer introduces Anthralan wool dyestuffs, later to be known as the Supracen range.

World events 1932

Japan proclaims Manchukuo to be a Manchurian State independent of China.

Reparations program is ended by the Lausanne Conference.

On January 27, Adolf Hitler explains his program in a speech before industrialists in Düsseldorf. By the appointment as an official of the Brunswick council, native Austrian Hitler becomes a German citizen.

In the German elections in July, the National Socialists become the biggest single party.

Nobel laureate Albert Einstein gives up all of his official positions and does not return to Germany from a trip abroad.

Swiss geologist and physicist Auguste Piccard makes a balloon ascent into the stratosphere, reaching a height of 55,580 feet.

American Malcolm Campbell breaks the land speed record by reaching some 254 m.p.h. in his racing car "Blue Bird."

Kidnappers abduct the 18-month-old son of aviator Charles Lindbergh. Although the parents pay the ransom demanded, the child is murdered.

The Bayer cross shines across the Rhine

On February 20, 1933, Carl Duisberg switched on the enormous Bayer cross towering above the Leverkusen plant. It was the biggest free-standing advertising sign of its kind in the world.

The cross consisted of 2,200 light bulbs, had a diameter of 236 feet and hung between two chimneys, each of which was some 413 feet high.

In those days, the Bayer cross shining across the Rhine was a technical sensation. Using a system of flashing lights, first the circle became visible and then the letter cross blinked on. After a pause of darkness, the "light show" repeated itself, flashing on and off all night long.

The engineers had quite a job to work out the statics of a vast wire mesh open to the wind. They solved this problem by having the lowest support bracket act as a counterbalance.

It was a great day for Carl Duisberg when he saw the shining landmark blaze out over the town and the works that had been his brainchild. At the dedication, he said, *"As the Southern Cross gives direction and hope to the mariner, may this 'Western cross' in the heart of German industry shine out to the German merchant, the German entrepreneur and the German working man as a symbol of our courage and our confidence. May it also be a symbol for the rest of the world of the conscientiousness and quality of German work."*

After the I.G. Farben had taken over the Bayer cross as the trademark for its pharmaceutical operations, it became even better known in the outside world.

Wherever possible, the group tried to use it as an illuminated sign. For example, a Bayer cross 65 feet in diameter shone over the entry to the Suez Canal in Port Said as of 1934.

When war broke out in 1939, blackout regulations required that the Leverkusen cross had to be left switched off. Soon afterwards it was taken down and was not to shine out over the Rhine again until September 2, 1958.

The new Bayer cross does not blink anymore and it is somewhat smaller than its predecessor, but its dimensions are still impressive: the diameter measures some 167 feet and the circumference 525 feet. Each letter is about 20 feet high. With a total power capacity of 67,000 watts, the cross consists of 1,680 light bulbs and weighs 300 metric tons.

This Bayer Cross shone out over the Leverkusen works for only six years. It was switched on by Carl Duisberg in 1933—and then dismantled when the war broke out in 1939.



Bayer's first trademark depicting a lion with a gridiron paid tribute to the coat of arms of Elberfeld, the city where the company initially had its headquarters.



The trademark grew more elaborate as the company prospered: this is the highly ornate version of 1886.



From 1895 onwards, the Bayer lion bore a caduceus and rested a paw on the globe, an indication of the company's self-confidence and international intentions.



The forerunner of today's Bayer cross was introduced in 1904 as an alternative trademark. This symbol was used primarily for pharmaceuticals.



The company dropped the original name surrounding the cross for use in foreign markets.



The Bayer cross was first introduced in its present form in 1929 and has been the company's exclusive logo since 1951.

Bayer chronicle 1933

Hans Kühne succeeds Karl Krekeler as head of the Lower Rhine Division of I.G. Farben and Plant Manager of Leverkusen.

A patent for a process to clean gases is applied for.

In order to sell popular American consumer goods in Germany, I.G. Farben sets up Drugofa (Drugs of America) in Berlin.

Evipan-Natrium is brought into clinical use as a short-term narcotic.

Fritz ter Meer becomes chairman of I.G. Farben's Technical Committee.

On December 14, I.G. Farben and the German government sign an agreement that guarantees the expansion of the Leunawerke plant to a capacity of 350,000 annual tons of synthetic gasoline.

Bayer chronicle 1934

Production of Buna N begins in Leverkusen.

Dormagen plant starts production of Cuprama, the first chemical staple fiber based on the copper oxide ammonia process.

Antimalarial drug Resochin is successfully synthesized in Elberfeld.

Bayer chronicle 1934

The building of company-owned apartments is made the responsibility of the newly formed Gemeinnützige Wohnungsbaugesellschaft mbH (Gewoge).

An autonomous Dental Department is set up.

World events 1933

President Paul von Hindenburg appoints Adolf Hitler Chancellor on January 30. After the February 27 fire in the Berlin Parliament (Reichstag) building, constitutional rights are annulled by a special "Law for the Protection of People and State." From July on, the National Socialists are the only political party in the country; the others went into "voluntary" liquidation. Germany leaves the League of Nations on October 14.

On March 4, Franklin D. Roosevelt is inaugurated as 32nd president of the United States. His administration announces numerous measures to boost the economy and strengthen the welfare system. The most important reforms are incorporated in Roosevelt's "New Deal" program.

World events 1933

Great progress is made in vitamin research when Albert von Szent-Györgyi and his team are able to produce almost 500 grams of pure Vitamin C (ascorbic acid) from red paprika. Simultaneously and independently, Tadeusz Reichstein and Sir Walter Haworth succeed in synthesizing Vitamin C.

Gaston Ramon and Christian Zoeller develop the tetanus antitoxin.

World events 1934

Because Ernst Röhm, chief of staff of the Nazi organization "Sturm-Abteilungen" (SA), is claimed to be planning a coup d'état, Hitler has him and other SA leaders shot without trial on June 30 by the "Schutzstaffeln" (SS). At the same time, a number of other imagined or actual opponents are murdered. The criminal behavior of the Nazi regime becomes clearer than ever.

President Paul von Hindenburg dies on August 2 at the age of 87. Hitler appoints himself Führer ("Leader") and Chancellor. A referendum results in 90-percent support for the necessary alteration to the constitution.

World events 1934

The so-called Malice Act is passed, making criticism of the Nazi government a punishable offense. To enforce this, a "people's court" is created.

Austrian Chancellor Engelbert Dollfuss is shot in an unsuccessful Nazi coup d'état.

King Alexander I of Yugoslavia and French Foreign Minister Louis Barthou are assassinated in Marseilles by Croatian nationalists.

Japan withdraws from the fleet treaty with the United States and begins building up its war fleet.

Reza Shah Pahlavi changes the name of his country from Persia to Iran.

The quartz timepiece, invented by W.A. Morrison in 1929, is developed by Adolf Scheibe and Udo Adelsberger to an accuracy of one-thousandth of a second per day.

Cebion, the first Vitamin C tablet, is introduced by E. Merck of Darmstadt.

Gangster boss John Dillinger, Public Enemy Number One in the United States, is hunted down by the FBI.

Domagk's sulfonamides revolutionize medical therapy

Pneumonia, childbed fever, blood poisoning, meningitis—all of these diseases were serious and quite often fatal up until 1935. They were caused by streptococci, chain-like bacteria that were known to science but could not be effectively countered.

Professor Heinrich Hörlein, head of the Elberfeld-based Pharmaceutical Department, was among the few who believed these illnesses could be cured by chemical remedies. He was accordingly impressed by the doctoral thesis of young scientist Gerhard Domagk entitled "The Annihilation of Infective Agents Through the Reticular Endothelium and the Formation of Amyloid." He recruited 31-year-old Domagk in 1927 and entrusted him with the leadership of the newly created Institute for Experimental Pathology and Bacteriology in Elberfeld.

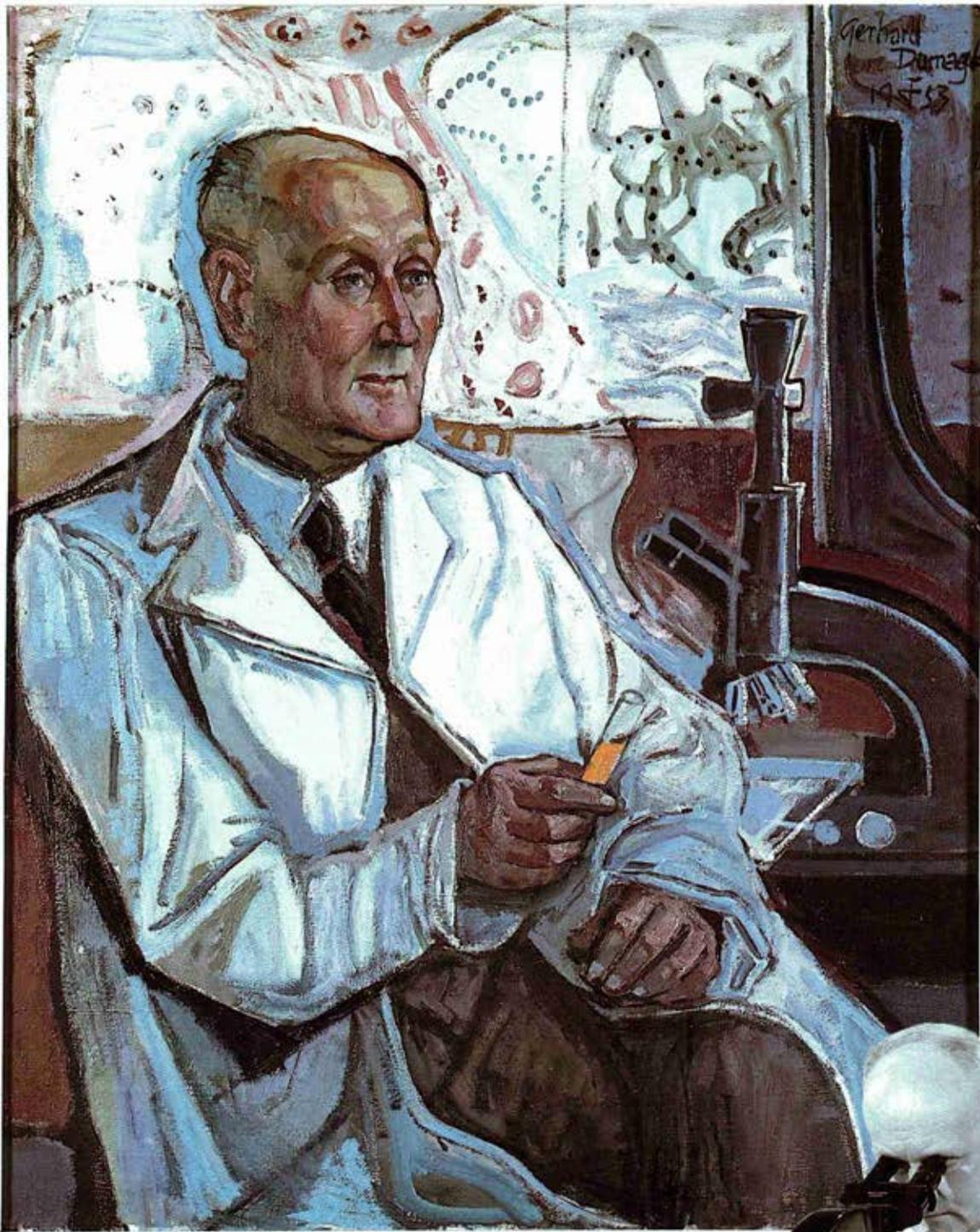
Gerhard Domagk was born at Lagow in the Brandenburg March on October 30, 1895, as son of a schoolteacher. After finishing school, he was sent to the front as a medic. Nothing distressed him so much as seeing wounded soldiers die from wound-fever, gas gangrene or other infections after what would otherwise have been a successful operation. Later, as an assistant at the Pathological Institute in Greifswald and as assistant professor at the University of Münster, he was again confronted by the limits of medical care: every fifth death in the hospitals was the result of infection.

These bitter experiences greatly influenced the young man. His goal was to find a way to apply chemotherapy to fight against acute bacterial infections. He was soon recognized as an up-and-coming scientist, even if he did discover that the results of his thesis had already been worked out by somebody else.

Domagk's first great success at his new job in Elberfeld was the development of the disinfectant Zephirol. Since the middle of the previous century, doctors had been relying on chlorine water and carbolic acid as antiseptics, even though these were effective only for a short period of time. On the basis of experiments made in Heidelberg and Switzerland with invert soaps, which had not proven very successful, he went on to discover dimethylbenzyl-dodecyl ammonium chloride in 1932. A 10-percent solution of this compound was introduced to the market three years later under the trade name of Zephirol. Even mere traces of diluted Zephirol

As a young doctor in the First World War, Gerhard Domagk realized how helpless the medicine of the day was against infectious diseases. His first great success as a researcher came in 1932 with the development of Zephirol, a disinfectant still in use to this day.

The painter Otto Dix portrayed Domagk with his most important research tool—a microscope with which he could examine the effects of various compounds on specific strains of bacteria.



*Reizlosigkeit, Ungiftigkeit,
angenehmer Geruch*

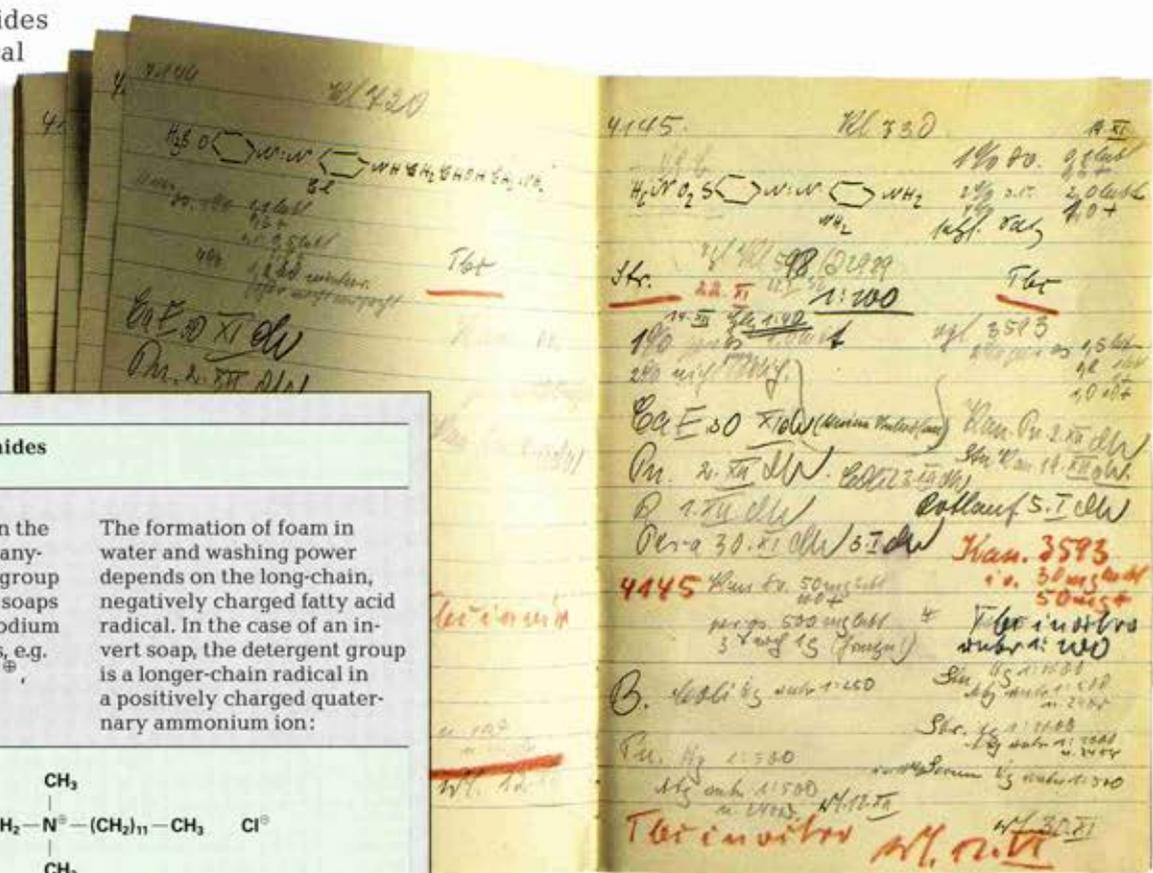
sind die Vorzüge des neuen Desinfektionsmittels

Zephirol

Zephirol dient sowohl zur Desinfektion der Hände, Instrumente und Gebrauchsgegenstände, zur Reinigung infizierter Wunden, als Hautdesinfektion vor Operationen als auch zu Spülungen und Tamponbehandlungen in der Gynäkologie und Geburtshilfe. Die intensive desinfizierende Wirkung, die Unschädlichkeit für Haut und Schleimhaut auch bei längerem Gebrauch und der angenehme Geruch bahnten dem Zephirol in kürzester Zeit den Weg in zahlreiche Kliniken u. Sperrkammern.

Originalherstellung: Thiermann & Co. KG, 1953

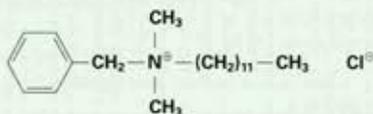


Zephirol and sulfonamides

Zephirol, referred to in the first part of the accompanying text, belongs to the group of invert soaps. Normal soaps generally contain the sodium salt of higher fatty acids, e.g. $\text{CH}_3(\text{CH}_2)_{16}\text{COO}^- \text{Na}^+$, sodium stearate.

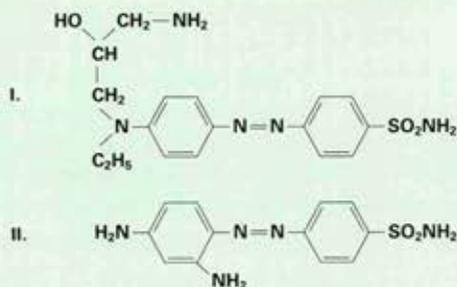
The formation of foam in water and washing power depends on the long-chain, negatively charged fatty acid radical. In the case of an invert soap, the detergent group is a longer-chain radical in a positively charged quaternary ammonium ion:



dimethyl benzyl dodecyl ammonium chloride
Zephirol

The first azo dyestuff to prove effective against streptococci was the compound I.

By simplifying its structure, Prontosil, compound II, was obtained:



Prontosil

Prontalbin possesses no dyeing azo group. It consists solely of the para-amino-

benzene sulfonamide on which its therapeutic ability depends.



para-aminobenzene sulfonamide
Prontalbin

adhering to a rubber glove or a washed hand acted as a strong bactericide against streptococci, which can cause dangerous infections in wounds. His breakthrough spurred similar research at home and abroad, and a number of similar agents were found. This group of disinfectants was given the generic name of quats, the abbreviation for surface-active quaternary ammonium germicides.

Today, more than half-a-century later, Zephirol is still used for disinfecting hands and for bodily hygiene. Its discovery was an important step in external disinfection. However, the main target, which was to attack the bacteria within the body, had not yet been reached.

At the time, it was generally held that primitive bacteria, unlike the more complicated protozoa and spirochaete, could not be tackled by chemotherapy. Domagk was not prepared to accept this assumption. He thought that either artificial substances must be introduced to the body to enhance natural defense mechanisms in the fight to destroy the pathogenic agent or that it may even be possible to damage directly the agent which had entered the body.

Chemists Fritz Mietzsch and Josef Klarer had developed a synthesis concept based on the assumption that because azo dyestuffs containing sulfon-

The picture at the top of the page shows an important excerpt from Domagk's laboratory journal. It describes the extraordinary effects of the azo dyestuff D 4145 on streptococci. The dyestuff was developed into a pharmaceutical and subsequently came on the market

in the summer of 1934 under the trade name of Prontosil. Shortly thereafter, it was discovered that the color components in the compound had no effect on the pathogenic agent and as a result, the tablets were left white.

amide groups selectively dye bacteria, they must be able to damage them. These substances, however, showed no effect on the pathogenic agents during test-tube experiments. But Domagk continued to test them in animal experiments that he devised, which involved infecting white mice with streptococcus cultures. In the fall of 1932, he discovered that sick animals treated with an azo sulfonamide recovered, while untreated mice died within 48 hours.

At last a partial success! After additional azo dyestuffs were tested, a product known as D 4145 proved better than any other for this purpose, and Domagk gave it the name Streptozon as a therapeutic agent for streptococcal infections. Clinical tests were initiated in various hospitals.

This discovery encouraged him even more, and he continued his search. In the summer of 1934, he was able to achieve a better solubility by changing the molecular structure. This meant even the most critical streptococcal infections could be treated with the large doses that were required. Ultimate success came in February 1935. Under the trade name Prontosil, a dark-red azo compound was introduced to the market as the first chemotherapeutic agent against cocci bacteria. It caused a sensation in the medical world.

Scientists all over the world now pursued the research methods so successfully applied at Bayer. Researchers at the Pasteur Institute established that the sulfanilamide was the effective part of the molecule against bacteria; hence, the name sulfonamide for the class of pharmaceuticals that ushered in a new era of medical history.

News of cures began to arrive from all over the world. The number of deaths from childbed fever fell dramatically; in the case of suppurative meningitis, use of sulfonamides reduced the death rate from 75 to 10 percent of all patients; deaths from pneumonia, the incidence of which had been some 20 percent, now became rare occurrences.

No drug is registered for use in the United States until all necessary clinical investigations have taken place in the country itself. When, in 1936, the son of President Franklin D. Roosevelt became critically ill with a suppurative inflammation of a lymph node, the attending physician Dr. Tobey tried Prontylin, which Winthrop had just introduced to the American market in cooperation with Bayer. Roosevelt Jr. was saved. The headlines in the American press read "New Chemical Kills Streptococci in Blood."



Domagk's sulfonamides
revolutionize medical
therapy

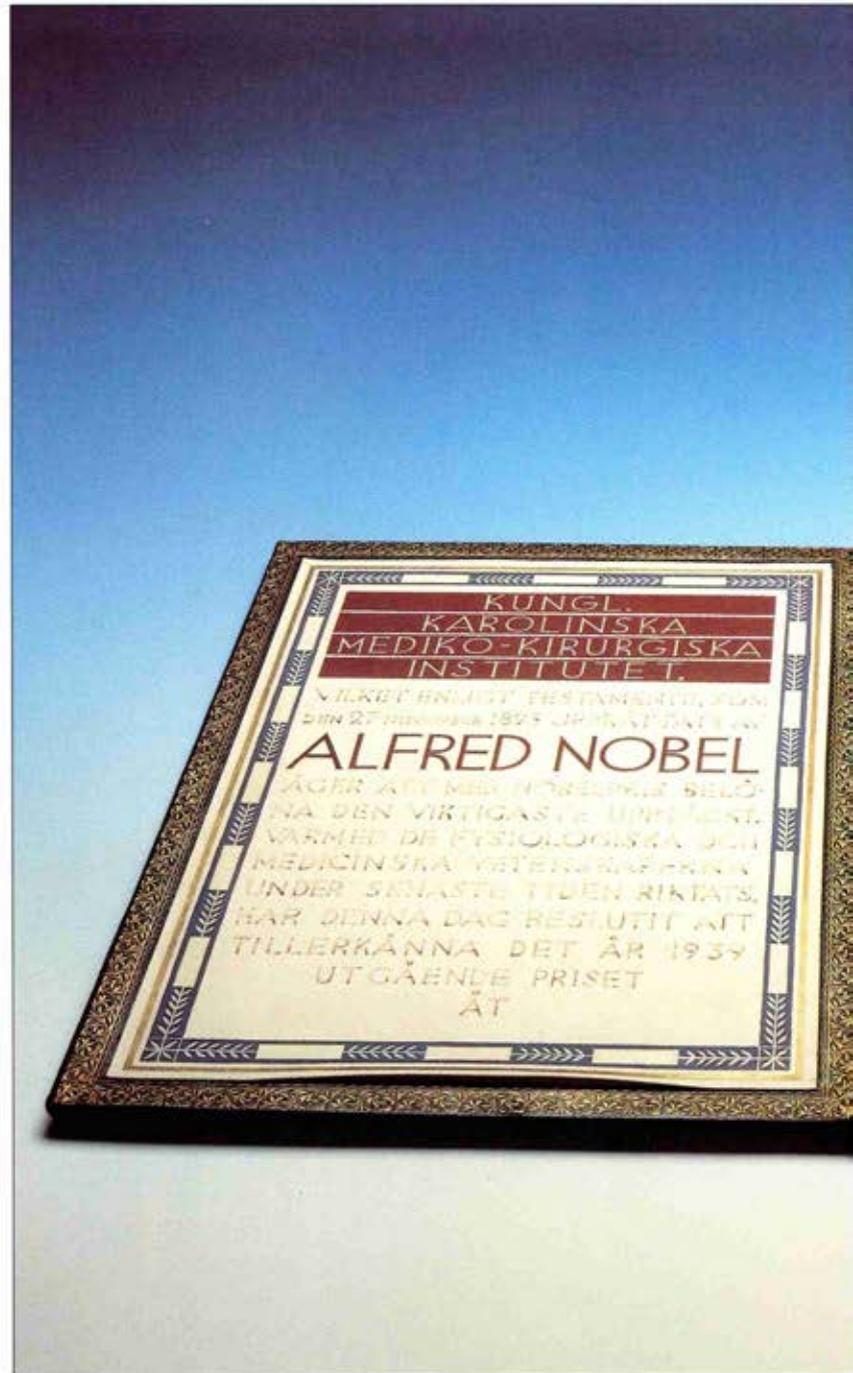
Domagk was far from resting on his laurels. The second part of his career as a researcher was dedicated to finding pharmaceutical remedies for the universal scourge of tuberculosis. This resulted in the discovery of Conteben in 1946 and subsequently of Neoteben in 1952, which is still the most important drug against tuberculosis today.

In 1937, Prontosil was awarded the Grand Prix at the World Exposition in Paris. Two years later, Professor Domagk was presented with the Nobel Prize in medicine for "recognizing the antibacterial effects of Prontosil." He was, however, not permitted to receive this honor. Since 1935, when Carl von Ossietzky had been given the Nobel Peace Prize as publisher of the liberal, pacifist magazine "Weltbühne," Hitler had forbidden all Germans to accept Nobel Prizes. Domagk thanked the Nobel Foundation Committee, indicating that he would still give a speech on his work, even though he could not accept the prize. The Gestapo prevented this too—the scientist was imprisoned for several days and subjected to intensive questioning. Not until 1947 was Domagk able to be presented with the Nobel medal and document, although the corresponding money award had in the meantime been forfeited.

Domagk's original discovery not only marked the triumph of sulfonamide therapy, it also heralded what was undoubtedly an even more revolutionary step in medicine. In 1928, Alexander Fleming had started experimenting with fungus cultures at St. Mary's Hospital in London, but without attracting much attention. Not until war broke out and new problems with infectious diseases developed did two British pathologists remember Fleming's work. As a top-secret project, the U.K. and the United States launched large-scale research in the field of penicillin (see page 506).

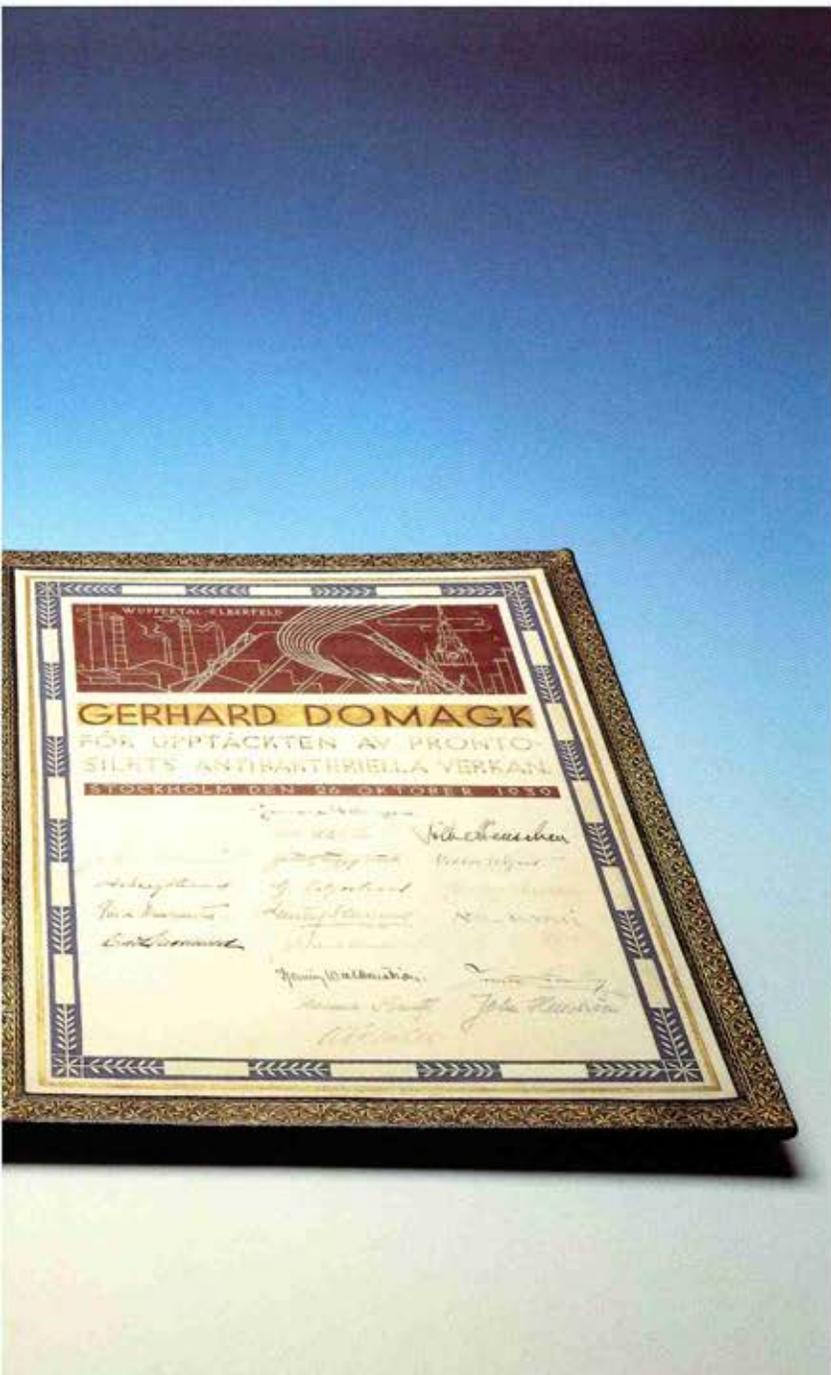


In 1939, Gerhard Domagk was awarded the Nobel Prize in medicine, but the Nazi authorities did not allow him to accept it. It was not until 1947 that the king of Sweden was finally able to present Domagk with the prize.



The Swedish text translates as follows: "The Royal Carolinian Medical-Surgical Institute, which is empowered by the last will and testament of Alfred Nobel dated November 27, 1895, to grant the Nobel Prize for the most important discovery for

the benefit of the physiological and medical sciences in recent times, has this day resolved to award the prize for the year 1939 to Gerhard Domagk for the discovery of the antibacterial effects of Prontosil. Stockholm, October 26, 1939."



Bayer chronicle 1935

Carl Duisberg dies in Leverkusen on March 19 at the age of 74.

A pilot plant for the production of Buna S goes on stream in Leverkusen.

To represent the pharmaceutical interests of I.G. Farben, "Bayer" Limitada is set up in Lisbon.

Alkydal output reaches an annual 1,800 metric tons.

Bayer's company newspaper since 1910, which is called "Die Erholung" (recreation), is merged into the joint I.G. Farben publication "Von Werk zu Werk" ("From plant to plant").

World events 1935

Hitler announces the introduction of compulsory military service.

Italy invades the Ethiopian Empire and takes control.

The population of the Saar, which has been under French administration since the end of World War I, votes 90.7 percent in favor of reunification with Germany.

Germany makes service in the national work corps ("Arbeitsdienst") obligatory.

Social Security Act is ratified in the United States.

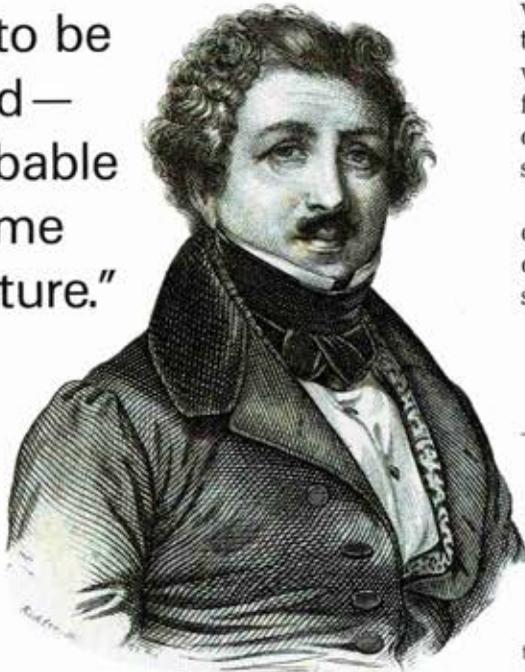
Wallace H. Carothers obtains the first synthetic fibers from polyamide.

Edward C. Kendall isolates cortisone from the adrenal cortex.

The first tape recorder is developed and marketed by AEG; the magnetic tape is supplied by I.G. Farben.

A dream becomes reality: photography in its true colors

“Attaining natural colors in photography, still the dream and hope of artists and laymen alike, is unfortunately neither to be expected nor— given theoretical considerations which are unlikely to be disproved— very probable at any time in the future.”



Speaking before the Royal German Academy of Sciences on July 3, 1890, Berlin physiologist Emil Du Bois-Reymond, author of a work on the limits of scientific knowledge, was quite mistaken. In 1936, Agfa introduced a color film that fully justified the high hopes of artists and laymen alike.

Today, some 1,600 professional and amateur photographers take pictures every second; this means something like 50 billion shots per year, which is equal to a strip of film of almost a million miles in length—or four times the distance to the moon. Of these photographs, only between five and six percent are not in color.

When Du Bois-Reymond held his Berlin speech, photography was already over 50 years old. It was in 1839 that French theater-scenery painter Louis Jacques Mandé Daguerre had published a report on his invention: silver plates were made light-sensitive by surface treatment with iodine vapor and could then be exposed in a camera. The photographed object was subsequently made visible with vaporized mercury.

Two years later, Englishman William Henry Fox Talbot found a way to copy any number of positive prints from a single negative. Photographs of remarkable clarity showing portraits, landscapes and city views from the mid 19th century can still be seen at exhibitions. They are, however, invariably black-and-white. Almost a century would pass before the advent of color.

As early as 1861, a select public could experience at least the illusion of a color photograph. In that year, physicist James C. Maxwell gave a lecture in London on the so-called three-color theory of human vision. To demonstrate his theory, he superimposed three black-and-white photographs on a screen, which were projected through red, green and yellow filters, respectively. Although it was far from real color photography, Maxwell's presentation gave a similar impression and was based on the right idea.

In the following years, numerous chemists worked on a color-photography process. In 1916, Agfa succeeded in producing color transparencies by a grain screen process. Although the photographic plates

This portrait of Louis Jacques Mandé Daguerre belongs to the Bayer archives' collection of copperplate engravings. Originally a scene-painter in the theater, he applied a light-sensitive coating to silver plates in 1839 on which he was then able to reproduce a lifelike

and durable picture. The "daguerrotype" was the cornerstone of photography, but this technology still had many years to go before the color era was established (right).



Agfa: the "Aktiengesellschaft für Anilinfabrikation"

On July 31, 1863, one day before the establishment of Friedr. Bayer et comp., Karl Jordan was granted a Royal Prussian concession to set up a works in Treptow for the manufacture of aniline and aniline dyestuffs. Four years later, chemists Karl Alexander von Martius and Paul Mendelssohn Bartholdy, the great-grandson of philosopher Moses and son of famous composer Felix Mendelssohn, registered the Gesellschaft für Anilinfabrikation (Company for Aniline Production) at Rummelsburg in the township of Lichtenberg. The intention was to manufacture raw materials and intermediates for dyestuffs and other chemicals.

They soon realized that they would not, in the long run, be able to live from starting materials alone; they felt the company would have to make the more valuable finished dyestuffs themselves if it were to have a future. To obtain the necessary capital, the founders turned their firm into a joint-stock corporation named "Aktiengesellschaft für Anilinfabrikation" in 1873. And for dyestuffs production, they took over the Jordan plant in Treptow, which was already turning out fuchsine, aniline blue and methyl violet.

Martius and Mendelssohn expanded the sales program, and the company grew accordingly. Its workforce, which totaled little more than a hundred in 1880, increased to 1,600 by the end of the century, and share capital rose

from 1.02 to 7 million marks. In addition to the Rummelsburg and Treptow facilities, the company opened new plants in Wolfen near Bitterfeld and outside Germany in Moscow, in the Baltic town of Libau and in the Lyons suburb of St. Fons. Like Bayer, Agfa had become a "multinational" by the time the First World War broke out.



Label for Agfa dyestuffs at the turn of the century.

In 1905, the company joined Bayer and BASF to form the so-called "little I.G.," and subsequently also participated in the establishment of the "big I.G." in 1916. It was the most dynamic company in the first alliance in terms of growth, even if it did remain the smallest of the three partners. By 1912, it had a payroll of 3,700, sales of 47 million marks and a share capital of 14 million marks; in the same year, Bayer was employing a total of 10,000 with annual sales of 107 million marks and share capital of 36 million marks.

While photographic products, primarily developer and films,

were of increasing importance for the company, chemicals and dyestuffs made up the largest part of its activities until 1925. Agfa also produced pharmaceuticals. Indeed, it was a highly diversified chemical concern.

A Photographic Department was set up in 1888; it was initially involved with the development, production and

American James Goodwin, and in 1909–1910, a major new factory was built for film production in Wolfen.

It was its activities within the I.G. Farbenindustrie AG, however, which made Agfa something of a synonym for photographic products in Germany. After being integrated into the new trust in 1925, "Agfa" was made the trademark for all I.G. Farben's photographic articles, including the photographic papers from Leverkusen and the cameras from Munich.

After the war, the headquarters and main plants of Agfa were located in the Soviet occupation zone, where they first became Soviet firms, and subsequently in 1954 nationalized units within the German Democratic Republic.

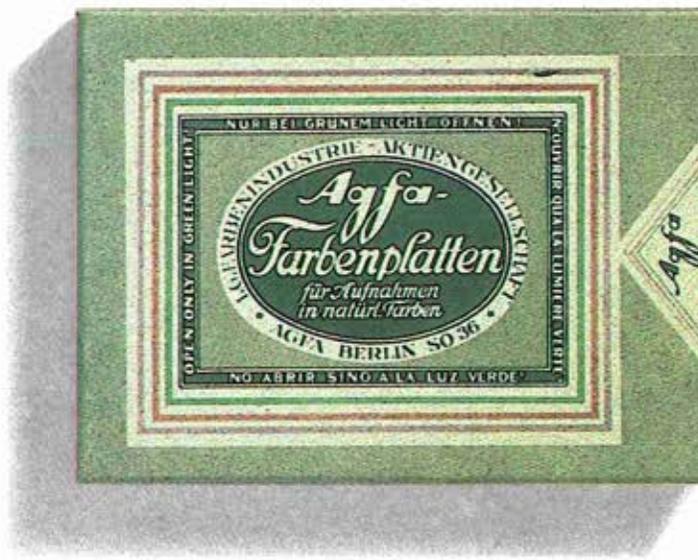
The plants in the Western zones were the photographic paper facility in Leverkusen and the Munich camera works. Since the chemicals, fibers and dyestuffs capacities were in the Eastern bloc and thus unattainable, the "Agfa Aktiengesellschaft für Photofabrikation," formed in Leverkusen on April 18, 1952, was no longer a diversified chemical company but active only in the photographic field. When I.G. Farben was disbanded, Bayer received a majority holding of the Agfa capital—a logical development in view of Bayer's historic link to the company's products within the I.G. Farben organization and the fact that the Leverkusen photographic paper unit was part of the Bayer plant. Agfa had thus become a Bayer subsidiary.

sales of photochemical articles. In the same year, Momme Andreesen introduced paraphenylene diamine to the photographic sector and followed up in 1889 with Eikonogen and in 1891 with paraaminophenol, better known under the trade name of Rodinal.

The Photographic Department's program grew rapidly and was based on the latest technology. In 1894, Agfa started producing dry plates and in 1901 put the first "Agfa film" on the market. Two years later, the company began the manufacture of cinematographic film, which was based on the process invented by

In 1916, Agfa introduced a special grain screen process which enabled the photographer to produce color transparencies. The picture above right, itself developed from a corresponding plate, shows an old package of Agfa Color Plates. The new "Agfacolor"

that was introduced by the company in 1936 was much more sensitive. The two slides shown below right, which appeared in Eduard von Pagenhardt's book "Agfacolor, das farbige Lichtbild," were taken with this newly developed Agfa film.

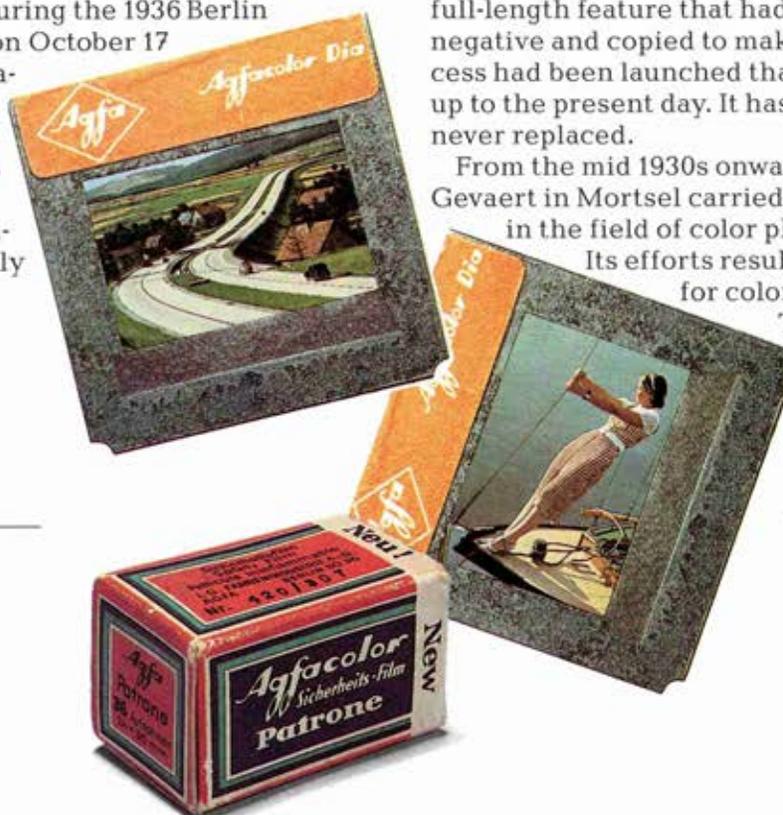


needed 80 times the exposure time of the black-and-white films of the day, this method was used until the thirties. Over the years, the exposure time could be halved, but the results were still not satisfactory.

The breakthrough to a universal system of color photography had actually been in the making since 1910, when German chemist Rudolf Fischer discovered the principle of "chromogen developing." In each of the two following years, he patented a specification of this developing method. In his process, three silver halide layers with one dye base each are developed into a negative that is made of three corresponding color layers. However, there was one drawback: during developing, the dye bases tended to run from one layer into another, making a clear picture impracticable.

In the mid 1930s, Wilhelm Schneider of the organic chemistry laboratories at the Wolfen film works hit on a solution to this problem. The so-called "color couplers" must be given more bulk by using long-chain molecule components to stop them from slipping from layer to layer. His superior, Gustav Wilmanns, subsequently had the department made responsible for working on color photography, though this had not originally been one of its tasks.

On April 11, 1935, the company registered a patent for its triple-layer reversal film. Test pictures were already being taken during the 1936 Berlin Olympic Games, and on October 17 of the same year, "Agfacolor New Reversal Film" was introduced to the market for slides and 8-mm photography. No special camera was necessary—only a single film, a single exposure and a single developing process.



The breakthrough was finally achieved.

At just about the same time, Kodak came out with its "Kodachrome" film. Both the Americans and the Germans had

aimed for the same goal and reached it at the same time. The difference was that "Agfacolor" already incorporated the color couplers in the film layers, while in the other process, they had to be added during developing.

For the time being, progress in the color-film sector was largely dictated by the needs of the motion-picture business. It was the heyday of movies, but the era of large-scale amateur photography had not yet dawned in Germany.

As the leading German supplier of film, Agfa was already well placed in this market. It had an experienced partner in UFA, the country's leading film producer at that time. In cooperation with UFA, Agfa gradually improved color-film processing techniques.

On October 31, 1941, almost exactly five years after the presentation of the Agfa color-transparency film, the première took place in Berlin of the song-and-dance motion-picture musical "Frauen sind doch bessere Diplomaten" ("Women Make Better Diplomats"), with Marika Rökk as leading lady. There had already been colored film commercials and cultural documentaries, but this was the first full-length feature that had been filmed on a color negative and copied to make a positive print. A process had been launched that has proved successful up to the present day. It has been improved, but never replaced.

From the mid 1930s onwards, the Belgian company Gevaert in Mortsels carried out development work in the field of color photography processes.

Its efforts resulted in a series of patents for color couplers and sensitizers. The combination of this technology with the

A dream becomes reality:
photography in its true
colors

Agfacolor process led in 1947 and 1948 to the introduction of the Gevacolor cinematographic film range. Many famous French films were subsequently made with Gevacolor, among them the "Three Musketeers" production of 1953.

After the war, the Agfa plant in Wolfen was in the Soviet occupation zone, so the company reestablished itself in Leverkusen. It continued to produce cinematographic film, but Germany's postwar "economic miracle" created an important new market: suddenly everyone wanted to be a photographer. As a result, research was concentrated on still picture film, a field in which Agfa was soon to become a leading name.

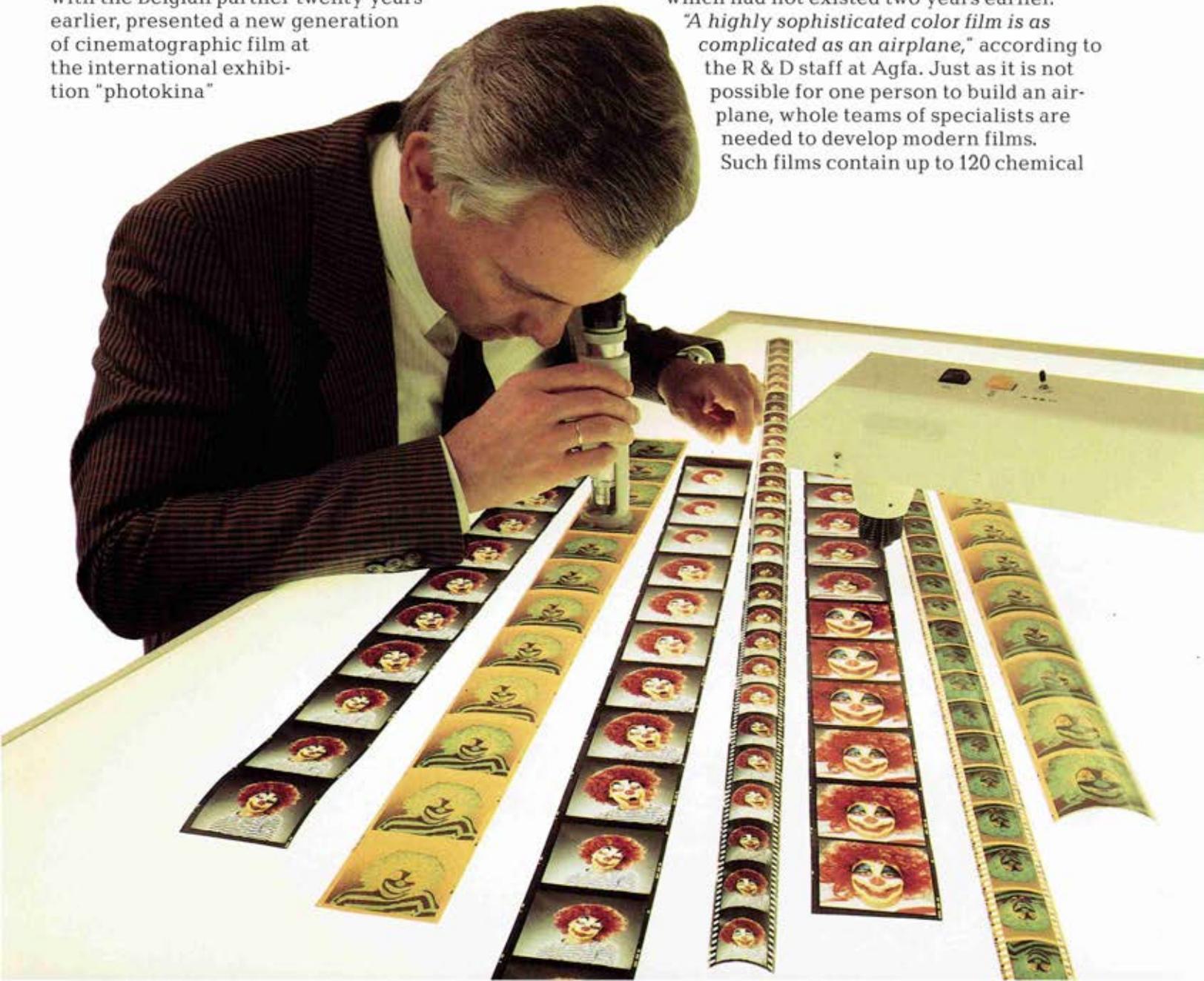
In the early eighties, the "CT 18" product that Agfa had introduced was still going strong. In 1984, Agfa-Gevaert, as the firm had been known since its merger with the Belgian partner twenty years earlier, presented a new generation of cinematographic film at the international exhibition "photokina"

in Cologne. This "XT" range soon went down in history as the film with which "Out of Africa" and "The Mission" were made; both movies subsequently won Oscars for Best Photography.

Also in 1984, Agfa-Gevaert presented photographers with a new generation of color films offering improved definition, brilliance and sensitivity. Until then, one of these properties could only be upgraded at the cost of the others. The ability to improve on all three qualities at the same time was the result of an unconventional layer construction, better emulsions and, particularly, the introduction of twin-crystal silver halides. The new 1,000-ASA films are some six-hundred times more sensitive than the first Agfacolor products of 1936. By 1985, 70 percent of all Agfa film sales stemmed from material which had not existed two years earlier.

"A highly sophisticated color film is as complicated as an airplane," according to the R & D staff at Agfa. Just as it is not possible for one person to build an airplane, whole teams of specialists are needed to develop modern films.

Such films contain up to 120 chemical



substances, most of which cannot be bought in the marketplace and thus have to be invented and produced in the film plant—many at two to three times the cost of silver.

Furthermore, color film today consists not of three but of 12 to 18 different layers. Since each of these layers is no more than three-thousandths of a millimeter thick, rapid and reliable production poses difficult problems for chemists and plant engineers. In the cascade casting process, several super-thin layers are applied at the same time in a single operation, and they must not be permitted to blend. The buildings where these machines are located have their foundations deep in the Rhenish sand so that even the most minute vibrations can be obviated.

Every amateur photographer knows that the best film material is of no use if there is a weakness in the processing chain leading from exposed film to finished picture. Photographic papers, chemicals, developing units, printers capable of exposing 18,000 negatives an hour and quality control systems are among the range of Agfa's photo-finishing products that help the customer to get the best out of his picture. Today, he does not even have to worry about fading; color paper now keeps the colors stable for a full century.

Agfa has become a well-established name in the photographic field. But many people don't realize that with its 10,000 different products, the photographic lines account for only about one-quarter of total sales of the Agfa-Gevaert Sector. More about Agfa can be found in the chapter beginning on page 408.

Quality control is an important consideration in the production of any Agfa film. Sample exposures are developed in a special testing laboratory and examined scrupulously, as shown here with the super-sensitive 1,000 ASA Agfacolor and Agfachrome films.

Bayer chronicle 1936

Hans Andersag and Kurt Westphal in Elberfeld succeed in synthesizing Vitamin B1 on an industrial scale. The product



resulting from this breakthrough is introduced to the market under the name of Betaxin.

Coatings and plastics test unit is set up in Leverkusen.

The "Y" power station starts up in Leverkusen as the first smokeless unit, i.e. without chimney.

Synthetic rubber Buna is introduced to the public at the Berlin Motor Show.

Soccer team "SV Bayer 04" first appears in red-and-black colors with the Bayer cross logo.

Basilite wood preservatives go into production in Uerdingen.

World events 1936

A new constitution becomes effective in the USSR; the Great Purge begins.

In March, Germany denounces the Locarno Pact of 1925. German troops occupy the demilitarized zone of the Rhineland.

The XI Olympics begin in Berlin on August 1.

After the formation of the Popular Front coalition government in Spain, right-wing officers organize a coup d'état in July; the Spanish Civil War breaks out on July 17.



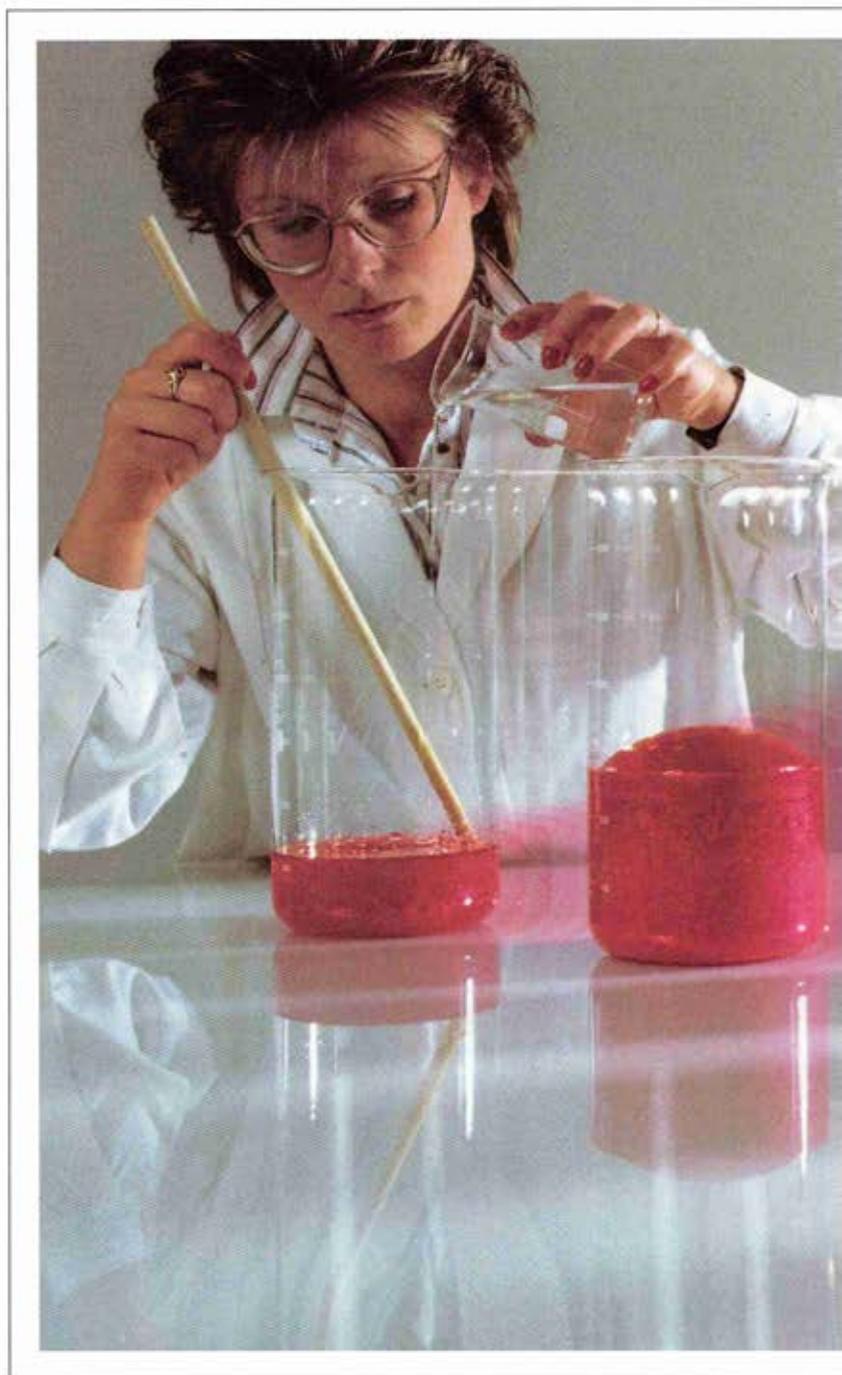
On November 12, the Golden Gate Bridge is opened in San Francisco.

In November, Japan and Germany sign the Anti-Comintern Pact, specifically aimed against the USSR. Italy joins the pact in January 1937.

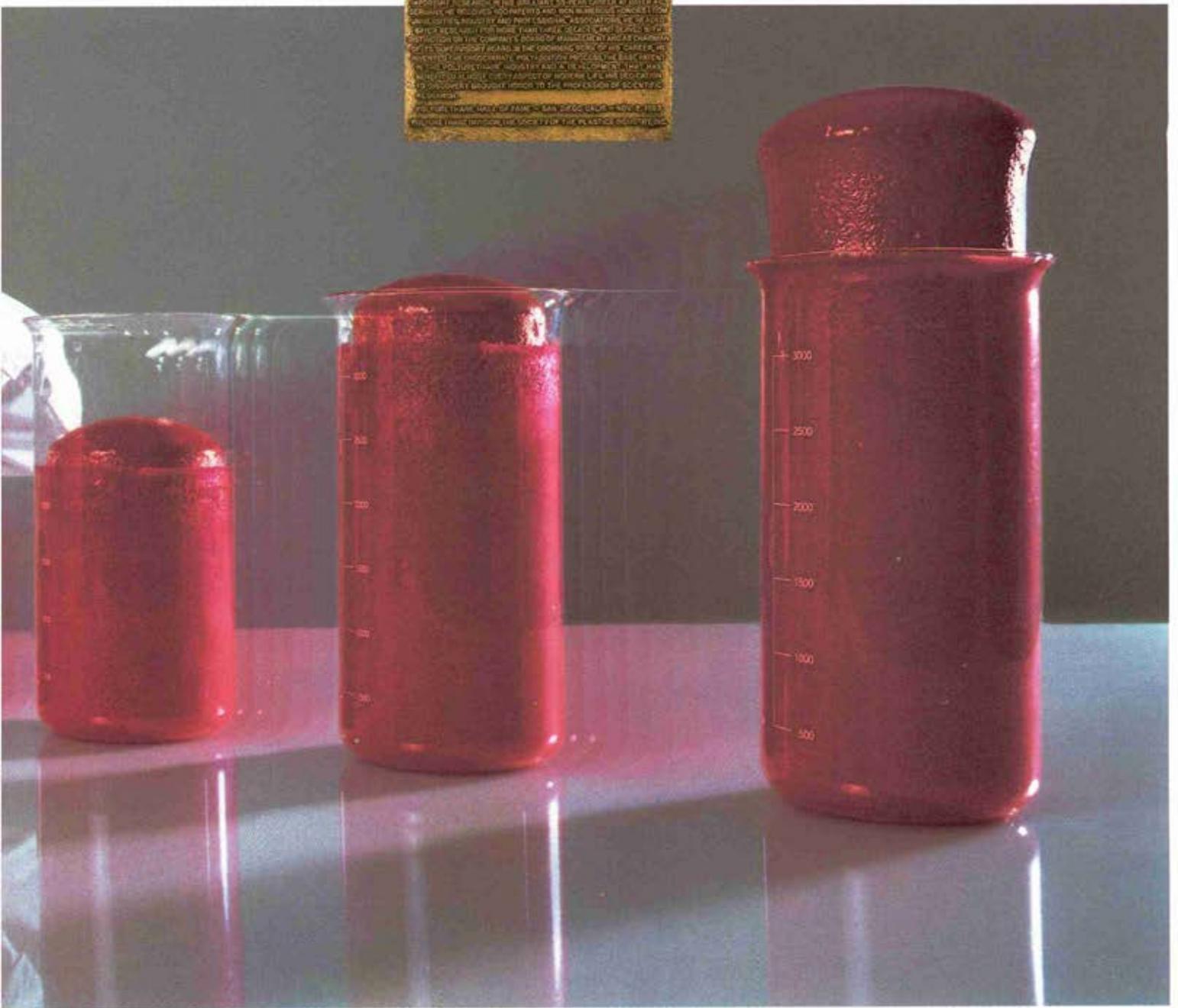
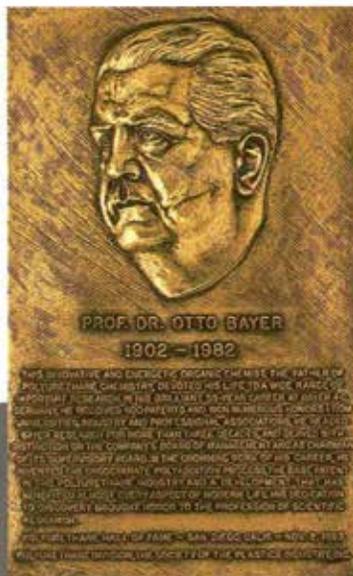
At the Party Congress on September 9, Hitler announces the second Four-Year Plan. His secret aim is to prepare Germany for war within four years.

Polyurethanes — a new class of plastics

In 1934, chemist Otto Bayer, who was no relation to the company's founders, became head of the Central Scientific Laboratory in Leverkusen at the age of 31. At that time, no one could have imagined that only a few years later he would invent polyurethane chemistry. In fact, his ideas still appeared quite far-fetched to some people in 1937.



Over and above the hard work and tenacity that went into the development of polyurethane, this invention was helped by sheer good luck. It all began with a far-fetched idea conjured up by Otto Bayer, who is shown here during a foaming experiment.

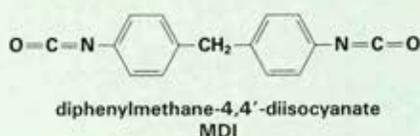


Today, the wonders of polyurethane chemistry are a matter of routine. In a fascinating demonstration for visitors, small quantities of two liquids are mixed together and within a matter of seconds, they produce a rigid foam. The plaque shown at the top of the page, which

is actually made of gilded polyurethane, is on display in San Diego, California. The Society of the Plastics Industry in the United States dedicated it to Otto Bayer, who joins the ranks of other great pioneers of polyurethane chemistry to be honored in this way.

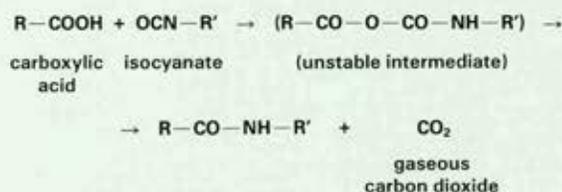
as a diisocyanate of rapidly growing importance and used

particularly in the production of rigid foams.



The formation of bubbles in the elastic molding substances in the early days of polyurethanes was due to the reaction

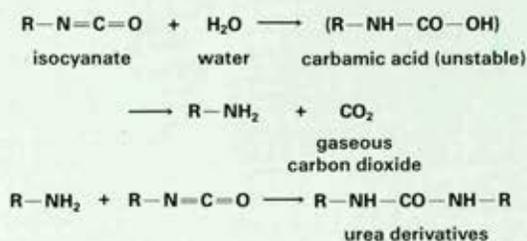
of the isocyanate group with residual free acid groups (-COOH) in the polyesters:



The gaseous carbon dioxide was unable to escape from the cohesive mass and was responsible for the bubbles.

In the manufacture of foam the bubbles are intentionally brought about in substantial

numbers by adding small amounts of water. Isocyanates react with water, forming substituted ureas and gaseous carbon dioxide (CO₂):



This reaction is still used today in the production of soft foams. In the case of rigid foam, low-boiling solvents

are added to the reaction mixture as foaming agents.

When Otto Bayer took over as head of the Main Scientific Laboratory, his work initially centered on dyestuffs. Management of I.G. Farben was, however, fully aware that future success depended on progress in new fields of production. As Otto Bayer said, *"I therefore made the effort to shift the emphasis in my laboratories to crop protection and macromolecular chemistry."*

Macromolecular chemistry was a new concept at the time. It was based on the ability to construct chain- or lattice-like supermolecules from simple compounds. This gave researchers a whole range of totally new raw materials to work with.

Much interest was directed to the discovery of starting materials for synthetic fibers. An initial success in this field was the PeCe fiber developed by I.G. Farben's Wolfen unit, but due to its low melting point, it was only suitable for certain uses as a technical fiber and not in the textile field. The invention of Nylon by Wallace H. Carothers of Du Pont brought the breakthrough for textiles.

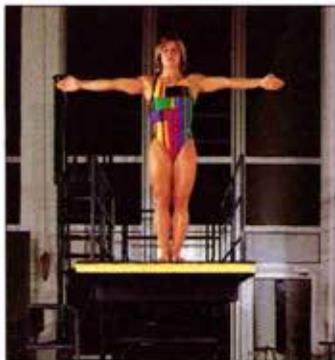
Nylon is a polyamide formed by the polycondensation of two components, whereby water is split off. Bayer: *"What I had in mind was a process which would enable the construction of macromolecules by letting two low-molecular compounds react with one another in a polyaddition phase, without either coreactant splitting off."*

Bayer wanted to bring about the polyaddition by using diisocyanates. When he presented his idea, however, his boss was far from enthusiastic; instead of uttering a word of encouragement, he thought for a long time before finally coming out with the devastating comment, *"You don't seem to be the right man to run the laboratory."*

Nor were his closest staff members much more encouraging. One of them remarked, *"If you had ever tried to make a monoisocyanate, you wouldn't have come up with the mad idea of trying to produce diisocyanates. The reaction of phosgene on diamines would result in almost anything except diisocyanate, and it would probably be thoroughly instable, anyway."*

The cross section of an experimental block, shown on the left, shows the homogenous nature of the structure of the product whose invention is described in this chapter. Pore size and firmness can be varied to the point where the foam is virtually "tailor-made."

Polyurethane—a new class of plastics



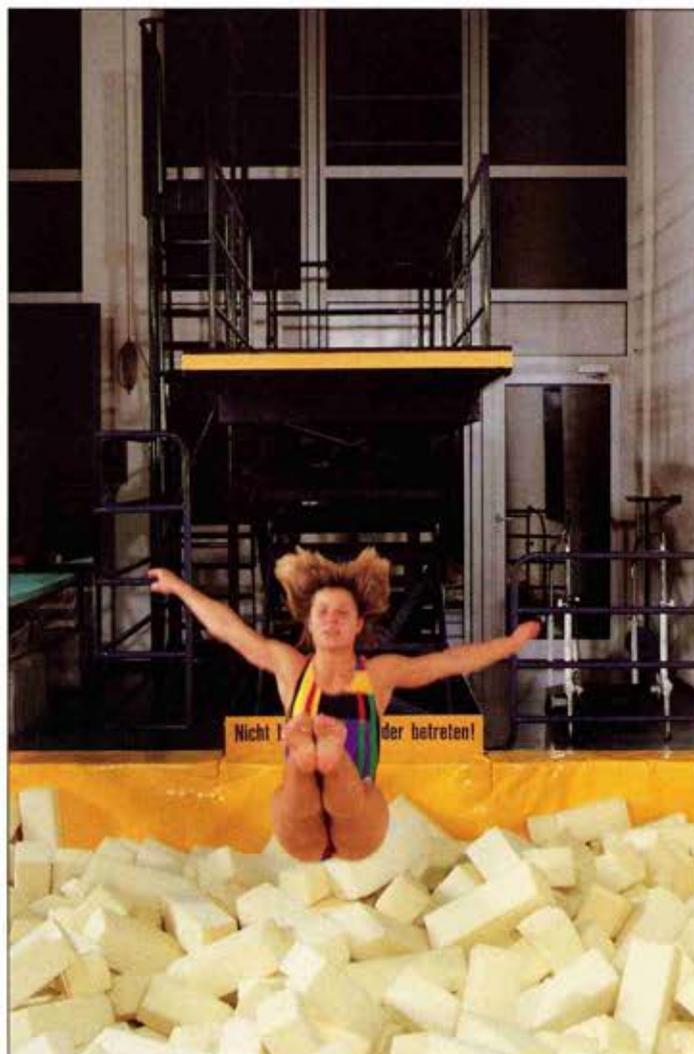
The technology seemed to present such insuperable difficulties that the project looked hopeless. Management did not even want to consider applying for a patent.

Heinrich Rinke, who worked with Otto Bayer, nevertheless had a try at solving the problem. After numerous experiments, he succeeded in finding a highly viscous substance that could be drawn out into filaments and showed similar characteristics to Carother's polyamides.

This discovery was encouraging and resulted in ambitious plans: the original polyurethane patent No. 728,981 was registered in 1937. But before a marketable product could be achieved, technical difficulties had to be overcome. The hoped-for fibers seemed to be a long way off, even if the new material could be used for the production of high-quality bristles. The point was that high-quality bristles were not exactly at the top of the government's or army's priority list, considering that the Second World War had broken out in the meantime. What they wanted was better synthetic rubber, so a different team was set up to look at the possibility of polyurethane molding substances with elastic properties.

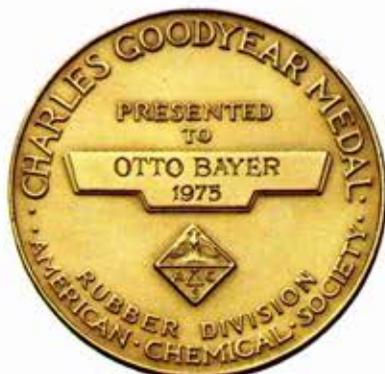
Ironically, success came with what seemed at first to be a failure. In 1941, experimental casting materials made from polyester and diisocyanates turned out to be so full of bubbles that the samples were sent back from the testing unit with the laconic statement: "*Suitable at best for the manufacture of imitation Emmentaler cheese.*"

Otto Bayer and his team investigated the reason for this slip-up—and found it could be put to revolutionary use. By adding small quantities of water, they intentionally started off the chemical process that led to the splitting off of carbon dioxide, and thus to the "Emmentaler holes." What emerged was polyurethane foam. It would still take more than ten years for the scientists and technicians to work out how to obtain foam of the desired consistency, rigid or soft depending on the intended use, but it had finally been proved that polyurethane was good for more than just high-quality bristles.



The Bayer patents that were registered in 1941 and 1942 had incredibly universal application. In fact, they covered uses for the polyurethane foams which were still inconceivable to scientists in 1937 and which Otto Bayer himself had not even thought of yet. His principle of polyaddition was, together with the existing process of polymerization and polycondensation, the third pillar in the construction of macromolecules.

Otto Bayer was the first German scientist to receive the Charles Goodyear Medal in recognition of his achievements.



Professor Otto Bayer lived to be almost 80, so he saw his idea developed into a universal plastic. He remained active in the field long enough to influence its development. On May 8, 1975, he was awarded the American Chemical Society's Charles Goodyear Medal in Cleveland as the first non-American ever to receive this honor. Bayer presented a paper at the awards ceremony entitled "The Odyssey of an Invention." He joked that while Ulysses had killed all Penelope's lovers on his way home, he, Bayer, was pleased with everyone who continued his work.

Otto Bayer's odyssey certainly became a triumph. Today, some six percent of total world plastics production is made up of polyurethanes. Four million metric tons of polyurethane raw materials were produced in 1987. With a market share of over 30 percent, the Bayer Group is the world's largest producer. Polyurethanes will feature repeatedly in the following years of Bayer's history.



This is not just an original idea for a studio shot by the photographer: the unusual application for polyurethane foam shown here can be seen in the National Diving Center in Aachen.



Elke Heinrichs has won the German Diving Championship 45 times. During her training, she practices diving into a swimming pool filled with blocks of soft foam.

Bayer chronicle 1937

At the World Exposition in Paris, I.G. Farben is awarded the Grand Prix for Agfacolor films, Buna, moth-repellent Eulan, light-metal alloy Hydronalium, indanthrene dyestuffs, the drug Prontosil and Vistra rayon.

First large-scale pilot plant for Buna S goes on stream at I.G. Farben's Schkopau works in January.

Peter Kurtz develops a process for the direct synthesis of acrylonitrile from hydrocyanic acid and acetylene.

With the introduction of the new sulfonamide Uliron, gonococcus infections can be cured by taking tablets.

A teaching laboratory with 48 workplaces is opened in Leverkusen.

Agfa introduces the new camera types Isolette (6x6 cm prints), Karat (35 mm film), Movex (8 mm film) and the Movector Projector.

World events 1937

Airship "Hindenburg" bursts into flames while trying to land at Lakehurst Airport in New Jersey on May 8.

Clash of Chinese and Japanese soldiers near Peking on July 7 marks the outbreak of war between the two countries.

Hans Brockmann and A. Busse obtain pure Vitamin D₃ from cod liver oil. Richard Kuhn and C. Morris synthesize Vitamin A.

Konrad Lorenz advances behavioral research to the status of an independent biological discipline.

Henrich Focke builds the first helicopter.

The chemical industry relies on international cooperation

As a consequence of the Great Depression, many governments began to see “salvation” in nationalism and in trade restrictions. However, for the chemical industry a strong presence in foreign markets was indispensable. The industry relied heavily on international cooperation.

Before World War I broke out, Bayer and the other large dyestuff manufacturers achieved the greater part of their sales outside of Germany. After the war, contacts to international markets were reestablished little by little. But with currency problems and protectionism seriously hindering business, the days of truly international free trade ceased to exist. Nevertheless, the world saw unprecedented prosperity in the twenties.

New products helped to create new market potential both in Germany and abroad. By setting up affiliated companies, it was possible to win back market positions that would otherwise have seemed unattainable because of the insuperable import barriers. Thus, I.G. Farben acquired companies in Italy, Spain and the United States in the 1920s.

The absolutely essential confidence in the political system also seemed to be reconfirmed. The Locarno Pact and the foreign policy of Gustav Stresemann created a basis for international cooperation. However, many problems still remained unsolved, and political intervention in the markets prevented growth at an even pace in the world economy.

The rude awakening came with the Great Depression, which lasted from 1929 until 1933. Instead of promoting international trade, lessening import barriers and working together to find a political solution, the governments of the industrialized countries pursued their own national interests. Currencies were devalued, import duties increased and programs introduced to boost domestic business. The National Socialist government of Germany carried this policy to an extreme by announcing its self-sufficiency program. Foreign trade policy became an instrument of the powers that be. Rather than pursuing an open trade policy, everything had to be spelled out in bilateral written agreements. Strict controls on foreign currency came as an added burden.

As a result, I.G. Farben ran into difficulties. As the largest German exporter, it was a welcome source of money for the government. The incoming foreign currency had to be handed over to the Reichsbank.



In addition, I.G. Farben was forced to give enormous amounts of money to the government, which were then used to promote the exports of other companies. But the worst was that because of the German politics, exporting itself became increasingly difficult.

Discrimination and persecution of the Jews led to boycott actions against German products. Government controls of foreign trade meant that possibilities for pursuing company interests were limited. In 1929, I.G. Farben recorded 55 percent of its sales outside of Germany; in 1937, it was less than a third.

The good relations between the international chemical companies were in clear contrast to the political development of the time. Mutual agreements were reached between the firms of different nations in an attempt to lessen the impact of the Depression and to stabilize the market situation. These kinds of cooperations were permitted in all countries except the United States, even though competition suffered in the process.

As early as 1929, the dyestuff manufacturers of Germany, France and Switzerland reached an agreement to regulate their export business. The British ICI joined the group in 1932. A similar agreement took place in the nitrogen fertilizer industry in 1930, and in 1931, the major manufacturers of synthetic fibers set up a joint sales office in Germany. In the same year, the aluminum industry signed an international accord.

Competition between the leading chemical companies did not come to a standstill, however. The search for new processes and products continued. Major discoveries in plastics, fibers and pharmaceuticals were achieved during these years, e.g. Nylon at Du Pont. As part of an international co-operation, Du Pont even licensed out this discovery to I.G. Farben and ICI in 1939.

In 1938, ICI and I.G. Farben set up a joint venture, the Trafford Chemical Company. This mutual project never got off the ground; World War II broke out in September of 1939.

The chemical industry's scientists and commercial staff remained internationally minded even when politicians were increasingly putting national interests first.

The picture on the left shows participants at the International Nitrogen Conference—the so-called Adriatic Conference—held in Trieste at the beginning of 1928.

Bayer chronicle 1938

The 75th anniversary of the foundation of Farbenfabriken vorm. Friedr. Bayer & Co. is celebrated in Leverkusen. A total of 21,774 employees now work for the Lower Rhine Division of I.G. Farben.

Edith Weyde in Leverkusen and, at the same time, André Rott in Mortsel develop the silver salt diffusion process. The resulting Agfa Copyrapid pioneers photocopying technology.

Paul Schlack of I.G. Farben's Aceta-Werk in Berlin invents the synthetic fiber Perlon.

Bayer-Pharma makes the first use of an airplane—the Junkers 52 shown below—to transport pharmaceuticals.



At the Leverkusen plant, power supplies are centralized and the principle of heat and power coupling introduced.

New job categories are introduced for young factory and laboratory workers.

First Astrazon dyestuffs, later to play an important role in the production of Dralon, come onto the market.

World events 1938

German troops march into Austria on March 12. The following day, Adolf Hitler proclaims the annexation of the "Ostmark" to the German Empire.

In the Munich Agreement of September 29, the United Kingdom, France, Italy and Germany agree on the ceding of the Sudeten region, most of whose inhabitants are ethnic Germans. On returning to London, Prime Minister Neville Chamberlain declares "Peace in our time!" Hitler states in a speech that Germany now has no further territorial demands.

During the night of November 9, the so-called "Kristallnacht," pogroms are carried out against the Jews throughout Germany.

Mass panic breaks out in America on October 30, when Orson Welles produces a radio dramatization of H.G. Wells' "War of the Worlds."

Konrad Zuse constructs the first digital calculator.

German chemist Otto Hahn succeeds in splitting the uranium atom.

A successful German film starring Gustav Gründgens bears the ominous title "Dance on the Vulcano."

1933 -
1938

The I.G. Farbenindustrie in the Third Reich

The government-controlled economic program brought Germany out of the Depression, but the politics that led the country out of the crisis were also responsible for its disastrous end. Signs of the impending catastrophe began to show in 1933.

On January 30, 1933, Hitler became chancellor. On March 23, the Reichstag passed the so-called "Enabling Act" which transferred legislative powers to the government and thus gave it dictatorial rights. When President Paul von Hindenburg died on August 2, 1934, Adolf Hitler was proclaimed "Führer (Leader) of the German Reich for life," a move that gained approval from 89.9 percent of the electorate in a subsequent referendum. In their years of need, the German people had hoped for a strong man at the helm. Now they had him.

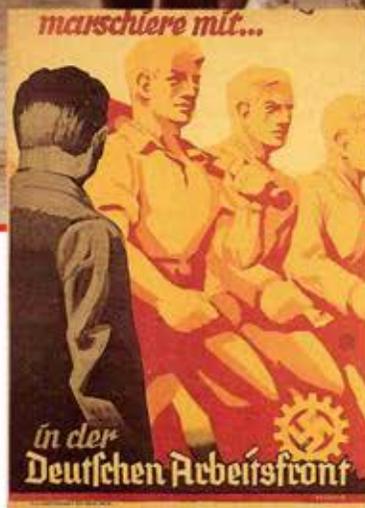
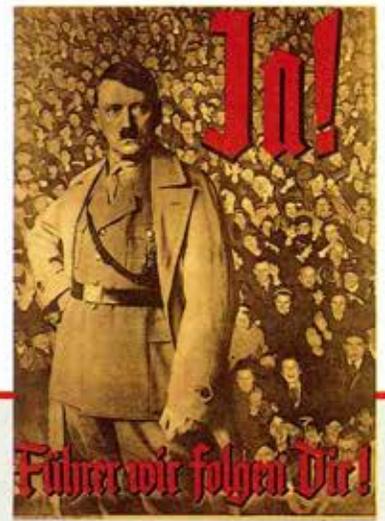
The "German Revolution," as the National Socialists liked to call their power takeover, had two faces. On the one hand, the introduction of a national labor corps, the resumption of compulsory military service, the much-publicized construction of the Autobahn system and other spectacular work-creation projects actually succeeded in doing away with unemployment. At the start of 1933, there had been almost seven million Germans without jobs; by 1936, there was full employment.

On the other hand, there was the terror campaign of the regime. The troops of the Nazi Party, the SA and the SS, were given the status of auxiliary police; a Secret State Police, called the Gestapo, was set up. Political opponents were sent to concentration camps; political parties and labor unions were banned; anti-Semitism was promoted by boycott campaigns, and the Jews began to be excluded from public life. The German catastrophe started long before the Second World War.

The outward appearance of the Third Reich was characterized by cheering crowds and wild demonstrations of enthusiasm orchestrated at massive public events. The plebiscites held after every new political move regularly showed approval rates of 90 percent or more. They conveyed the impression to the country and the world at large that the Germans stood behind their "Führer."

Like the rest of the economy, I.G. Farben benefited from the upswing. The company had been calling for a work-creation program and an active policy of encouraging business since the Depression had begun.

This picture was taken on May 1, 1933. It shows Leverkusen workers on their way to a May Day celebration. Nazi propaganda, in the form of small meetings or mass events or posters like those shown, was soon part of daily life in Germany.



Basically, it was in favor of the economic policies of the National Socialists although the company had remained aloof toward the Nazi Party until its seizure of power. On April 21, 1933, the then-chief executive of the trust's Lower Rhine Division told works managers how happy he was that the country again had a government that put duty and work in the forefront and wanted to bring together "those who work with their heads and those who work with their hands." A few days later, on May 1 (the "Day of German Labor"), employees marched through Leverkusen under the swastika.

In 1934, the government passed a "Law for the Regulation of National Labor" which divided the



labor force into "leaders" and "subordinates." In I.G. Farben, with its dozens of plants and the five major regional divisions, there was one central manager, one manager of each of the divisions and one works manager for each plant. The head of the Lower Rhine Division and the Leverkusen works itself was Hans Kühne. He had joined the Nazi Party in 1933, but he soon lost his membership because he belonged to a Freemason's Lodge and was not reinstated in the Party until 1939.

Prior to 1933, only one member of I.G. Farben management had been in the Party. By 1938, most members of the Board of Management had joined.



The majority of them had no strong political feelings and did not play an active role in the Party. They viewed the Third Reich in light of scientific and business developments and wanted a good relationship between the company and the local Party organization.

Most of I.G. Farben's managers were critical of the growing terror against the Jews and the increasing interference of the federal government in the economy. However, it did not occur to them to feel politically responsible or even take action in political terms. They knew that the chairman, Carl Bosch, was one of the few to complain to Hitler about the expulsion of Jewish scientists, but they also saw that Bosch had spoken in vain.

The meeting between Bosch and Hitler took place in the early days of the Third Reich. Nobel laureate Fritz Haber had lost his professorship at Berlin University, and Bosch was determined to intervene on his behalf. It was a stroke of luck when he was invited to a talk with Hitler in May 1933, at a time when the chancellor wanted to meet the representative of the chemical industry who was to join the planned general business council. Bosch attempted to persuade Hitler that the dismissal of Jewish scientists would set Germany's chemistry and physics back "a hundred years." Hitler's answer: *"In that case, we'll work for a hundred years without physics and chemistry."*

The Lower Rhine Division also felt the impact of the government's economic program. At the end of 1932, there had been 9,600 employees at Leverkusen. This total rose to 11,200 the following year, and by 1936, the payroll of 13,170 was bigger than it had ever been. The same applied to other I.G. Farben plants. The mobilization of business followed the plans of the Nazi government, whose real target was rearmament. As Germany had learned from World War I, it could be militarily strong only if it were free from dependence on strategic imports—such as Scandinavian ores, rubber from Southeast Asia, American cotton and fats and Canadian nickel ores and mineral oil products.

Processions and in-plant assemblies in the I.G. Farben works in Leverkusen as elsewhere belonged to the ceremonial of the Third Reich. The photograph on the left shows marchers in front of Gate 4 on the "Day of German Labor" in 1935. The one above gives

an impression of a gathering in the Central Scientific Laboratory. At the 1936 Automobile Exhibition in Berlin, tires stemming from Germany's own synthetic rubber production were on display. The tires were tested on army vehicles.

A series of Four-Year Plans was to make Germany self-sufficient. The chemical industry played a key role in these efforts. In fact, the expansion of such basic industries as iron, steel, coal and chemicals was one of the focal points of the government's economic program after 1933.

In December 1933, I.G. Farben signed an agreement with the government concerning the expansion of the synthetic mineral oil plant in Leuna. This represented a solid guarantee for the I.G. project, while for the government it meant a step towards self-sufficiency in motor fuel. Contracts for the expansion of light-metal capacities followed, and production of rayon and cellulose was also increased.

The biggest single project of this kind, however, was the manufacture of synthetic rubber (see page 248). When the Nazis began to stress the importance of motorization and showed interest in German-made rubber, I.G. Farben resumed the research work that had been abandoned earlier. It took until 1937 for a suitable process to be developed, and a serviceable material was first available in 1938. In cooperation with the government planners, the company launched the construction of large-scale synthetic rubber facilities in Schkopau and Hüls. For the financing of new production units, specifically those for synthetic rubber and gasoline, the government granted loans, tax breaks and purchase guarantees for products which otherwise could not have been sold.

In September of 1936, Hitler announced the second of his Four-Year Plans. The press reported that it was designed to create a basis for a "crisis-proof economy, independent of imports." In a secret memorandum written shortly before this announcement, Hitler had indicated his real goal: Germany was to be prepared for war, both economically and militarily, within four years.

When Hermann Göring was put in charge of raw materials and monetary policy in early 1936, he set up a committee of advisers and appointed Fritz Löb, Lieutenant Colonel of the Luftwaffe, as its head. Löb then approached I.G. Farben about an expert on chemicals. Carl Krauch, head of the nitrogen and mineral oil division, agreed to take on the assignment. He remained a member of the Board of Management at the same time.

The military had set production targets that the chemical industry had to meet in 1938 and 1939. When Hitler started to prepare the invasion of Czechoslovakia, it became obvious that the targets were far from having been reached. As the designated expert on chemicals, Krauch drew this fact to Göring's attention. In return, Göring appointed him "Plenipotentiary General for Special Questions on Chemical Production," or "Gebechem" in the German abbreviation. Krauch resigned from I.G. Farben's management but returned in 1940, when he succeeded Carl Bosch as Chairman of the Supervisory Board.

I.G. Farben grew with the construction of new plants and the expansion of existing facilities. Substantial investments were made in the Lower Rhine Division, from which the Farbenfabriken Bayer was to be formed after the war. The main operations of this region were inorganic and organic starting materials and intermediates, in addition to dyestuffs in Leverkusen and Uerdingen, pharmaceuticals in Elberfeld and synthetic fibers in Dormagen.



1939 -
1945

The I.G. Farbenindustrie during World War II

On August 31, 1939, the illuminated Bayer cross over the Leverkusen plant went out. It had to be switched off under the new blackout regulations. This was more than just the introduction of a further restriction, it was a symbol. The lights were going out all over Germany.

On September 1, 1939, the German army invaded Poland. Two days later the United Kingdom and France carried out their commitment to guarantee Polish independence and declared war on Germany. The "blitzkrieg" against Poland was only the first act of a tragedy that was to be played on the world stage over the next six years. It was also the initial step of Hitler's grand design to send his soldiers eastward and thus to extend the borders of Germany.

Modern warfare demands full support from industry and technology. All arms systems—whether tanks, aircraft, submarines, torpedos or rockets—are industrial products. Chemicals also have a role to play in the production of armaments; apart from steel, the war machine needs explosives, rubber, fuel, lubricants, rare alloys, nitric and sulfuric acid, fibers, coatings and pharmaceutical products.

At the outbreak of the war, the plants of the chemical industry were declared to be of strategic importance. This meant that they were able to enjoy special treatment in respect to supplies of raw materials, building materials and manpower.

Manpower was to become a serious problem as the war continued. There had already been a shortage of labor in Germany as far back as 1937. The draft of ever-increasing numbers of workers was now jeopardizing even strategic industries.

The government had long taken steps toward solving this problem. In 1936, before the war, a number of legal requirements were enacted that subjected the labor market to tight regulation. Work became "duty" for every German, with the federal government empowered to direct labor as it thought fit. Companies had to report their manpower needs to



official Labor Offices in accordance with their production and construction orders. When wartime exigencies meant that German labor was no longer capable to keep up with production quotes, the government first tried recruiting volunteers abroad. In addition, their ranks were soon joined by prisoners-of-war allotted by the army.

But even with these measures, there was still not enough manpower for industrial needs. In order to maintain and increase the production of strategic materials, the Nazi regime subsequently decided to apply more brutal methods to solve the labor shortage problem. From the occupied countries of Eastern Europe in particular, hundreds of thousands of people were deported to work in Germany.

Government regulations laid down every detail of how this slave labor was to be treated. Accommodations, meals, working conditions, payment and recreation were all systematically organized by the Nazis. There were rules for everything. People from Poland and the Soviet Union, in particular, were treated badly.

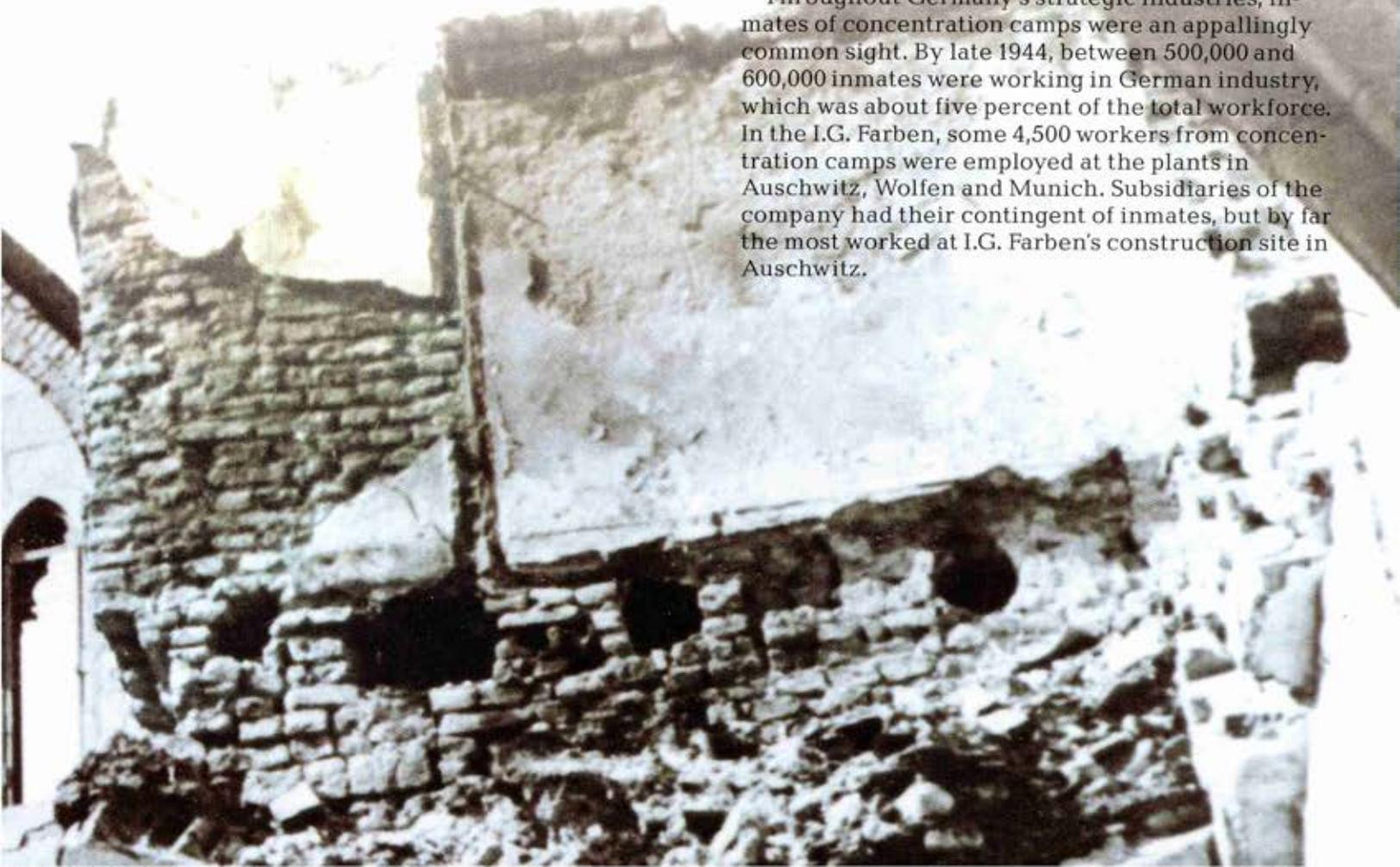
The foreign workers were thus split up into different categories according to their nationality. For example, those from Eastern Europe did not receive full pay rates because the employers had to pay state-imposed special levies on the use of Eastern Europeans to the government. Scarcely more than a bit of pocket money was left over for the workers themselves.

In order to meet its production commitments, the Lower Rhine Division of the I.G. Farbenindustrie also applied to the Labor Offices for an increasing number of foreign workers. Initially, most foreign workers that were employed in the Division were volunteers from Western Europe. The first Poles arrived in June 1940.

With the start of the Russian offensive, the use of forced labor grew rapidly. The first Ukrainians and Russians came in the fall of 1941. The number of foreign laborers in the Leverkusen I.G. Farben plant rose steadily to reach its peak of 4,300 out of a total workforce of 18,000 in the fall of 1944.

As bad as the situation of the forced labor contingent was, workers supplied by concentration camps were even worse off. They were quite literally slaves; they had no rights at all under the Nazi system.

Throughout Germany's strategic industries, inmates of concentration camps were an appallingly common sight. By late 1944, between 500,000 and 600,000 inmates were working in German industry, which was about five percent of the total workforce. In the I.G. Farben, some 4,500 workers from concentration camps were employed at the plants in Auschwitz, Wolfen and Munich. Subsidiaries of the company had their contingent of inmates, but by far the most worked at I.G. Farben's construction site in Auschwitz.



I.G. Farben received an order on November 2, 1940, to build a large-scale plant in Silesia for the production of synthetic rubber and motor fuel. Auschwitz was a village in a region that had just been annexed by Germany. The new plant was to be built in the East because of the frequency of air raids by the Allied forces in western areas. A site near Auschwitz was chosen because of the availability of coal, water, lime and power.

At first the question of manpower remained unsolved. The company envisaged bringing in skilled labor from its own plants in western and central Germany, but the responsibility for providing construction workers rested primarily with the state government officials.

There had been a concentration camp close to Auschwitz since mid 1940. By the beginning of 1941, the SS held several thousand prisoners there and by the fall of 1941, Auschwitz had become the largest "extermination camp" of the SS. Millions of people were murdered in this camp by the end of 1944.

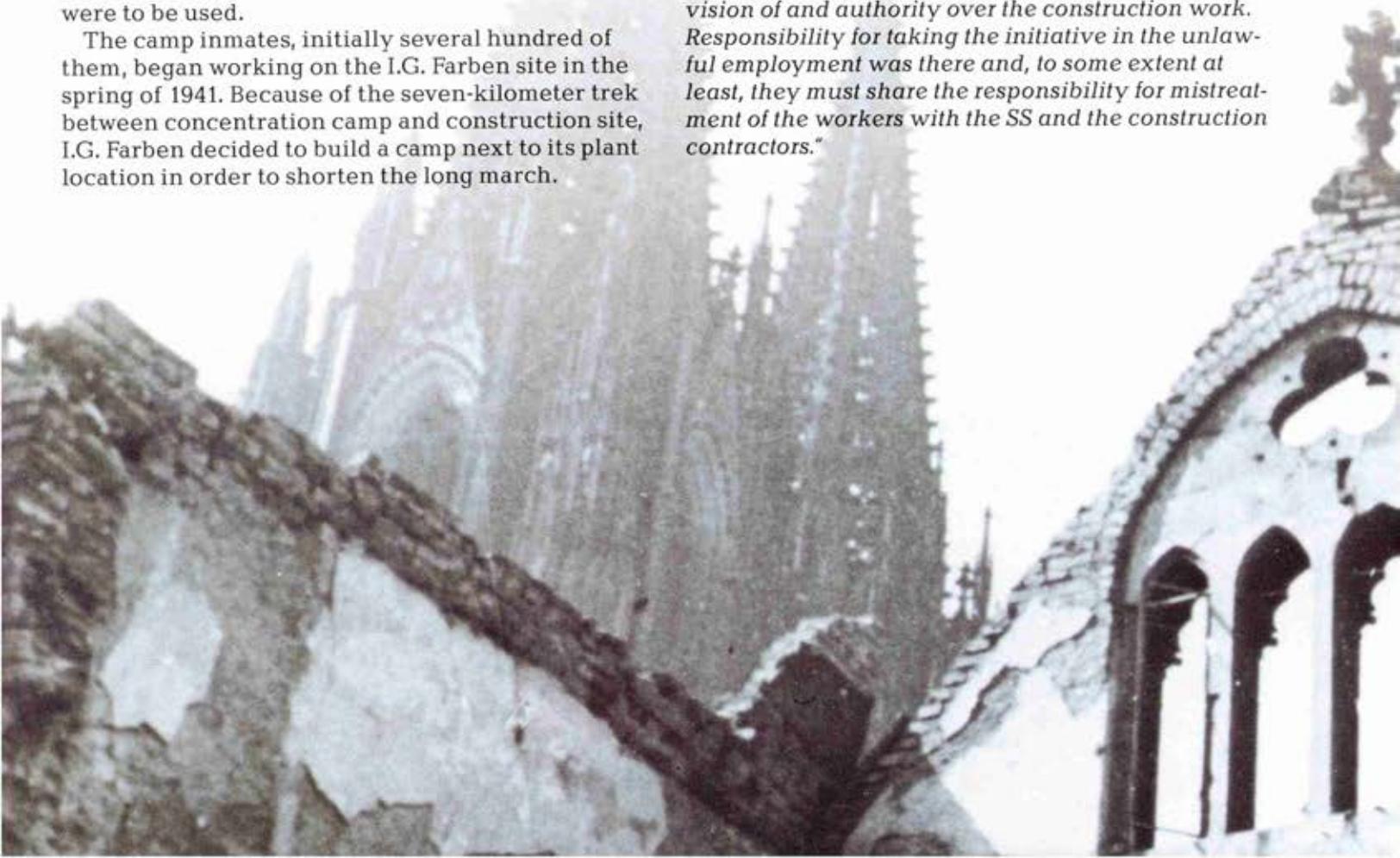
After approval from the joint chiefs of staff, Göring asked Himmler to provide prisoners for construction work. Himmler passed on a corresponding order to the SS in March 1941. The Plenipotentiary General informed I.G. Farben, which subsequently contacted the SS and agreed on the details of how the inmates were to be used.

The camp inmates, initially several hundred of them, began working on the I.G. Farben site in the spring of 1941. Because of the seven-kilometer trek between concentration camp and construction site, I.G. Farben decided to build a camp next to its plant location in order to shorten the long march.

According to the "Jewish Conference on Material Claims against Germany," a total of some 38,000 mainly Jewish prisoners were forced to work at the site between 1941 and January 27, 1945. It is assumed that over 30,000 of them subsequently died. When they were no longer able to work, they were murdered by the SS in the Auschwitz extermination camp.

The American Military Tribunal judged as follows in the I.G. Farben trials (see page 304): *"It is clear that I.G. Farben did not deliberately pursue or encourage an inhumane policy with respect to the workers. In fact, some steps were taken by I.G. Farben to alleviate the situation. It voluntarily and at its own expense provided hot soup for the workers on the site at noon. This was in addition to the regular rations. Clothing was also supplemented by special issues from I.G. Farben.*

"Despite this, however, it is evident that the defendants most closely connected with the Auschwitz construction project bear great responsibility with respect to the workers. They applied to the Reich Labor Office for labor. They received and accepted concentration camp workers, who were placed at the disposal of the construction contractors working for I.G. Farben. The chief engineer, Walther Duerrfeld, with the help of other defendants, had a definite responsibility regarding the project in the overall supervision of and authority over the construction work. Responsibility for taking the initiative in the unlawful employment was there and, to some extent at least, they must share the responsibility for mistreatment of the workers with the SS and the construction contractors."



Bayer chronicle 1939-45

In 1939, a breakthrough in synthetic rubber technology is achieved with Paul Logemann's success in the field of redox polymerization.

Polyurethane-polyaddition reaction discovered by Otto Bayer in 1937 leads three years later to the development of new kinds of DD coatings.

First antituberculosis drug is developed in Gerhard Domagk's laboratory in 1940.

Leverkusen plant is first hit by bombs in 1940.

Hans Kühne resigns as chief executive of the Leverkusen works and the Lower Rhine Division for health reasons in 1943 and is succeeded by Ulrich Haberland.

In 1943, the Welfare Department sets up an independent unit for occupational safety at the workplace. A service is established to help bombed-out employees.

Leverkusen plant is practically closed down by a bomb attack on October 26, 1944.

World events 1939-45

World War II begins with the German invasion of Poland on September 1, 1939. Two days later, France and the United Kingdom declare war on Germany.

Finnish-Soviet "Winter War" begins on November 30, 1939, when the Soviet Union attacks Finland.

On April 9, 1940, German troops invade Denmark and Norway.

Germany's Western offensive begins on May 10, 1940, with the invasion of the Netherlands, Belgium and Luxembourg.

Italy joins the war as an Axis power on June 10, 1940. On June 22, Germany and France sign an armistice agreement. General Charles de Gaulle escapes to England on June 18 and proclaims the continuation of the war against Germany.

Italy opens hostilities against Greece on October 28, 1940.

On April 6, 1941, Germany attacks Yugoslavia and Greece.

Germany breaks the Hitler-Stalin Pact on June 22, 1941, with the invasion of the Soviet Union. Joseph Stalin proclaims the "Great Patriotic War" against Germany.

World events 1939-45

Japanese aircraft attack the U.S. Navy base at Pearl Harbor on December 7, 1941, marking the start of the war in the Pacific. Four days later, Hitler declares war on the United States.

The "Declaration of the United Nations" is signed by the Allies on January 1, 1942.

At the so-called "Wannsee Conference" in Berlin on January 20, 1942, the SS and various German ministries reach an agreement on the deportation and murder of Jews in Germany and occupied countries. Organized genocide begins, leading to the murder of between five and six million people.

In the Battle of Midway from June 3-7, 1942, American forces succeed in breaking the Japanese stranglehold in the Pacific.

Anglo-American summit is held in Casablanca from January 14-26, 1943. Germany is called upon to surrender unconditionally.

The American Air Force launches a strategic air offensive against Germany on January 27, 1943, by bombing important centers of the country's war economy. This includes attacks on the I.G. Farben's hydrogenation and synthetic rubber facilities.

World events 1939-45

On June 30, 1943, U.S. forces land on New Guinea and begin the process of "island-hopping" which leads to the expulsion of the Japanese from the Pacific region.

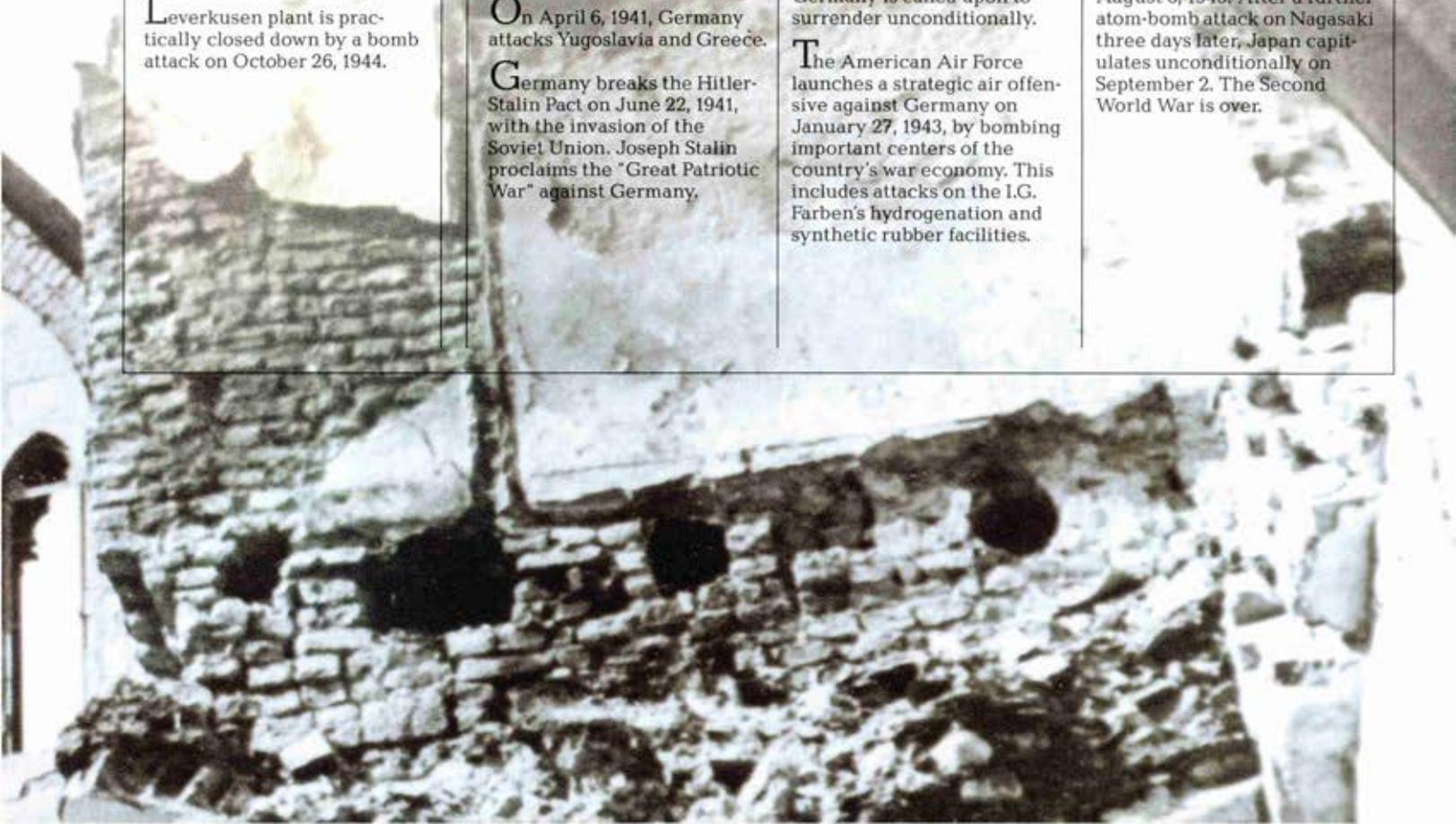
Allied troops land in Normandy on D-Day, June 6, 1944, marking the long-awaited offense to liberate the Continent.

On November 7, 1944, Franklin D. Roosevelt is elected to a fourth term of office as president. He dies on April 12 of the following year and is succeeded by Harry S. Truman.

The United Nations is officially founded at a conference in San Francisco on April 25, 1945.

Unconditional surrender of the German forces is signed in Reims on May 7, 1945, and repeated two days later at Soviet headquarters.

Hiroshima is destroyed by an American atom bomb on August 6, 1945. After a further atom-bomb attack on Nagasaki three days later, Japan capitulates unconditionally on September 2. The Second World War is over.



Picking up the pieces and making a new start

During the months of February and March 1945, Leverkusen had been under shellfire from American artillery units. On April 14, the plant was occupied by soldiers of the 59th U.S. Infantry Division. The Lower Rhine factories of I.G. Farben entered into a new and provisional phase of their existence that was to last until the establishment of a new Bayer organization at the end of 1951.



The same gatehouse shown on page 294 looked like this after a bomb attack in 1944. Although Leverkusen had been the target of bombing raids since 1940, and then later on in the war suffered from the artillery attacks, not all buildings were destroyed to the extent shown in this photograph.



In the spring of 1945 nobody really knew what plans the Allies had for Germany. One thing seemed certain—there would be no I.G. Farbenindustrie AG in the future.

Although the companies of I.G. Farben had grown together to form an integral unit over the years and none of its managers would have wanted to see it scrapped, no one had any false hopes. Everyone knew that times had changed.

In the first phase of the postwar era, which was marked by shortages of just about everything, the reorganization of I.G. Farbenindustrie was not the major concern. The first priority was to get the plants working again so that urgently needed products could be produced. The decisions necessary to achieve this had to be taken by the Allied military authorities.

On June 15, 1945, the Americans handed over control of Leverkusen to the British Military Administration in accordance with the provisions of the agreement that established occupation zones. Consequently, a British Army officer took over the responsibility for the Lower Rhine plants. For the time being, no important decisions could be made without his approval.

Only a few days after the war ended, the employees of the Lower Rhine facilities were back at work—at first the only work for them was to clear away the rubble and make a few temporary repairs. No one was asked what his or her normal job had been; chemists put in time as glaziers, and patent experts tried their hand at repairing roofs. No building materials were available. Drums were hammered flat and used to patch roofs, while girders were hauled out of the debris for use as temporary props.

It was not long before the local work force was strengthened by released prisoners-of-war and employees from I.G. Farben's central German works. Among these were people from the Agfa plant in Wolfen who brought along production secrets hidden in their shoes. All of these people could be provided with only scanty food and even scantier accommodations.

Right from the beginning of the occupation, there was an absolute ban on production. However, the emergency conditions soon put an end to this. In June, the first permits were issued for individual product groups.

The nearby city of Cologne needed chlorine for the treatment of its drinking water and disinfectants to keep epidemics at bay. The population was in urgent need of pharmaceuticals. Among the first of these to go into production again were vermicides and sulfonamides; the first batch of Prontosil was produced in October 1945. In Dormagen Perlon bristles were soon being made for brushes, and finally, Agfa was allowed to use up its film emulsions before they spoiled and to produce X-ray paper.

From the start, interrogation teams visited the plants regularly. These groups consisted of American, British, French, Russian and even Chinese experts who questioned executives on production processes and research. The chemists usually turned out to have a remarkably poor memory. They also frequently claimed to have no key to filing cabinets, which were then blown open. The results of the interrogations were summarized in detailed reports and made available to the industries of the various Allied countries.

Employees often turned the interrogations into a farce by "passive opposition." An example is given by Heinz Berger, who had come to Leverkusen from Wolfen: When an interrogation team wanted to know how Agfa's excellent black-and-white photographic papers were made, Berger simply jotted down instructions on a piece of paper and handed them to the foreman. This was the way it had always been done, he claimed, with no "recipes" or laboratory journals. The workers made up the quite absurd emulsions without a word. Since the interrogators were told it would take 12 hours before this could be used, they decided to come back the next morning. They then found a first-rate emulsion which had been exchanged with the other concoction during the night shift. The interrogators never discovered how it was produced.

The stamp on the right symbolizes the transition between the days of I.G. Farben and the rebirth of Farbenfabriken Bayer. Although an actual corporate entity did not stand behind the designated company name until 1951, it was already obvious that the new firm would continue the Bayer tradition.

The production capacity and the workforce of the Lower Rhine units grew much faster than anyone could have imagined in April 1945. When the war came to an end for Leverkusen, only 1,730 people were at work there; a year later there were 10,940.

Chemical products were needed, and so were jobs. To the astonishment of many foreign observers, the Germans did not fall into a state of apathy and resignation in the face of their ruined cities and their national disaster. After all of the destruction the war had left in its wake, the country wanted to get back to doing something constructive.

The rebuilding of the Lower Rhine chemical plants was aided by the pragmatic approach of the British officers. The victors and the vanquished learned how to get along with one another. The British soon realized that the link-up between the Lower Rhine works in Leverkusen, Elberfeld, Uerdingen and later Dormagen made economic and technological sense. Ulrich Haberland, who had headed the Division since 1943, was given the chance to maintain the plants as a unit—and thus lay the foundation for the renaissance of Bayer. He received invaluable help from Walter Hochapfel, chairman of the newly formed Works Council.

It was more than just a symbolic act when the British Military Government ordered the former Division to be renamed "Farbenfabriken Bayer, I.G. Farbenindustrie AG in Dissolution (under British Control)" on July 1, 1947. Even though it was to take more than three years for the actual corporate form of the operation to be sorted out, this set the stage for what was yet to come.

Bayer chronicle 1946

In April, a Denazification Commission is set up in the Leverkusen plant as part of the regional denazification committee.

	Year	Month	Day	Place
1. 1945	1945	1945	1945	1945
2. 1945	1945	1945	1945	1945
3. 1945	1945	1945	1945	1945
4. 1945	1945	1945	1945	1945
5. 1945	1945	1945	1945	1945
6. 1945	1945	1945	1945	1945
7. 1945	1945	1945	1945	1945
8. 1945	1945	1945	1945	1945
9. 1945	1945	1945	1945	1945
10. 1945	1945	1945	1945	1945
11. 1945	1945	1945	1945	1945
12. 1945	1945	1945	1945	1945
13. 1945	1945	1945	1945	1945
14. 1945	1945	1945	1945	1945
15. 1945	1945	1945	1945	1945
16. 1945	1945	1945	1945	1945
17. 1945	1945	1945	1945	1945
18. 1945	1945	1945	1945	1945
19. 1945	1945	1945	1945	1945
20. 1945	1945	1945	1945	1945

(The above illustration shows page 6 of the questionnaire issued by this Commission.)

Bayer is given back the trademarks confiscated in Italy.

On February 19, the first postwar Works Council elections are held in Leverkusen with 75-percent participation.

Clinical tests begin on TBI (Conteben), an antituberculosis drug developed by Gerhard Domagk.

World events 1946

Emperor Hirohito of Japan makes a public disclaimer of his divinity.

Winston Churchill supports the principles of European unity in a number of speeches and starts the initiative for the founding of the North Atlantic Treaty Organization (NATO).

On October 1, judgments are pronounced in the Nuremberg war crime trials. Twelve leading representatives of the Third Reich are condemned to death by hanging.

President of the United States Harry S. Truman approves an aid program for the population of Germany on February 21. (The picture shows the dis-



tribution of CARE packages in Germany.)



Nuremberg and the end of the I.G. Farbenindustrie

In 1945, almost exactly 20 years after the formation of the trust, the existence of I.G. Farbenindustrie AG came to a virtual end. Its assets in central and what had been eastern Germany were lost. In the West, the group was broken up and the plants put under Allied control. The top managers had to answer to a U.S. military tribunal.

One of the major strategic targets of the Allies was the destruction of the German armaments industry. Many viewed I.G. Farbenindustrie as a symbol for the harnessing of business to the war effort. For this reason, the total assets of the company were confiscated with the intention of dissolving I.G. Farben and making the capital available for reparations. Production units manufacturing essential goods for civilian use were initially to be controlled by the victors and subsequently handed over to new, small-scale companies. These intentions were announced by the Allied Control Council in its Law No. 9 of November 1945.

In fact, the clear and plausible provisions of this decree turned out to be impracticable. The Allies were soon in disagreement; each had a policy of its own. The Russians confiscated the central German works and made them into "Soviet corporations." The American military government wanted to turn every individual plant into a company of its own. The French administered the works on the left bank of the Rhine in Ludwigshafen and Oppau. The British took a pragmatic approach and left the Lower Rhine Division intact.

Production policy was not any more uniform. In the Soviet zone, work continued because the occupying power needed the products in question. As long as the war in the Pacific went on, the Americans took the same view. When the war was finally over, however, this attitude changed. Industry was only allowed to produce essential products, and there was a complete ban on anything even remotely connected with arms.

This policy was to prove unrealistic. Numerous chemical products that had gone into the war effort were still needed in peacetime. The Allied authorities also came to accept that it was impossible simply to close down production units which were tied in with many other facilities in a complicated system of industrial integration. In addition to this, the Allies were responsible for supplying provisions in their zones, and Germany was close to starvation. It was therefore only logical to keep up



industrial production so that the Germans would be able to pay for food imports. There was, however, no change in the plan to disband what was left of I.G. Farben.

The Allies did not only want to alter the structure of the economy, they also wanted to call those people to account who had been responsible for the crimes committed in the Third Reich. Between 1945 and 1949, a series of trials without precedent in history were held in Nuremberg. They began with the trying of leading war criminals, who were then condemned to death or sentenced to long prison terms on October 1, 1946.

The main trials were followed by proceedings before American Military Tribunals against members of the Army General Staff, the National Security Agency ("Reichssicherheitsamt") and the medical and legal professions, as well as former civil servants and industrialists.

On August 27, 1947, the prosecuting counsel opened the case against top managers of I.G. Farben. It lasted 152 working days and involved the study of

6,384 documents and the testimony of 189 witnesses before judgment was passed on July 29 and 30, 1948. Of the 24 defendants, ten were acquitted and 13 were given prison sentences of between 18 months and eight years; proceedings against one defendant were dropped for health reasons.

The indictments consisted of five counts:

1. Crime against peace by the planning, preparation, initiation and waging of wars of aggression and invasions of other countries.
2. Crimes against humanity and war crimes by participating in the plundering of public and private property in countries under German occupation.
3. War crimes and crimes against humanity by participating in the enslavement of the civilian population in occupied areas.
4. Membership in a criminal organization.
5. Conspiracy in the execution of crimes against peace.

All defendants were found not guilty on counts one, four and five. The Four-Year Plan and rearmament had led to a war of aggression, but it was

The trial of I.G. Farben executives began in Nuremberg on August 27, 1947, and lasted 152 days. After hearing 189 witnesses and studying 6,384 documents, the American judges acquitted ten of the defendants and sentenced 13 to prison terms. The above

picture of the Nuremberg court shows the bench on the right and the defendants on the left.

held not to be a punishable offense for industrialists to take part in a national arms program. It was also found to be proven that none of the defendants had known the aims of the Nazi government, much less taken part in conspiracy against world peace (count five).

Count two involved the question as to the extent that changes in property ownership or holdings in occupied countries in favor of I.G. Farben had been based on voluntary agreements or brought about under pressure. The Tribunal decided that some I.G. Farben managers had been guilty of this charge in Poland, Norway and France.

As far as the employment of slave labor (count three) was concerned, the Tribunal accepted that the defendants were themselves under pressure. The company would not have been able to meet construction and production targets without using the labor allotted to it by the government. However, the court found that on this count the defendants in question had taken the initiative in applying for inmates of concentration camps to work on the construction of the Auschwitz plant. They were sentenced accordingly.

Further questions were also raised with regard to count three. Had I.G. Farben supplied the widely known insecticide Zyklon B for use as a poison gas in the extermination program of the Nazis? The Tribunal determined that Zyklon B was produced not by I.G. Farben but by the German insecticide manufacturer "Deutsche Gesellschaft für Schädlingsbekämpfung" (Degesch). While I.G. Farben had a stake in Degesch, it was found not to have any persuasive influence on the management policies of the company.

The Tribunal further decided that neither the volume of production nor the destination of the product would alone have been sufficient to show the use to which it was being put.

The judgment in the Nuremberg Tribunal—the so-called "Farben Trial"—is itself a valuable source of the trust's history. It was published in German and English after the 1948 judgment with the approval of the U.S. Military Administration.

The defendants were consequently found not guilty on this count.

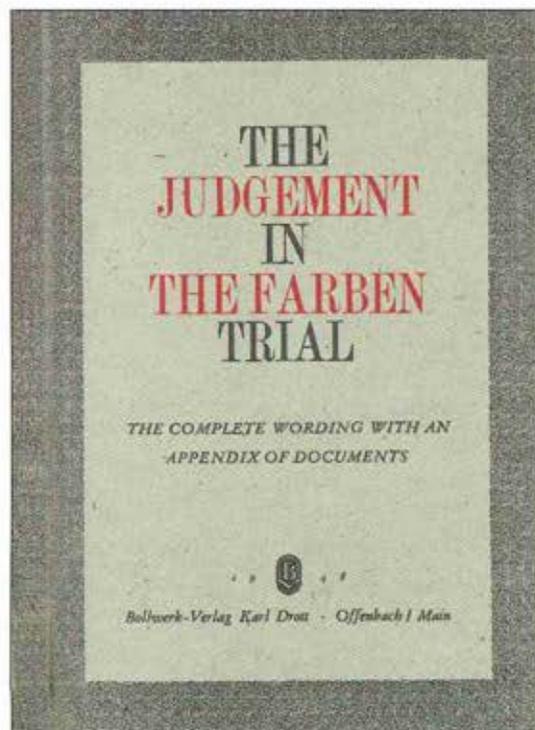
Had I.G. Farben supplied pharmaceuticals for illegal experiments on concentration camp inmates? The Tribunal determined that the defendants had discontinued supplying drugs to the SS camp doctors as soon as they had found out about the illegal and unethical use. Also in this case, the defendants were found not guilty.

Except in cases where allowance was made for the time served while awaiting trial, the 13 defendants sentenced to prison were sent to Landsberg penitentiary. One of them was Fritz ter Meer. He had been found guilty of playing a decisive role in the acquisition of Polish property and in setting up a French dyestuffs company with a 51-percent I.G. Farben stake. The first act was considered to constitute plundering, the second an offense against private property rights.

As the head of Product Division II, which covered I.G. Farben's synthetic rubber facilities, ter Meer was also held to share responsibility for the building of the synthetic rubber plant in Auschwitz. The Tribunal came to the verdict that "*I.G. Farben officials subordinate to ter Meer took the initiative in securing the services of (concentration camp) inmates on the plant site.*" The court added, "*We cannot say that he countenanced or participated in abuse of the workers.*" Fritz ter Meer received a seven-year sentence, of which he served more than five years in prison.

Colleagues in the industry were dismayed by this

judgment. Fritz ter Meer was not known to have been a Nazi proponent. His involvement was seen to have arisen from a compelling situation in which most others would not have acted differently, and did not act differently. He was an excellent chemist, organizer and technologist and was highly regarded in the international chemical industry.



This must be kept in mind in order to understand Meer's appointment to the Supervisory Board of Farbenfabriken Bayer in 1956.

The story of the I.G. Farbenindustrie did not end with the Nuremberg verdicts. The American Tribunal had determined that the managers had not wittingly taken part in the preparation and realization of Hitler's hostilities. This meant that there was no longer a legal basis for enforcing Law No. 9 of November 1945, which had laid the ground for the confiscation and dissolution of I.G. Farben. The claim that it was necessary to break up an industry strategic to war was not justified.

The new reproach was that I.G. Farben had thwarted competitive conditions within the international chemical industry. The decision was therefore made to create successor companies that would be big enough to meet the technological requirements of modern production and to stand up to competition. On the other hand, these newly formed companies would be kept as small as possible to obviate negative effects on the market.

The dissolution was to take years because the Allied and German authorities could not reach an agreement on how competitive successor corporations should be formed. The Allied High Commission unexpectedly ordered the final dissolution of I.G. Farbenindustrie AG on August, 17, 1950. This move led to a further series of disagreements until 12 successor companies were finally established in 1951 and 1952.

Bayer chronicle 1947

On July 1, the various works in the Lower Rhine Division of I.G. Farben are given the joint name Farbenfabriken Bayer.

New sales offices are opened in Hamburg, Hanover, Barmen and Krefeld.

Production begins in Elberfeld of new agrochemicals based on phosphoric acid ester (E 605).

Five-day workweek is introduced on a temporary basis.

Female employees are granted one "laundry day" per month.

Cohevalt adhesive system is introduced in the shoe industry, making stitching unnecessary.

World events 1947

British and American zones of Germany are united to form a common economic area.

General George C. Marshall becomes U.S. secretary of state. The policy of "containment" is introduced as a means to halt Soviet expansion.

The "Truman Doctrine" is proclaimed by the American president. The United States promises economic and military aid to free peoples in the case of internal or external threat. At a meeting of foreign ministers in Moscow, East and West fail to agree on the German question.

Marshall Plan, the United States' aid and reconstruction program for Europe, is announced on June 5.

India is given its independence by the United Kingdom. Muslim area is separated off into the new nation of Pakistan.

Japan becomes a British-style constitutional monarchy.

On November 29, hostilities similar to a civil war break out between Arabs and Jews after the announcement of the division of Palestine.

The Four-Power meeting of foreign ministers in London on policy regarding Germany breaks down.

The currency reform paves the way for the “economic miracle”

The financing of the war had led to such a massive expansion of the money supply that the Reichsmark had become practically worthless. There was money enough in circulation, but goods were scarce. Bartering had replaced buying and the black marketeer was king.

A modern economy is not viable without a well-functioning currency. Bayer was able to help its employees by payment in kind as well as in the increasingly valueless Reichsmark, but it was not exactly easy to pay the rent, do the grocery shopping or buy a pair of shoes with artificial sweeteners. Nor could the company itself go on accepting goods from its customers instead of money.

The occupation authorities had laid down a wage freeze for the entire industry. Indeed, wage increases would not have done much good at a time when shortages of just about everything meant that purchases were possible only in conjunction with a ration card. And even this was often only theoretical because the goods were not available anyway.

Management had to come up with new ideas all the time. One of these was dividing up fallow land on the site into allotments that were apportioned out equally, whether the recipient was a laborer or a leading executive. Wives were given passes so that they could come into the plant and do the necessary gardening. In another example, Cellit stocks that were located at the Dormagen plant were processed into combs or razor-blade holders. For its part, the Central Scientific Laboratory concocted an adhesive to glue disintegrating shoes together. And the company dispensed artificial sweeteners in addition to normal pay.

Nobody needed this many combs, razors or sweeteners, but they were excellent barter goods. Bayer's sweeteners soon became a quasi-currency on the Lower Rhine just as American cigarettes had been made into a kind of legal tender all over the country at an “exchange rate” of RM 7–10 apiece. The works canteen went into the barter business in a big way, with Cuprama fibers buying potatoes, vegetables and sometimes even meat.

Not everything was strictly within the confines of the law. “Fringsen” was the order of the day. This strange term was taken from the name of the Archbishop of Cologne, Cardinal Josef Frings. At a time when even lawyers and priests were taking part in night raids on farm fields or coal trains,

After the war, the value of the Reichsmark rapidly decreased and a barter system replaced most cash transactions. Since sugar was scarce, artificial sweeteners became a quasi-currency. The economy did not return to a normal cash system

until the currency reform of June 20, 1948, when every German received 40 new Deutsche Marks.

the Archbishop ruled that theft of vitally essential materials was to be considered a pardonable sin.

The introduction of a new standard currency became a tug-of-war between East and West. The Soviets insisted that the country be treated as a single unit, thus stressing their own rights in decisions affecting the Western zones. The Western Allies for their part feared that the Soviet Union could extend its sphere of influence beyond Central Europe. The United States wanted to help rebuild the political, social and economic structures of Western Europe and realized that this would prove impossible unless West Germany was reintegrated into the world economy. In 1947, the U.S. Administration announced the launching of the Marshall Plan, which made funds available to Germany to finance future investments and imports.

The new currency was a further step in the same direction. Under utmost secrecy, the Americans made preparations for the issue of the Deutsche Mark, which had been printed in the United States. On June 20, 1948, the legal tender was distributed throughout the Western zones—which in the meantime had become a united economic area—and West Berlin. Every German was given DM 40, while employers received DM 60 for each employee as a means of financing production. Detailed regulations were introduced to govern the exchange of Reichsmarks into Deutsche Marks.

Stalin retaliated with harsh measures. The Soviet Union blocked road and rail links between the Western zones and West Berlin and thus cut off normal supplies. The Allies answered with the legendary airlift, thus guaranteeing the flow of food, medicine, fuel and raw materials to the population of the former capital.



Bayer chronicle 1948

World events 1948

All operations within Farbenfabriken Bayer connected with personnel are put under a single management. The new personnel and welfare service is responsible for the welfare department, the pension fund, the company health insurance fund, the staff fund, the medical services department, the Bayer store, the canteens and restaurants, works security and the works magazine.

First postwar chemical graduates join the company after finishing studies interrupted by the war.

Soft foam Weichmoltopren is invented.

German Patent Office opens in Munich on October 1. First new Bayer patent to be registered is Potosan, effective against Colorado beetles.

Ground is broken for a new film factory in Leverkusen—even though it is not yet certain that Agfa will become part of Bayer.

In August, the British and American occupation authorities agree on a joint decartelization of I.G. Farbenindustrie. A German committee is appointed but does not present its findings and recommendations for two years.

The General Agreement on Tariffs and Trade (GATT) comes into force for its 23 signatory countries on January 1.

Former British Empire continues its transformation: New Zealand and Ceylon become dominions on November 25, 1947, and February 4, 1948, respectively, while Burma takes on the form of a republic on January 4, 1948.

Last British troops leave Palestine on May 14. State of Israel proclaimed although its borders are not determined.

Indian politician Mahatma Gandhi is assassinated on January 30.

After a Communist coup d'état in Czechoslovakia, a Soviet-style "People's Republic" is set up.

Currency reform in West Germany on June 21 ends postwar inflation.

In August, Korea is divided at the 38th parallel into two states: the Republic of Korea in the South and the (Communist) People's Republic of Korea in the North.

Benjamin Duggar develops the first broad-spectrum antibiotic and names it Aureomycin.

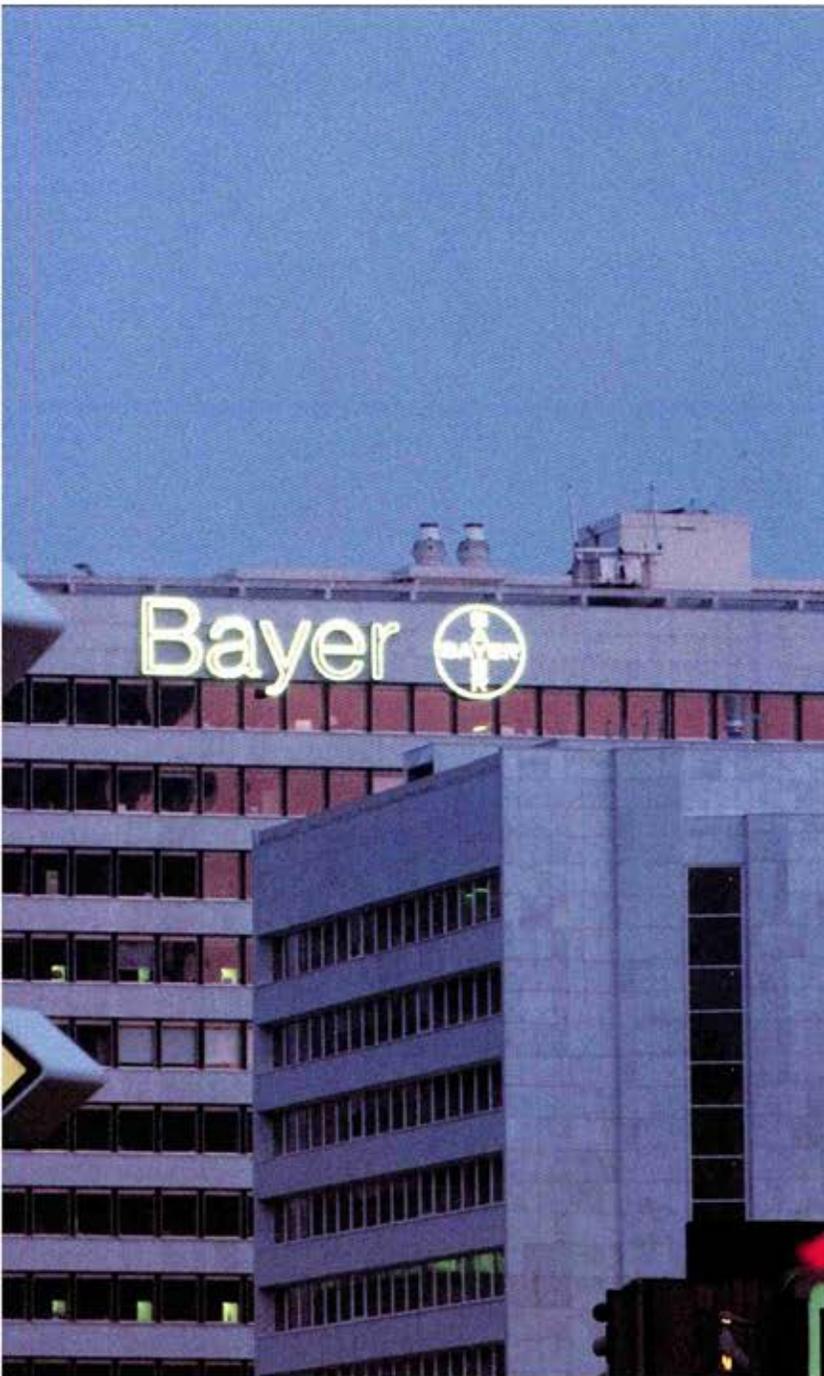
Bayer makes a new start in France

Bit by bit, international connections were reforged after the war. This chapter tells the story of Bayer's return to France, an example of how the company gradually returned to the world market.



In 1949, I.G. Farben had gone into liquidation, but it would still take two years before the new Farbenfabriken Bayer AG was formed. Reconstruction of the company nevertheless got well under way in this interim period. French businessmen were among the first to resume

contacts with Leverkusen after the war. Today, Bayer France in the Parisian suburb of Puteaux is one of the Bayer Group's leading European subsidiaries.



Frenchman Jacques Martin had been in the chemical import business before the war. In 1946, he set up the firm SOGEP (Société Générale des Produits Chimiques) to trade in chemical products from the United Kingdom, Sweden and the United States. Three years later, he made contact with Leverkusen.

The high regard the French already had for German products—and especially for the help German producers offered in the field of application—was a good basis for the success of a Bayer agency in France. SOGEP assumed the role of the company's agent in the French market. Bayer itself acquired a holding in SOGEP, which was increased in subsequent years until it had almost a 100-percent stake. In 1970, SOGEP then changed its name to Bayer-Chimie.

At the same time, a further link was established. While SOGEP sold Bayer's chemical products, DISTRI (Distribution des Colorants) started up as an outlet for its dyestuffs and fibers. In 1957, DISTRI had a staff of 53. Of these employees, three people sharing the same office were responsible for the fibers sector. As yet, no one expected Bayer's Dralon fiber to be the smash hit on the French market it was soon to become. Over the years, Bayer took total possession of DISTRI, which was given the new name of Bayer France in 1962. In 1950, a third agency for agrochemicals was set up in the form of Bayer-Phytochim.

France, where agriculture accounts for about one-fifth of the economy, is the world's fourth biggest market for agrochemicals after the United States, Japan and India. I.G. Farben specialties had for a long time played an important role in wine-growing. The French market of the day was, however, protected by high tariff barriers, and the most promising Bayer product for French farmers, E 605, was already being made by Rhône-Poulenc.

This meant that Bayer had to market new and indispensable specialties which had not been developed until the postwar era and that justified issuing of an import license to overcome the trade barriers. The policy worked: today, Bayer is the market leader in France for agrochemicals.



All three Bayer companies started out as mere agencies. For the first decade after the war, actual production of chemicals in France was out of the question. Not until 1959 did Bayer launch an operation of this kind, initially as a 50-percent partner in PBU (Progil-Bayer-Ugine). This new company was based in Paris and operated a plant near Grenoble for the production of polyurethane raw materials, specifically for foams and DD coating systems.

Decisive alterations in the structure of the French chemical industry, which led to the integration of business partners into larger concern groups, resulted in Bayer's giving up its holding in PBU in the early 1980s. Bayer itself began supplying the French market with polyurethane raw materials.

The pharmaceuticals sector was in a particularly difficult situation at first, since all such products sold in France also had to have been made there. In 1952, Monaco-based pharmacist Raymond Paris offered to act as agent for Bayer pharmaceuticals in all countries of the French Communauté. His firm was originally called "Produits Chimiques et Pharmaceutiques de Monaco (Dr. Paris)," but was then changed to "Laboratoires des Spécialités Pharmaceutiques Bayer S.A. (Monaco)" in 1961. Four years later, its shares were taken over by Bayer's

holding company Bayforin, and the company was renamed for the final time: "Bayer Pharma S.A." At the same time, its headquarters moved to Sens, where the company began producing pharmaceutical specialties. Bayer also cooperated with Rhône-Poulenc in pharmaceutical research between the mid sixties and 1979, when the agreement came to an end. All this helped to pave the way for further Bayer development in France's pharmaceuticals market.

The French still tend to link Bayer with "Aspirin," even though this product has been made and sold in France by competitors under numerous trademarks for more than 40 years. Bayer was able to prove itself anew when its "Adalat" came on the market in 1979. Used in the treatment of coronary heart disease and circulatory disorders, this product became an important pillar of the Bayer Pharma program and was the first German drug to receive the Prix Galien, France's top prize for pharmaceuticals, in 1980. (In the meantime, this award has also been presented to Bayer's "Biltricide," a remedy for the tropical disease schistosomiasis.)

The Bayer France organization gradually grew together. In 1963, its sales and administrative activities were centralized at Neuilly. In 1970, the company

The plant site in Port-Jérôme, today a major French production facility, has belonged to Bayer since 1980. It currently turns out some 80,000 annual metric tons of synthetic rubber and latex for applications in the plastics industry.

The above photograph shows the regeneration unit for the solvents used in the plant with its corresponding storage tanks.

relocated to bigger premises at Issy-les-Moulineaux and in 1975, today's headquarters was established in Puteaux, a modern business suburb of Paris. In the same year, the three original companies—Bayer-Chimie, Phytochim and DISTRI—were merged to form the new Bayer France. Its president was Jacques Martin, the man who had been involved from the very start.

Bayer France is not identical with "Bayer in France." Apart from the main French company, there are 12 other subsidiaries with a total of 4,000 employees—among them Bayer Pharma and the French subsidiaries of Miles and Haarmann and Reimer. The Group has plants in Sens, Epernon, Port-Jérôme, Pont-à-Marcq and Marle-sur-Serre.

Bayer's French staff is proud of its achievements. One-quarter of Bayer's total sales in the European Community stem from business with France. The TGV super-express trains running between Paris and Lyons have been treated with DD coatings, as have the Airbus airplanes, the Loire Bridge near St. Nazaire, the Parisian subway cars and French sports cars. Bayer plastics are used in a wide range of applications by such leading French firms as Renault, Peugeot, Télématique, Moulinex and Matra. The Paris subway system works with non-flammable cables made with Bayer's "Levapren." Michelin invented the radial tire in 1946, and its success was spurred by Bayer's rubber chemicals. Every "grand magasin" in Paris has a Dralon stand of its own, something which Bayer has not even been able to accomplish in Germany. Every November, the "Dralon Week" is a major attraction for customers who want to keep in touch with the latest trends and styles in textile fibers.

Bayer chronicle 1949

In the plant at Dormagen production begins of the cellulose ester foil marketed under the trade name of Triafol for the electrical industry. Leverkusen starts producing Agfa film and paper, magnetic tape and Copyrapid paper.



On March 17, a process for the continuous spinning of polyacrylic fiber succeeds in Leverkusen for the first time.

First postwar meeting of the Waste Water Commission takes place.

Bayer chronicle 1950

On November 1, Bayer recruits Productos Químicos Sintéticos S.A. for the marketing and production of its pharmaceuticals for the Spanish market.

Last phase of I.G. Farben's dissolution in the Federal Republic of Germany begins with the Allied High Commission's Law No. 35 regulating the "splitting up of the assets of I.G. Farbenindustrie AG."

World events 1949

On January 25, the Council for Mutual Economic Aid (Comecon) is formed by Eastern European governments.

The North Atlantic Treaty Organization (NATO) is established on April 4.

French occupation zone in Germany is integrated into the economic unit formed by the British and American "bi-zone."

The Republic of Eire is formed as successor to the Irish Free State.

With the ratification of the constitution on May 23, the Federal Republic of Germany is born. First Federal German Parliament (Bundestag) is elected on August 14, with Theodor Heuss as president and Konrad Adenauer as chancellor.

German Democratic Republic is established on October 7.

On October 1, Mao Tse-tung announces the creation of the People's Republic of China.

World events 1950

The Korean War begins on June 25, when North Korean troops invade South Korea.

Jet aircraft and helicopters are used for the first time in civil aviation.

Bayer is incorporated for the second time

88 years and 140 days after the founding of Friedr. Bayer et Comp. in Elberfeld, the company was registered for the second time in its history. Farbenfabriken Bayer Aktiengesellschaft was officially reincorporated on December 19, 1951. These new beginnings are closely tied with the name Ulrich Haberland.

On August 17, 1950, the Allied High Commission passed Law No. 35, which laid down that what remained of I.G. Farben should be broken up into a number of economically viable, independent corporate units. These companies were to be autonomous in respect of both management control and ownership, thus promoting competition in the chemical and other related industries.

I.G. Farben had been confiscated in 1945 on charges of having participated in the planning and preparation of Hitler's wars of aggression. At the Nuremberg trials, however, the firm had been acquitted of these alleged crimes in 1948. Despite this, the Allies decided not to lift the seizure order. I.G. Farben was now to be dissolved on the grounds that it was too big and would be an obstacle to competition in the chemical industry. But just how this was to take place was the subject of dispute between the Allied High Commission, the government of the Federal Republic, trade associations and the representatives of the individual plants. The first ordinance implementing Law No. 35 provided for the establishment of 12 successor corporations; these were subsequently incorporated in the years 1951 and 1952.

A point of particular interest was the fate of the three major operating units. The first of these successor companies to be registered was "Farbwerke Hoechst Aktiengesellschaft" on December 7, 1951. On the 19th of the same month, "Farbenfabriken Bayer Aktiengesellschaft" was formed with headquarters in Leverkusen. Its first Supervisory Board Chairman was Oswald Roesler—soon to be succeeded by Heinrich Hörlein—with Ulrich Haberland as Chairman of the Board of Management. "Badische Anilin- & Sodafabrik AG," Ludwigshafen, dates from January 30, 1952.

Haberland had fought hard to retain the assets of the former Lower Rhine Division in the new company. Originally, the plant in Dormagen was supposed to have become an independent company. In the end his efforts led to success. On January 15, 1952, the Allied High Commission decided that Dormagen

The picture above right, which was taken in the conference room of the old administration building in Leverkusen, shows the inaugural meeting of Farbenfabriken Bayer Aktiengesellschaft on December 19, 1951. From left to right:

Berthold Wenk, Kurt Riess, Heinrich Köhler, Ludwig Klebert, Fritz Jacobi, Julius Drucker, Paul Dencker, Helmuth Borgwardt, Otto Böhme, Otto Bayer, Oskar Loehr, Ulrich Haberland, Friedrich Silcher, Martin Meyer (notary), Heinz



should be apportioned to Bayer. Thus, with the Leverkusen, Dormagen, Elberfeld and Uerdingen works, Bayer had obtained the basis for a viable company.

There were considerable problems to be solved, however. The I.G. Farben management had divided up production activities in the interest of inter-plant synergy. This meant that the individual plants were interdependent. After the breakup of I.G. Farben, products hitherto supplied by sister plants now needed to be made within the new corporations. In fact, the Bayer corporate group was not too badly off in this respect because it consisted of four plants and had the broadest production program.

Things looked grim with regard to returning to world markets. For the second time, the German chemical industry had lost all of its foreign assets. Foreign competition had grown stronger in the meantime, and political obstacles blocked entry into foreign markets. Without an international presence, a new company had little future potential. Reincorporation therefore necessitated a completely new start abroad.

Bayer was also looking for new paths to take in the field of technology. Ulrich Haberland

realized that the company could not simply continue where it had left off. The reestablished firm may have been called "Farbenfabriken," but dye-stuffs were not a sufficient basis for the future. Fortunately, Bayer had processes and products at its disposal whose potential was far from having been exhausted.

To make full use of the new company's opportunities, all existing plants had to be expanded. In the case of the Leverkusen works, additional acreage was available in the Flittard fields. The Uerdingen factory was able to buy up neighboring land—but this still proved to be insufficient for future requirements. At the Dormagen location, where fibers were produced, there was enough free land to accommodate new units.

One further important question still had to be answered. Within the I.G. Farben organization, Agfa's activities in film and photographic products had been concentrated in the Berlin and Wolfen works. Leverkusen only made photographic papers; Wolfen was situated in the Soviet zone, and West Berlin had become a virtual island. A large number of experts



Wittrock (assistant notary), Hans Adler, Otto Einsler, Gustav Cremer, Oswald Roesler, Richard Bayer, Gustav Brecht, Adolf Butenandt, Theo Goldschmidt and Helmuth Wohltat.

The opening balance sheet of the three merged companies Farbenfabriken Bayer, Agfa Aktiengesellschaft für Photofabrikation and the Agfa Camera-Werk is dated January 1, 1952.

**Ulrich Haberland, Chairman of the Board of Management
from 1951 to 1961**

Ulrich Haberland could truly be called the second founder of the company. It was thanks to his energy and tenacity that Bayer was able to emerge as a strong business enterprise from the ruins of I.G. Farben after the Second World War.

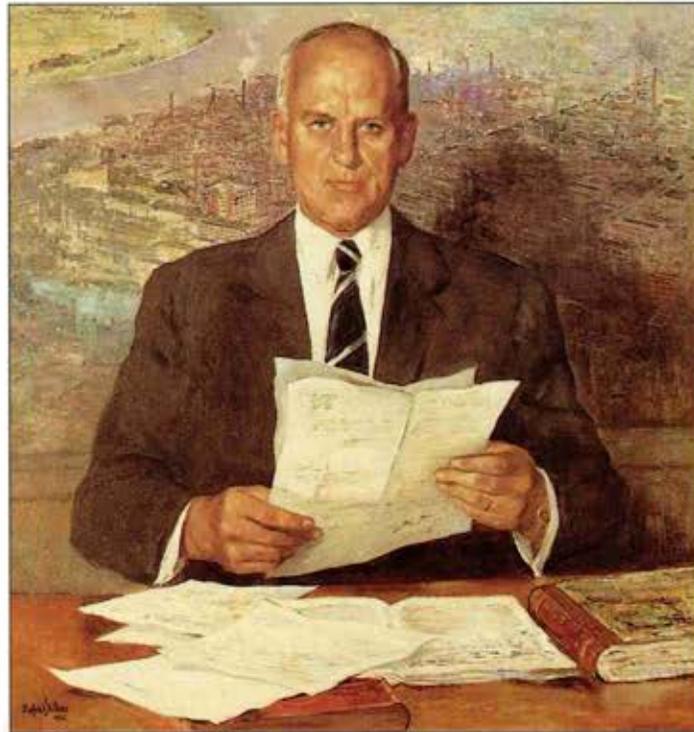
Haberland was born on December 6, 1900, the fifth child of a parson's family in the Saxon village of Sollstedt. After the early death of his father, Haberland's mother moved with the children to Halle, where the young Ulrich attended the Latin High School of the Francke Foundation until graduation. His schooling was interrupted by military service in 1918.

From 1919 to 1924, Haberland studied at the University of Halle, where he majored in chemistry. After taking his doctorate under Daniel Vorländer, he joined the Hanover company Meyer & Riemann as a chemist. However, this firm was a victim of the Depression, so Haberland moved to what was then the Uerdingen plant of I.G. Farbenindustrie AG.

His talents and innate energy allowed him to go up through the ranks until he was appointed Plant Manager at Uerdingen in 1938 and in 1943, he succeeded Hans Kühne as head of I.G. Farben's entire Lower Rhine Division. He did not join the Board of Management of I.G. Farben because the Lower Rhine was already represented by four executives.

When the Allies seized control of the factories in 1945,

they allowed Ulrich Haberland to retain his position. He proved an able, assiduous and tactful negotiator. His most difficult tasks were to form a competitive corporate unit out of the various Lower Rhine works and Agfa during the decartelization of I.G.



Professor Ulrich Haberland

Farben and at the same time see to it that the company kept up with scientific and technological progress despite all economic, legal and political obstacles.

In 1951, Haberland became Chairman of the Board of

Management of the newly formed Farbenfabriken Bayer AG. His ten years as chief executive saw the participation of the company in Germany's "economic miracle" and its return to the world market. The unification of Europe, a cause which he whole-

Adenauer, thought highly of his advice. With entrepreneurial daring he succeeded in rebuilding the company and expanding both production and sales.

Everyone who knew Ulrich Haberland agrees that he pushed himself very hard. He seemed to realize that he was demanding too much of himself when he decided to move from management to a place on the Supervisory Board before the Bayer centennial in 1963. But his heart did not allow him to go on: Ulrich Haberland died at the age of only 60 on September 10, 1961.

Haberland left behind a company with a total of 58,000 employees and annual sales of DM 2.8 billion stemming from business activities in 133 different countries around the world. Fifty percent of those sales resulted from products which had not been in the program in 1948.

On the day of Haberland's interment, all public buildings in Leverkusen had their flags at half-mast. The speeches held at the funeral service stressed how versatile his influence and work had been as the head of one of Germany's leading companies, as a scientist, as a patron of science and the arts and as a human being who was not only respected but also admired.

That afternoon when the coffin was let down into the grave in the Manfort cemetery, all the church bells in Leverkusen pealed in tribute.

heartedly supported, represented for Haberland a chance to overcome nationalist thinking and thus create a basis for German and European prosperity.

Many politicians of the young republic, including Chancellor

Holders of the I.G. Farben shares could no longer make use of them after 1945. They were eventually able to exchange the old ones for shares of the I.G. Farben successor companies after the reincorporation. In fact, I.G. Farben liquidation certificates are still being traded to this day.

had come from Wolfen to Leverkusen in the hope of a new start there. It remained to be seen whether Bayer could take over the Agfa operations. As early as 1947, Haberland was bold enough to have work started on a new film factory in Leverkusen—long before any decision had been made about Agfa.

On April 18, 1952, "Agfa Aktiengesellschaft für Photofabrikation" was set up as a further I.G. successor company. On March 20 of the following year "Agfa Camera-Werk AG" was founded in Munich. Bayer was given permission to acquire both of the new Agfa units as subsidiaries, but only on the condition that they retained their individual entities.

Although the production facilities of "Titan-gesellschaft mbH" were—and still are—located in Leverkusen, this former I.G. Farben affiliate was not transferred to Bayer. The American partner, National Lead Company, took over its entire capital and today the titanium oxide plant operates as an "enclave" on Bayer's Leverkusen site.

On March 21, 1953, the government of the Federal Republic and the Allied High Commission announced the completion of the decartelization of the I.G. Farben trust. I.G. Farben assets assigned to Bayer were contractually transferred to the newly incorporated company. On March 24, 1953, an extraordinary general meeting voted to increase capital stock from DM 100,000 to DM 387.7 million; the corresponding shares were to be given to the "I.G.-Farbenindustrie in Liquidation" in exchange for the transfer of assets.



Bayer chronicle 1951

Development by Gerhard Schrader of the phosphoric acid ester Systox opens the way to internal plant therapy; the insecticide is reduced within the treated plant to non-toxic phosphoric acid. Systox becomes the first of the "systemic" pesticides.

Research station for tropical and semi-tropical plants is set up at Vero Beach, Florida.

New Phthalogen range of dyestuffs permits the direct coloring of fibers in bright and extremely fast blue and green shades.

Synthetic rubber production is resumed.

Engineering department for applied physics is set up. It plays an instrumental role in the development of process, measuring and control technologies.

Production of Agfacolor cinema film is resumed.

Welfare Department opens a children's home in Antweiler in the Eifel hills.

Farbenfabriken Bayer AG is formally established on December 19 with an initial capital of DM 100,000.

World events 1951

Occupation Statute is amended: Federal Republic is now permitted to take up diplomatic relations.

In the United States, the spies Julius and Ethel Rosenberg are sentenced to death; they are executed in 1953. The Congressional Committee for Nuclear Energy states in April that their disclosure of atomic secrets to the Soviet Union has set back the long-term American program by 18 months.

On April 18, the treaty on the formation of the European Coal and Steel Community is signed in Paris.

In order to boost agricultural production, the federal government of Germany grants a DM 50 million subsidy for the manufacture of phosphate fertilizers.

Federal Republic joins the General Agreement on Tariffs and Trade (GATT).

On September 8, the United States and 48 other countries sign a peace agreement with Japan in San Francisco. The Soviet Union does not follow suit until October 1956.

The United Kingdom and France declare on October 19 that a state of war no longer exists with Germany.

Color television is introduced in the United States.

Polyurethane foams come in all shapes and sizes

At the International Plastics Fair in Düsseldorf in 1952, Bayer presented a light, soft foam that promised to be an ideal material for the upholstery sector. At the same time, Maschinenfabrik Hennecke exhibited a new kind of machine which manufactured this foam. Polyurethane foams had come of age.

In fact, they had originally been invented in the early war years—what at first appeared to be a rather annoying production problem turned out to be a useful spin-off of elastic molding compounds. Otto Bayer, who initially had synthetic fibers in mind when he developed the polyaddition process, soon realized just how extraordinarily versatile the polyurethanes were.

A systematic investigation of this hitherto unknown field of plastics technology was held up by wartime exigencies; research projects focused on a small number of “strategic” products, such as adhesives and coating bases, and the chemical industry continued to search for a new type of synthetic rubber. Foam production was discovered in the process, and rigid polyurethane foam soon found limited use as a reinforcing material in the aircraft industry. However, the actual manufacture of the polyurethane raw materials was difficult and the foaming technology was still not fully developed. Consequently, it proved to be a major effort to convince the skeptical authorities that it was worth carrying out further research in this field.

Although the polyaddition process would later be termed the “method for making tailor-made plastics” in the United States, at first none of the chemical manufacturers outside Germany felt confident enough to venture into this field. There was a good reason for this reluctance: considering the contemporary level of scientific know-how in mind, setting up an industrial-scale production of isocyanates would definitely have been a formidable task before the war. And even by the end of the war, the manufacture of rigid or soft foams from polyols, diisocyanates, water, activators and emulsifiers was still considered quite a feat.

This situation provided a great opportunity for Bayer—once the Allied ban on all kinds of research activities, including such disciplines as polyurethane chemistry, had been lifted. Top management, to which Otto Bayer now belonged, decided that polyurethane chemistry should be made a priority within the field of plastics development.



There were three prerequisites: the safe and economical large-scale production of raw materials, reliable processing technology for elastic molding compounds and foams, and the availability of corresponding machines and equipment that would be required for production.

A fundamental and far-reaching decision was made early on, and it was to influence the development of polyurethane applications. Bayer may have invented polyurethanes, but it was not interested in becoming a manufacturer of the finished products made out of polyurethanes.

Thus, a partnership began between Bayer, as the raw material producer, and the processing industry and manufacturers of end products. In addition to its raw materials, Bayer supplied a comprehensive service package to its customers,

which included recipes, processing recommendations and even the necessary criteria to evaluate the finished product.

The Intermediates Department was given the job of producing the two base materials, polyols and diisocyanates, on an industrial scale. The polyol program presented no particular difficulties. The real problem lay with the diisocyanates, which from the start had to be available in large quantities. This necessitated production on a continual basis, which is something that had never been done before.

In retrospect, it is hard to specify what is more surprising—the courage with which the Intermediates Department and the plant engineers tackled the task, or the speed with which they accomplished it. After all the clearing-up, repairs and refitting of the immediate postwar period, the company had at last

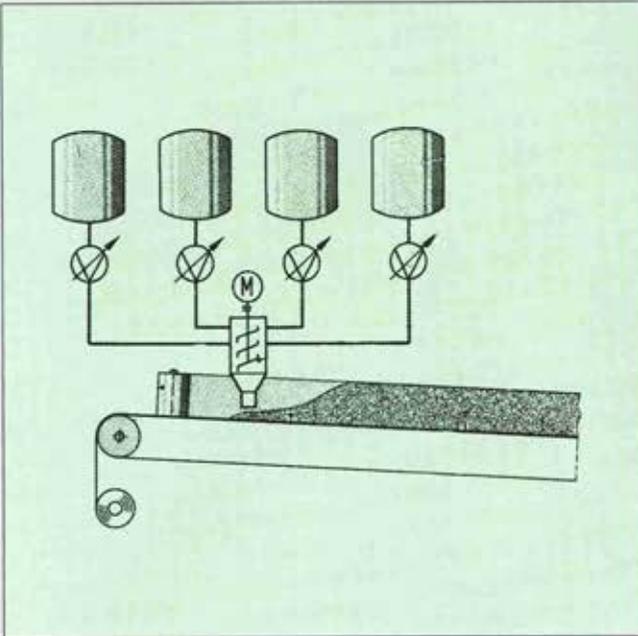
What looks like a piece of modern art in the above photograph is nothing more than a shot of foam blocks waiting in the storehouse to be sent on for further processing.

Polyurethane foams come in all shapes and sizes

Processes and machines for block foaming

If the liquid base components of a polyurethane foam are mixed together rapidly in a wide beaker, the resultant compound turns creamy within a few seconds and then rises to fill the entire vessel before solidifying. For production to be economical on an industrial scale, this process has to be carried out continuously. A special mixing head was constructed

to this end. It consists of a cylindrical vessel with a capacity of about one liter and containing a high-speed stirring device placed on its longitudinal axis. The components are pumped into the container from the side in appropriate doses for immediate intensive mixing and then released downwards onto a conveyor belt:

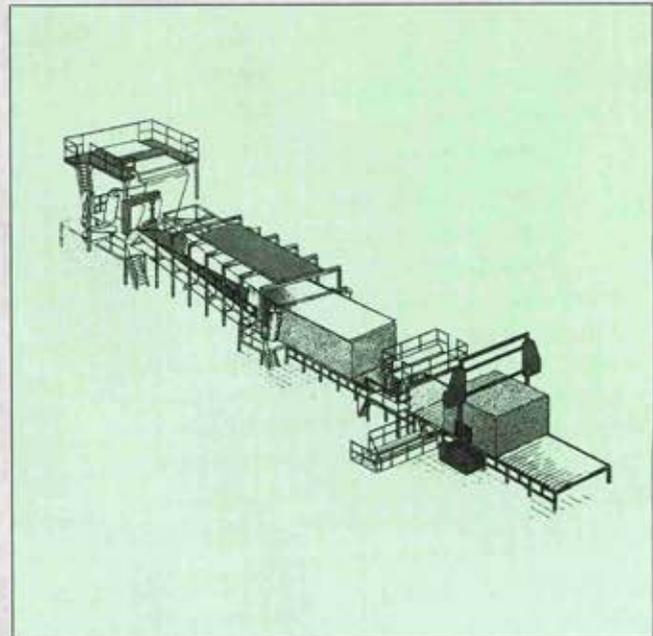


The necessary additives, such as activators, emulsifiers and water, can either be mixed with the polyol component ahead of time or else be separately pumped into the mixing head in a one-shot process. Since the foaming reaction is affected by even

small fluctuations in the input of the raw materials, exact dosage by the feed pumps is a decisive factor in determining how well the unit will work.

The reaction mixture does not fall directly onto the conveyor belt but rather onto a paper web whose sides are folded up to form a trough.

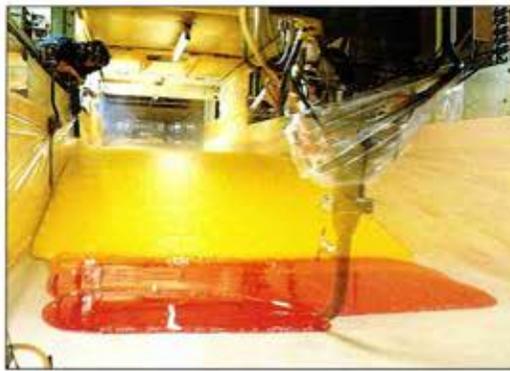
Large-scale production units turn out foam blocks of up to 2.2 meters in breadth and more than one meter in height:



During the foaming process the conveyor belt runs through a vacuum tunnel, which removes the fumes of the foaming agent and the activators. The continuously foamed block leaving the tunnel is subsequently cut up into suitable lengths. Various other cutting machines turn out different shapes for further processing into semi-finished products.

Foaming units of this kind enabled the introduction in the 1950s of industrial-scale production of upholstery

stuffing on the basis of "Moltopren" soft polyurethane foam. Technical aspects of the units were improved upon in the following years, and with the subsequent development of mold foaming, technology took a completely new direction, which called for the construction of a fundamentally different mixing head. Details are described beginning on page 390.



a major new project that looked quite promising. The plant proved its worth and soon needed to be expanded. Similar isocyanate units were built in the United States and later in other foreign countries. Plant safety constantly improved on a par with the various processing techniques.

The smooth production of the raw materials was only one reason for the striking success of polyurethane chemistry, however. The other was the work of the applications research technologists.

The methods by which polyurethane products or semi-products were made, especially the actual foaming process, had to be perfected to the point where a customer with no experience in chemical production could feel confident about making the necessary investment. And after taking this step, he must be able to reckon that his investment will turn out to be a success.

The initial stress was put on soft foams that could be used in applications such as stuffings for upholstered furniture and mattresses. These kinds of applications called for a machine that could work reliably and rapidly. It would have to turn out large blocks of foam from which the necessary semiproducts could be cut. Such a machine also had to operate continuously.

The principle was straightforward enough. A mixing head into which the foam components would be fed via separate flexible tubes would blend these raw materials mechanically and

move to and fro to distribute the reaction mixture onto a slow-moving conveyor belt which was positioned above it at a right angle. The mixture would then foam and solidify.

Bayer was fortunate to find a local partner that was able to produce the required equipment: Maschinenfabrik Hennecke of Birlinghoven near Siegburg took out a license for the Bayer machine.

Any manufacturer that wanted to make foams signed a contract with Bayer which guaranteed him a machine from Hennecke, raw materials from Bayer and technical service from both companies. By using this exclusive strategy in the difficult early years while gaining experience with the technology, it was possible for all concerned to take their time developing know-how and markets.

Numerous further developments resulted from the cooperation between Bayer and Hennecke. The chemical company acquired a minority stake in Hennecke, which it raised to 60 percent after the death of the proprietor; the engineering company subsequently became a fully owned subsidiary in 1978.

Today Hennecke is one of the world's biggest producers of polyurethane processing units. In the meantime, block foaming is far from the only method for the manufacture of soft foams for upholstery. For example, entire car seats can be produced in series; if necessary, complete with covers.



In the first phase of the production of polyurethane foam, the feedstock is transferred through a mixing head onto a conveyor belt, and soon this liquid substance turns into foam.

The foam is subsequently cut up into individual blocks and then transformed into a variety of finished products, such as mattresses or upholstery elements.

Fighting tuberculosis with Neoteben

In Thomas Mann's famous novel, "The Magic Mountain," which was written in 1924, tuberculosis is a pervading theme. During the first half of this century, "consumption," as the disease was commonly called, still attacked the population in several different forms and spared neither rich nor poor.

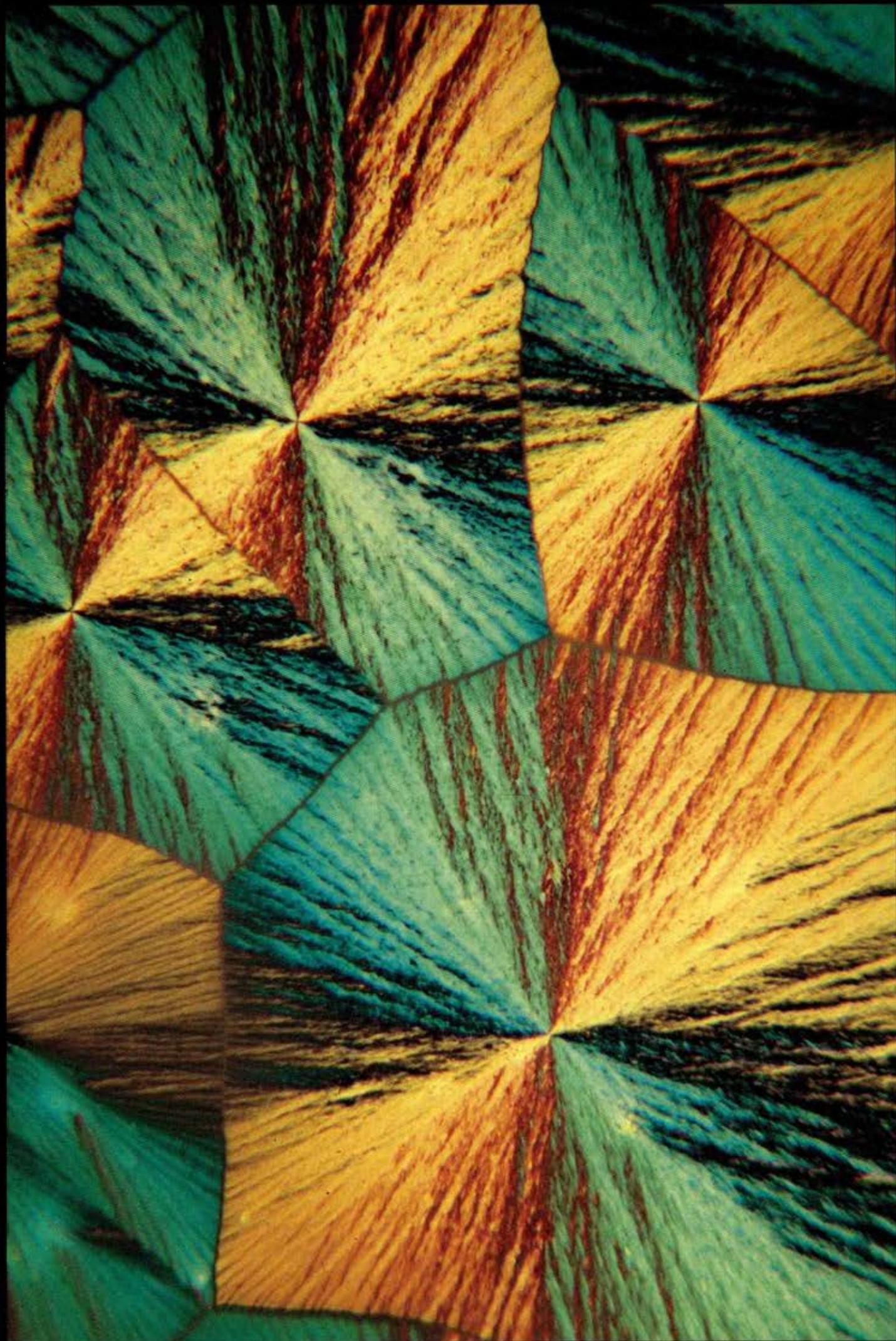
Tuberculosis (TB) accounted for 79 deaths per 100,000 inhabitants in Germany in the early 1930s. After the introduction of Neoteben, this figure fell in 1957 to only 19; in the United States there were only five deaths. Today, TB has been virtually eliminated in the developed countries of the world.

After the therapeutic effects of sulfonamides had been discovered (see chapter on 1935), Gerhard Domagk set about the task of proving that tuberculosis could also be treated with the help of chemotherapy. He initially tested hundreds of sulfonamides, but these showed no or only insignificant effects. His first breakthrough was when laboratory and animal experiments demonstrated that sulfathiazole clearly worked as an inhibitor against tubercle bacilli. In 1940, Domagk reported on his findings in Vienna, but there was very little response from the medical world.

After the war, an intensified search for a new tuberculosis therapy was spurred not only by scientific ambition, but to an even greater extent by the generally perilous situation. Unhygienic living conditions and hunger, the classic breeding ground for consumption, led to a new outbreak of the disease. During World War II Bayer chemists Robert Behnisch, Fritz Mietzsch and Hans Schmidt had already synthesized the first thiosemicarbazones, which are related to sulfathiazole. Domagk also observed a marked inhibiting effect on TB bacilli using these substances. At last, the company had a promising product that could be released for clinical testing.

The new drug, which was given the name Conteben, rapidly cured patients afflicted with tuberculosis of the larynx; they were soon able to speak and swallow again without difficulty. Similar successes were registered for tuberculosis of the skin, the intestines and the bladder. By 1949, Conteben had passed the test with flying colors; some 20,000 patients had been cured. Conteben was then released for general medical use as the first chemical therapy against TB. Its success in treating the pulmonary form of the disease, however, still varied from case to case.

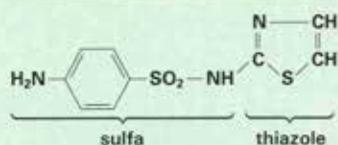
Researchers are sometimes confronted with remarkable pictures during their work. After being dissolved and then subsequently recrystallized, the drug Neoteben offers a fascinating sight—here in an 80-fold enlargement under the polarizing microscope.



Conteben and Neoteben

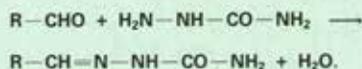
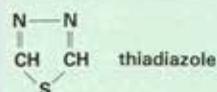
The first compound that showed a tuberculostatic effect in both plate cultures and animal tests was

2-(4-aminobenzene sulfonamido)-thiazole, or sulfathiazole for short:



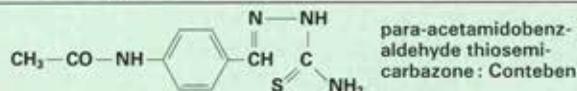
According to the starting point of investigations, it was still a sulfonamide which had been substituted by a heterocyclic ring. In subsequent experiments, researchers departed from the sulfonamide principle and modified the ring that was found to be effective. The sulfathiazoles tested in this case have a cyclic system in which one CH group is replaced by a second nitrogen atom:

The next step was to attack the tubercle bacilli with the starting products of compounds incorporating the complete heterocyclic ring, instead of the compounds themselves. These are, for example, derivatives of semicarbazide, $H_2N-CO-NH-NH_2$, or of its sulfur analog, thiosemicarbazide, $H_2N-CS-NH-NH_2$, which form (thio) semicarbazones in reaction with aldehydes or ketones:



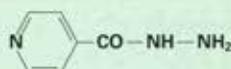
Conteben is constructed according to this principle. The structural formula for this substance, para-acet-

amidobenzaldehyde thiosemicarbazone, is presented so that its relationship to sulfathiazadiazole can be seen:



Further molecular variations subsequently led to isonicotinic acid hydrazide,

isoniazide for short. This product was marketed under the trade name of Neoteben:



isonicotinic acid hydrazide, isoniazide: Neoteben

In the United States, Selman A. Waksman had discovered the antibiotic Streptomycin, which was effective against what had been the invariably fatal tubercular meningitis. And in Sweden, J. Lehmann had come up with Pasalon, a para-aminosalicylic acid with tuberculostatic effects. So Bayer incorporated Streptomycin (1950) and Pasalon (1953) into its sales program. Together with Conteben, these products proved to be very effective in the fight against TB. There were now drugs to tackle various forms of the disease, but the search for a truly universal therapy continued.

Working in collaboration with Werner Siefken, chemist Hans Offe synthesized numerous hydrazine derivatives in the Main Scientific Laboratory in Leverkusen. One of them was isonicotinic acid hydrazide. In bacteriological tests carried out under Domagk's supervision, this substance proved to have excellent tuberculostatic properties. Clinical testing began in 1951. Success rates for tuberculosis of the lungs and mucous membranes were unusually high. And in November, a patient suffering from tubercular meningitis who had not responded to either Streptomycin or Pasalon was cured.

The specific effects of the drug and its remarkably good tolerability indicated that it could be used in long-term therapy without complications. There was also hope that this drug could help to eradicate the worldwide scourge of tuberculosis. In 1952, the substance was released for use by doctors and sold under the name of Neoteben.

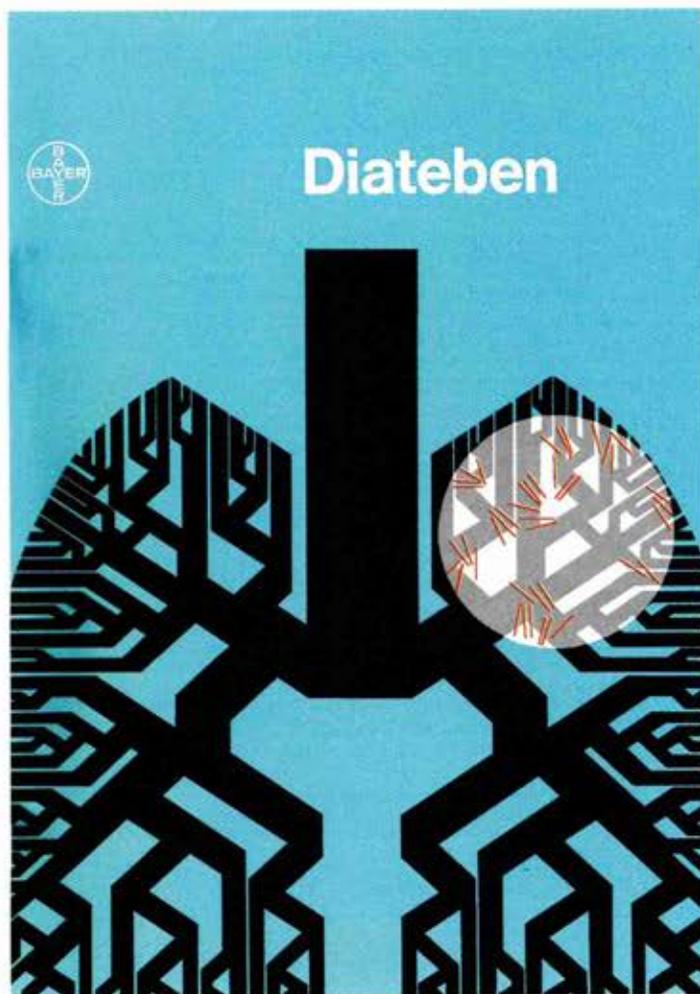
As so often with discoveries of this kind, scientific minds had been thinking along the same lines. Knowing nothing of Bayer's research, New York scientist H.H. Fox successfully treated 12 tuberculosis patients with isonicotinic acid hydrazide, and another group of American scientists led by Richard Barry Bernstein also recognized its tuberculostatic effects. Once again, various scientists had independently and simultaneously discovered the therapeutic qualities of a single substance.

Conteben, Streptomycin, Pasalon and Neoteben provided the necessary means to wipe out the fatal

effects of tuberculosis. The problem of bacterial resistance remained, which is why Bayer continued to test products with combined active substances. In the mid 1950s, Nicoteben—a combination drug of Neoteben and thiosemicarbazone—enabled a double-pronged attack on the pathogenic agent.

Gerhard Domagk's discovery of sulfonamides was a major breakthrough in the development of antibiotics; his success in tuberculosis research formed the basis for all future work in this field.

Ironically, the man who had dedicated his life to the fight against infectious diseases died from an infection of the gall bladder on April 29, 1964. By the time the disease had been diagnosed, it was too late for treatment.



Tuberculosis of the lung, which can be treated with Diateben, is only one of the many forms of this disease. It can attack the skin, the intestine or the larynx, as well as many other parts of the body. The new combination of active agents used in Diateben has proved particu-

larly stable in tropical conditions and has been recommended by the World Health Organization as an effective therapy for numerous forms of TB.

Bayer chronicle 1952

A large-scale penicillin facility is opened in Elberfeld. Fully synthetic production of Leukomyacin begins; the schistosomiasis remedy Miracil D comes on the market.

Bayer silicone rubber (Silopren) is produced on an industrial scale. Rollable polyurethane elastomers (Urepan) are developed.

Production of polyester resins in Uerdingen is expanded to include units for the manufacture of the unsaturated polyesters (Leguval) for the plastics industry and Roskydal for the coatings industry.

An agrochemicals laboratory is opened in Elberfeld.

A Vitamin B product is introduced to the market under the name of Polyvital.

The housing subsidiary Bayer-Wohnungen GmbH is formed, and construction of employee housing units is resumed after having been interrupted by the war.

Bayer buys back the Brazilian company Aliança Comercial de Anilinas.

Cooperation with Nihon Tokushu Noyaku Seizo in Japan is resumed.

Quimicas Unidas is reestablished in Mexico.

Kurt Hansen starts to build up a Bayer presence in the United States.

World events 1952

The "Germany Treaty" of May 26 replaces the Occupation Statute and the Federal Republic becomes a sovereign state. The Western Allies do, however, reserve a number of rights in regard to the stationing of troops, the administration of Berlin and the Peace Treaty. As a reaction to the May 26 move, the Soviet Union closes the inner-German frontier and reduces the number of inner-sector checkpoints in Berlin.

Under the so-called "equalization of burdens" act of July, the Federal Republic moves to help those most affected by the results of the war with a series of measures to share the load equitably among the population.

The Federal Republic signs a reparations agreement with Israel in September.

The United States explodes the first hydrogen bomb on the Central Pacific atoll Eniwetok on November 1.

Makrolon is a plastic as transparent as glass

Imagine a plastic as transparent as glass, which is fracture-proof and impact-resistant and presents no physiological risk. Thirty-five years ago this list of properties in a single plastic was something new.

On October 16, 1953, Bayer obtained a patent for polycarbonates, an invention of Hermann Schnell. Marketed under the trade name Makrolon, a whole range of products was introduced in the late 1950s.

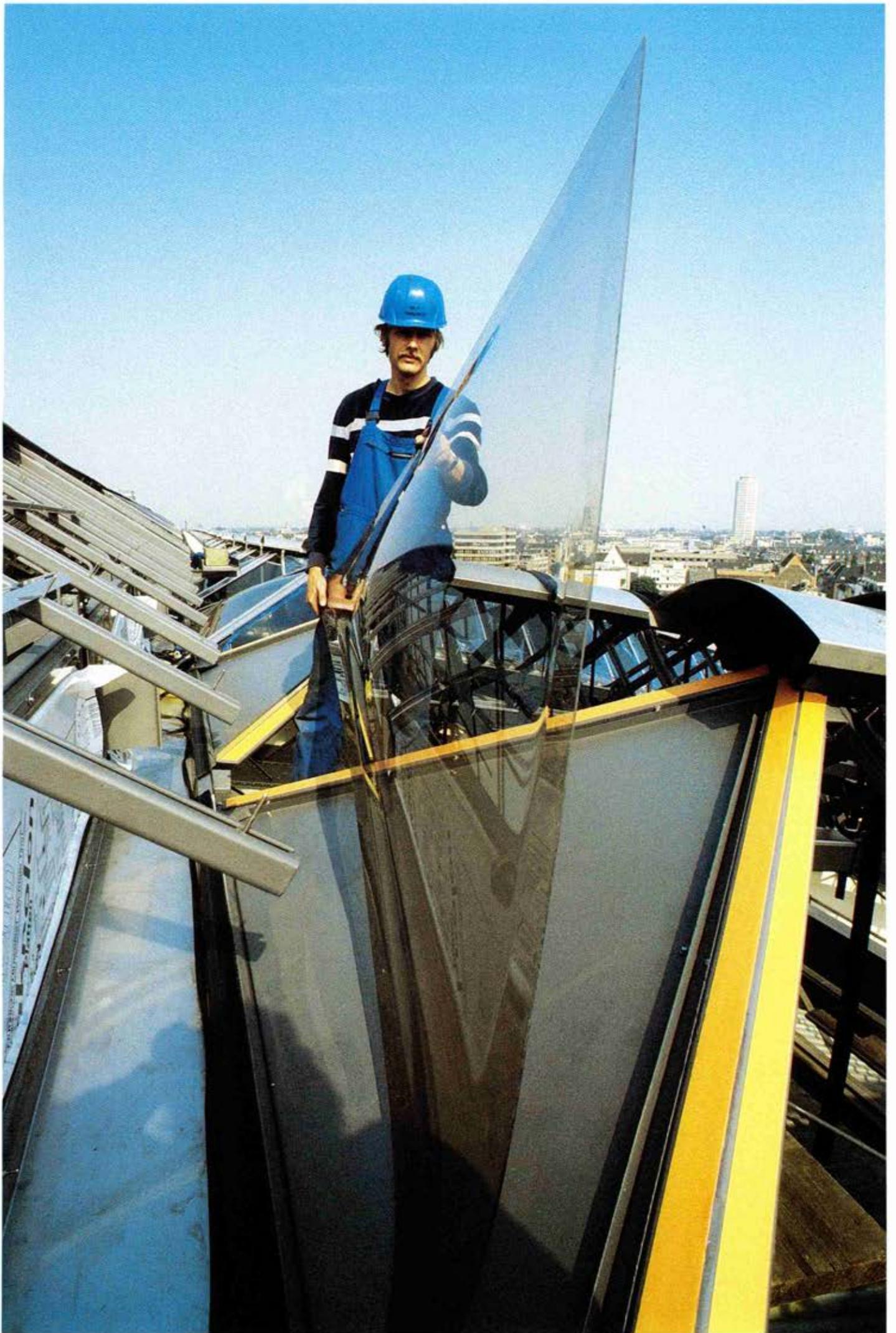
Also in 1953, Freiburg chemistry professor Hermann Staudinger was awarded the Nobel Prize for his discoveries in the field of macromolecular chemistry. His findings on the structure of high-molecular compounds and their creation by the polymerization of low-molecular components opened the way for the systematic construction of new materials. It was a coincidence that this award and the invention of Makrolon took place in the same year.

Plastics had been in existence long before the discoveries of Hermann Staudinger and Hermann Schnell. And if products obtained by converting natural substances are included in the definition, the processing of synthetic materials goes back over a hundred years. It was 1869 when John W. Hyatt invented celluloid. Although it was highly inflammable, celluloid was used to make dolls and photographic film. Cellophane and vulcanized fiber were similar products converted from natural substances.

The spontaneous formation of macromolecular compounds in a purely synthetic process had frequently been observed at the turn of the century. But it was far from a welcome sight. When a chemist heated an unsaturated compound, for example, or let formaldehyde react with phenol, all of a sudden the contents of the test tube sizzled and spattered before forming a darkish, resinous substance. The resulting primitive "plastic" was not greeted by shouts of Eureka; it was thrown into the nearest garbage can.

Belgian-born Leo Hendrik Baekeland decided to investigate this phenomenon. In 1907, he showed how phenols and formaldehyde could react under proper control to yield usable synthetic resins. Fillers could also be added as desired. This discovery made Baekeland the inventor of the first "real" plastic, which was subsequently named Bakelite after him.

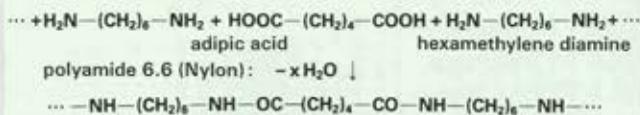
After obtaining the first patent in 1953, Bayer has introduced a whole range of different polycarbonates to the market under the trade name of Makrolon. In 1985/1986, the old glass roof of Cologne's main train station—a surface of 145,000 sq. ft.—was replaced by Makrolon sheets.



The production and processing of plastics

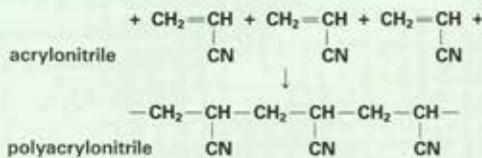
Plastics are synthetic macromolecular compounds, which can be used as starting materials for further processing. They come in the form of compact materials, foils or foams. Most polyurethanes are also categorized as plastics. Bayer has organized this large class of materials in a single Business Group because of the need for special processing and applications technology.

There are three processes for the production of macromolecular materials:
 1. Polycondensation: Low-molecular base materials (generally two different ones) that have at least two reactive end groups react by splitting off a condensation product such as water. One example of this is polyamide 6.6:



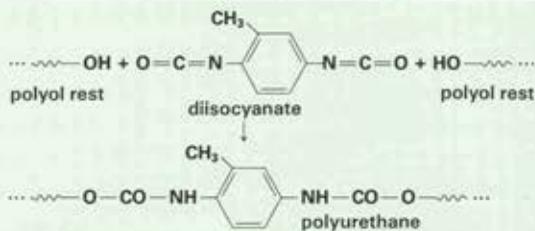
2. Polymerization: A low-molecular compound containing a reactive C=C double bond is polymerized by either

a catalyst, ultraviolet light or heat. Example: polyacrylonitrile (Dralon):



3. Polyaddition: This is related to the polycondensation process, but the end groups of the reactants are chosen so that no third substance is split

off; this means that in most cases the production process is easier. Polyurethanes are a primary example of this processing method:

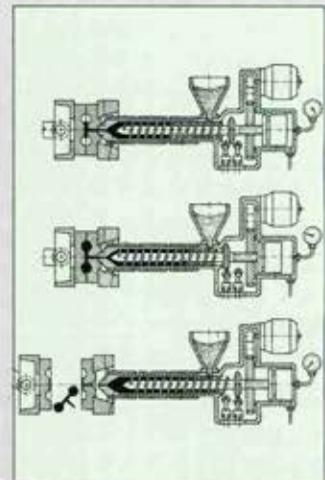


Depending on the composition of the macromolecular structure, the plastics behave differently when heated. If the long, threadlike molecular chains are curled and positioned parallel to one another, constant heating will increase the thermal movement of the individual chains until they begin to slide past each other. The plastic becomes soft and finally melts. These materials are called thermoplastics.

If there is a three-dimensional, cross-linked molecular mesh, the melting process will be hindered. At higher temperatures, the plastic will begin to disintegrate as a result of the thermal movement of the individual macromolecular segments. The mesh construction is torn apart, and the plastic is irreversibly destroyed. These materials are known as duromers.

These fundamental differences between thermoplastics and duromers influence the choice of processing methods for molding. Bayer mainly supplies thermoplastics in the form of granules. They are then transformed into semifinished or finished products by a process of first melting and then molding. There are two basic methods of molding: injection and extrusion.

In injection molding, the plastic granules are funneled into a cylindrical tube, where a worm gear presses them forward. At the same time, the pellets are melted by friction heat and with the help of outside heat. Moving like a



piston, the gear now presses the melted plastic into a forming die consisting of two or more parts. Here the material solidifies, and the finished molded form is ejected.

The extruder works according to the same principle but dispenses with the piston movement. The melted substance is pressed out through a special jet in a continuous extrusion. This permits the production of a multitude of contoured shapes and, by using circular jets, of pipes and tubes. After further developments, bottles, foils and sheets could be manufactured by this process.

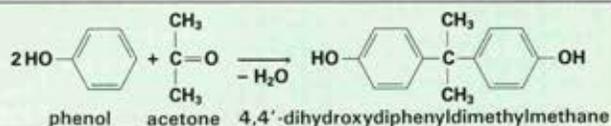
In the case of duromer plastics, Bayer supplies only the primary products or components. During processing, the customer then molds the plastics into the desired shape. This class of materials includes unsaturated polyester resins and almost all polyurethane plastics.

Composition of some of Bayer's major plastics

Makrolon:

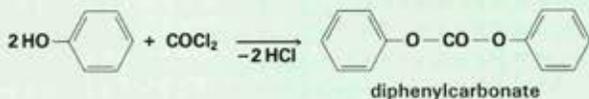
The main component of this product is 4,4'-dihydroxydiphenyldimethylmethane

(bisphenol A), which is easily obtainable from phenol and acetone:



In initial production processes, bisphenol A reacted with diphenylcarbonate,

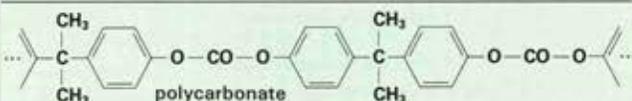
the phenyl ester of carbonic acid that was obtained from phenol and phosgene:



When a mixture of bisphenol A and diphenylcarbonate is heated, polycarbonate (polycarbonate melt) forms, and phenol is released in the process. Since the early 1970s, a process has been in use in which bisphenol A reacts

directly with phosgene in the presence of a solvent. This process yields a so-called solution polycarbonate.

The length of the macromolecular chains can be varied by adding small quantities of chain regulators,



Bayblend:

"Alloy" of polycarbonate and ABS polymer.

APEC:

The constitution of this plastic is similar to Makrolon, whereby some of the carbonic ester groups are replaced by bifunctional aromatic acids, such as terephthalic or isophthalic acid. The result is that the plastic can be used

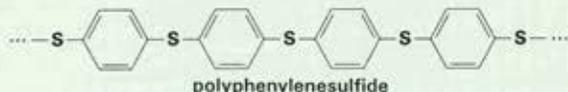
for applications at higher temperatures.

Pocan:

Terephthalic acid polyester

Tedur:

An extremely heat-resistant specialty thermoplastic which is reinforced by short-length fiberglass (45 percent by weight). In terms of its chemistry, the product is a polyphenylenesulfide.



Polyurethanes have the peculiarity of forming long molecular chains which are juxtaposed and can also be cross-linked. Depending on the composition of this macromolecular structure, plastics offer a variety of different properties. The space-filling

atom model of a polyurethane molecule (right) is used for instructional purposes.

Other products followed, and the requirements of the First World War especially spurred new developments. But the systematic and scientific study of this new branch of chemistry only became possible on the basis of Staudinger's fundamental discoveries.

International research spanning decades has led to a class of raw materials whose applications today seem close to limitless—from a lightweight yoghurt container to a durable, high-precision electronic component. Plastics now offer the same wide scope in use and design as any of the more conventional feedstocks: possibilities range from brilliant art and high-performance technical components to silly, tasteless kitsch.

During the I.G. Farben era, plastics accounted for only a small share of Leverkusen's production. Compounds that promised a wide range of uses, such as PVC, had been allotted to other works within I.G. Farben in 1925. But when Bayer was reestablished after the war, it was free to choose what it wanted in its production program. Management decided against bulk plastics and concentrated instead on products with special technical properties.

The consequences of this decision were not at all foreseeable at that time because it was new territory for the company. Existing production facilities could not simply be refitted to turn out a new plastic; a whole new plant would have to be built. Nor was it at all clear just how the market would react to the new products.

Concentration on specialty plastics was indeed risky. It meant not only lower tonnages at higher prices, but also a greater degree of research and investments. But Bayer's CEO Ulrich Haberland was a man who was willing to take risks at the crossroads of the newly incorporated company.

In Bayer's postwar organization, Elberfeld was not involved in plastics, Leverkusen was putting a lot



Makrolon is a plastic as transparent as glass

of emphasis on polyurethanes and synthetic rubber, and Dormagen was concentrating on fibers. In fact, cellulose acetate had already been produced in Dormagen under the trade name of Cellit in the days of I.G. Farben, and a few hundred tons of it were still left on the site. After extensive experimentation, technicians discovered that by using a Cellit plasticizer, a plastic capable of being injection molded with interesting properties could be made.

The first five metric tons of "CA Injection Compound" were produced in 1946, and in 1952, the product was given the trade name of Cellidor. It was transparent, had an attractive surface shine, was scratch-resistant and easy to dye. Plastics manufacturers processed Cellidor into combs, barrettes, screwdriver handles, glasses' frames, telephone housings, toys and other common consumer articles. Because of its excellent insulating properties, Bayer also introduced a range of electrical insulating foils based on Cellidor and sold under the name of Triafol.

Uerdingen's operations in the plastics sector were even bigger. Shortly after the war, work was resumed on unsaturated polyester resins. Unfortunately, the development of these resins for the plastics sector, which were marketed under the trade name of Leguval, was not without its surprises. Since the international exchange of information was still insufficient in the early postwar years, scientists could not keep abreast of what was going on around the world. It turned out that Bayer had developed products which were, in some cases, already on the market in the United States. This necessitated immediate license negotiations for these particular business areas.

Alkali-free glass used in the United States to reinforce moldings was not yet obtainable in Germany in 1950. Bayer's newly established Application Technology Department in Uerdingen came up with processes adapted to the German requirements. Researchers observed that Leguval resins could be mixed with powdery fillers, or even with sand or gravel, to form compounds as hard as stone or concrete. And they showed much better resistance to pressure than either of these conventional materials.



With these properties, Leguval became an interesting raw material for prefabricated elements, particularly in the field of sanitary installations.

The background of the second plastics units at the Uerdingen plant was quite different. In 1938, I.G. Farben chemist Paul Schlack had obtained a polymeric substance from caprolactam that could be spun into fibers. This polyamide 6 fiber, named Perlon, proved to be Bayer's answer to Du Pont's Nylon for the textile industry. Its technical properties also made the fiber base PA 6 an interesting material for use as a thermoplastic.

A caprolactam plant was built and production of polyamide 6 under the trade name of Durethan began in 1953. Besides Durethan B and BS, the starting material for Perlon, a Durethan BK program was developed for the processing of plastics. This material was used in the manufacture of such highly stressed products as bearings, cogwheels and technical threads. It also could be used for foils in the food packaging industry. Glass-fiber reinforced products were later added to the range. They opened up such applications as housings for electric tools, coils, hubcaps and heating valves. Further developments included elastomer-modified plastics and products containing fillers for sport and leisure articles.

Uerdingen's third plastics program emerged almost simultaneously with Durethan. In 1953, Hermann Schnell moved from the Main Scientific Laboratory in Leverkusen to head the Central Laboratory in Uerdingen where he continued his earlier research on polycarbonates. Schnell's idea that the highly sensitive carbonic esters could be starting materials for durable plastics sounded as unlikely to many experts as Otto Bayer's plan 15 years earlier to produce diisocyanates on an industrial scale.

Bisphenol A had long been known as a condensation product of phenol and acetone. Schnell discovered that by using phosgene, Bisphenol A could be converted into polycarbonic ester with unexpectedly good properties. This invention was patented on October 16, 1953, but it took five years for production to get started.



Cellidor came on the market in 1952 and soon became a favorite for designers. For example, the dashboard of the Ford 17 M as well as the steering-column cladding and the steering-wheel cover (see above) were made of Cellidor. This material was

also used to manufacture the housing of the portable radio on the left; Cellidor's properties helped to reduce vibrations to an absolute minimum.

Converting the polycarbonate into a thermoplastic that could be processed proved very difficult. Researchers had more success in using it to make a foil with outstanding insulating properties. This foil, marketed as Makrofol, could be manufactured in thicknesses of only one-fifteenth that of a human hair. With their extremely high tensile strength, these super-thin foils were also soon used in Agfa's film production.

In 1958, Bayer scientists finally succeeded in making an easily processable thermoplastic from polycarbonates. The new product called Makrolon came on the market at just the right time: both industry and the public had finally accepted that plastics were more than simply an ersatz material.

Customers with practical experience in the processing industry soon inspired further improvements in Makrolon's properties. No thermoplastic to date had as wide a range of desirable properties.



Cologne's unmistakable main train station with its advertisement for the eau de Cologne of a world-famous local company has become lighter and brighter because daylight can now stream through the clear and virtually unbreakable Makrolon roof construction.

It is transparent and practically unbreakable, dimensionally stable up to 135° C and impact-resistant down to -100° C. It can be easily processed and dyed any color. It is non-toxic and without a taste of its own. These two latter properties make it safe for use in such applications as plastic eating and drinking utensils, components of milking machines and medical equipment that has to be heat-sterilized.

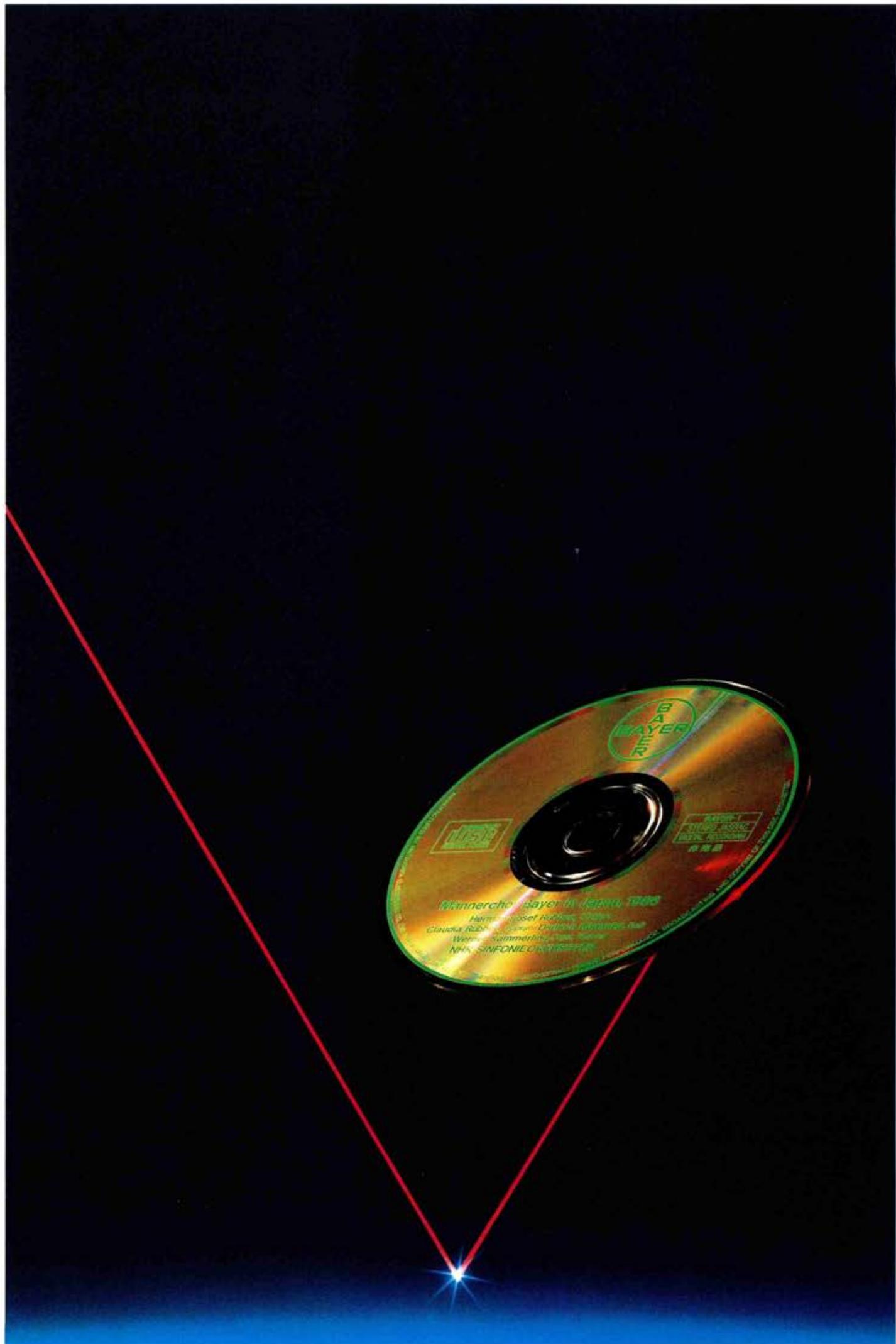
At first, it was impossible to make a colorless polycarbonate. Early Makrolon was the color of brandy, and later it had the color of honey. Advertisers made a virtue out of necessity in proclaiming its "noble golden glow." But this problem was overcome in time, and Makrolon became as colorless and transparent as glass.

The history of polycarbonates shows once again that new technical developments rarely occur at a single company. The American company General Electric brought out a carbonic ester-based plastic at about the same time as Bayer introduced its version. Neither side realized the duplication at first, but respective license negotiations cleared up the situation.

The Makrolon program was gradually expanded to include over 60 types and 500 shades for an equally broad range of applications. The now well-known and popular product made headlines when the former glass roof of Cologne's main train station was replaced by over 145,000 square feet of Makrolon sheets in 1985 and 1986.

A more recent breakthrough was the use of the newly created Makrolon CD 2000 for the production of compact disks. Some 75 percent of all compact disks manufactured in Europe today are made of Makrolon. In the United States, Makrolon is distributed by Bayer's subsidiary Mobay Corporation.

It might look as though Leverkusen is the capital of polyurethanes and Uerdingen the home of thermoplastics and unsaturated polyester resins, but this is not at all the case. An important range of thermoplastics was developed up to the marketing stage in



Leverkusen's laboratories: Novodur, a so-called ABS plastic. The acronym stands for acrylonitrile, butadiene und styrene.

This development proved that a macromolecular product can be created from not one, but three different components. Examination with a microscope shows two clearly defined and completely separate phases in this polymer, instead of an indiscriminate molecular composition. This structure lends itself to a particularly high impact-resistance.

By the end of the 1960s, the impracticality of maintaining application units for plastics with expensive machinery in more than one plant became obvious. But there was another important consideration: for a large number of technical applications, several different plastics had to be tested to find the best choice. This meant that customers needed central consulting facilities.

As a result, all applications work in the plastics field was moved to Leverkusen in the early 1970s, although polyester resins were kept separate because of their particular technical problems. A technical applications center was set up in Leverkusen with comprehensive machinery and excellent testing installations.

It is often said that modern life would be inconceivable without plastics. But this statement has a negative connotation. A more positive way of summarizing the role of plastics is that they are absolutely indispensable engineering materials: not only are they a complement to conventional raw materials, but they have also revolutionized the processing industry.

More and more hi-fi fans are switching to compact disks and are thus experiencing the virtues of Makrolon. About three-quarters of all European CDs are made with this product from Bayer. "CD 2000" was developed in Leverkusen as a special Makrolon type for

compact disc production. It has ideal properties for use in these laser-activated, digital records, which, after years of playing, sound as they did on the first day.

Bayer chronicle 1953

Bayer shares are once again quoted on the stock market. Employees are offered a stock option for the first time.

First collective agreement on conditions of employment is reached for the employees of the chemical industry.

Gusathion against cotton pests and Gusathion K for the control of Colorado beetle come onto the market.

Resotren, a spinoff of Resochin, is introduced as a cure and prophylaxis against both amoebic dysentery and malaria.

Production begins of silicic acid and silicate fillers (Vulkasil).

Dralon production capacities are increased in Dormagen to meet growing demand.

In the United States, Bayer acquires a one-third stake in Chemagro Corporation, which manufactures and markets agrochemicals.

Bayer buys a holding in the British firm J.M. Steel, which is later to become Bayer Chemicals Ltd.

A holiday resort for Bayer employees is opened in Garmisch-Partenkirchen.

World events 1953

Dwight D. Eisenhower becomes 34th U.S. president.

On May 29, New Zealander Edmund P. Hillary and Sherpa



Tenzing Norgay are the first to climb Mount Everest.

Elizabeth II is crowned queen of the United Kingdom on June 2.

A strike of construction workers in East Berlin on June 17 turns into a popular uprising in the German Democratic Republic. It is subsequently suppressed by Soviet troops.

Korean War ends on July 27.

George C. Marshall, the author of the Marshall Plan, is awarded the Nobel Peace Prize.

James D. Watson and Francis H. Crick discover that deoxyribonucleic acid (DNA), the carrier of genetic information, has the structure of a double helix (1962 Nobel Prize).

Dralon becomes a symbol of quality

In November 1954, Bayer launched its acrylic fiber under the trade name of Dralon. The company introduced a licensing system whereby use of the trademark was restricted to customers who committed themselves to uphold the standards of quality laid down by the manufacturer. Dralon went on to achieve worldwide renown.

On July 21, 1969, millions of viewers all over the world saw a television broadcast of an event taking place 238,000 miles away: Edwin Aldrin and Neil Armstrong were walking on the moon. Exposed to temperatures varying from 160° C to -130° C, the two men were wearing spacesuits consisting of 21 layers of special fabric, 20 of which were made from synthetic fibers. Their moonwalk would not have been possible in a suit made of natural materials.

Today, a jumbo jet or another similarly giant aircraft lands somewhere in the world every few minutes. A 335-ton jumbo sets down its 18 pneumatic tires on the runway at a speed of over 135 m.p.h. Only tires with supporting material made from synthetic fibers can take this sort of strain.

These may be extreme examples, but there are plenty more closer to home. Just look at people's clothes in old paintings or early photographs. The rich dressed in splendor, while most of the population had to make do with decidedly more modest, if not to say shabby, garments.

Expensive wool and even more costly silk, cotton and linen were the only textile fibers a hundred years ago. Apart from the wealthy, nobody had a wardrobe of clothes for every possible occasion. Nor was travel as light as it is with our less bulky apparel today.

With the introduction of artificial silk, fashion became democratic. Rayon offered more opportunities still. But only synthetic fibers surpassed natural products when it came to value, availability, quality and versatility.

In his book, "Chemiefasern," Werner Meyer-Larsen makes the following comparison: "A modern plant for polyacrylonitrile textile fibers produces 150 metric tons of fibers per day. To obtain the same quantity of wool, it would be necessary to have 12 million sheep grazing over an area as big as the German state of North Rhine-Westphalia."

Bayer turns out 556 metric tons of acrylic fibers daily, i.e. 3.7 times Meyer-Larsen's amount. These enormous production volumes have become

Synthetic fibers opened up a wide range of new perspectives for fashion designers. Extensive product information—on the right the title page of the first issue of a Bayer fibers publication—was part of the company's marketing efforts right from the start.



SILBERFADE



ZEITSCHRIFT FÜR BAYER-FASERN

Heft 1 / Frühjahr 1969

necessary not only because the world population is constantly increasing in number, but also because individuals expect more out of life in terms of material comfort. Not even cotton could meet half of today's textile requirements.

The first big trade name in the history of synthetic fibers is undoubtedly Nylon. First in America, later all over the world, this product altered consumption patterns as radically as did the Model T Ford.

Chemist Wallace Hume Carothers was employed at E.I. Du Pont de Nemours & Co. in the 1930s. The company had hired him from Harvard and given him a job at its headquarters in Wilmington, Delaware. He worked in the company's laboratory, which was called Purity Hall because gifted scientists could dedicate themselves to "pure" research. No specific goal was set for their work and money was no object.

Du Pont was already one of the world's leading producers of artificial silk and was now searching for raw materials to produce synthetic fibers. After years of research, Carothers came across super-polyamide 6.6 in 1934. It was a fiber with sensational properties: firmer than cotton, but as fine as silk. Du Pont's management was delighted.

The product came on the market five years later under the trade name of Nylon. Unfortunately, its inventor did not live to witness the marketing of Nylon or to see his brainchild's success. In a fit of depression, Carothers committed suicide in the spring of 1937.

The first application of Du Pont's new product—a toothbrush with Nylon bristles—was not exactly revolutionary. But the company correctly predicted what the product had to offer. In 1939, the first large-scale Nylon unit was built in Seaford, Delaware. Each woman working at the plant was given the chance to buy two pairs of Nylon stockings at a total price of \$2.30. This was quite a bargain for women who had never been able to afford silk stockings.

In 1938, a Du Pont delegation traveled to Europe to offer I.G. Farben a license for Nylon. The Americans were quite surprised when I.G. Farben's chemists showed them a similar product of their own. Quite

independently of Carothers, Paul Schlack had been studying polyamides for years at the Aceta plant in Berlin. In January 1938, he had also come up with a super-polyamide.

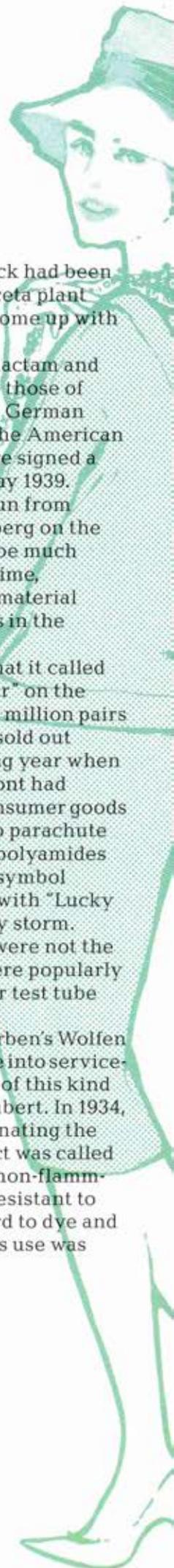
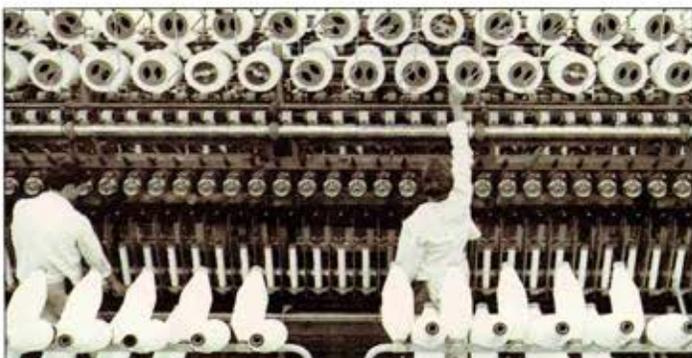
Schlack's product was based on caprolactam and had technical properties very similar to those of Nylon. I.G. Farben named it Perlon. The German company did, however, recognize that the American product had come out first and therefore signed a licensing agreement with Du Pont in May 1939.

During the war, parachute silk was spun from Perlon in the I.G. Farben plant at Landsberg on the Warthe. The man-made fiber proved to be much sturdier than natural silk. At the same time, Nylon was becoming an important raw material for the production of women's stockings in the United States.

On May 15, 1940, Du Pont launched what it called the stocking made of "coal, water and air" on the home market. The first shipment of five million pairs sent to New York and Philadelphia was sold out within hours. By the end of the following year when the United States entered the war, Du Pont had extended applications of Nylon from consumer goods like stockings, underwear and linings to parachute silk, too. But the real breakthrough for polyamides came after the war. "Nylons" became a symbol of the new consumer era and, together with "Lucky Strike" and "Coca-Cola," took Europe by storm.

Carother's and Schlack's polyamides were not the only "synthetics," as synthetic fibers were popularly called. Chemists had been searching for test tube fibers since the 1920s.

In 1931, the artificial silk unit at I.G. Farben's Wolfen plant managed to spin polyvinyl chloride into serviceable synthetic filaments. The first fiber of this kind was "Igelit P.C.O." developed by Emil Hubert. In 1934, Herbert Rein improved it by post-chlorinating the starting materials. The resulting product was called "PeCe Fiber." It was almost completely non-flammable, as well as extremely durable and resistant to chemicals. But unfortunately, it was hard to dye and did not stand up well to heat. This fiber's use was



therefore largely limited to applications where the emphasis lay on its positive properties, such as for filter fabrics in the chemical industry.

Scientists had also been attempting to process polyacrylonitrile into fiber for a long time. In 1939, two years after the invention of the poly-addition process, Peter Kurtz and Otto Bayer in Leverkusen succeeded in synthesizing acrylonitrile directly from acetylene and hydrocyanic acid. This not only facilitated the production of the acrylonitrile rubber, Perbunan N, but also provided the positive economic basis for a possible acrylic fiber program.

The polyacrylonitrile (PAN) itself was available, but spinning it was made extremely difficult for lack of a suitable solvent. Working in I.G. Farben's plant at Wolfen in 1941, Herbert Rein found the answer in the form of dimethylformamide. But the war held up any further development of acrylic fibers.

An entry in a Leverkusen diary on March 17, 1949, documents the first continuous spinning of a poly-acrylic fiber. The industry has come a long way since then. Today, the jets of a fiber machine shoot out filament at a rate of 400 meters per minute. A thread is not allowed to have a single break for a length of 4,000 kilometers; that's comparable to the distance between Copenhagen in Denmark and Palermo in Spain.

But this capacity was still a long way off. The first production unit for Perlon and acrylic fibers was built in Dormagen in 1951. Even after expansion, the unit had an annual capacity of only 6,000 metric tons, a modest volume by modern standards, but it was enough to make Bayer Germany's biggest single producer of acrylics.

In the meantime, two important decisions had been made. First, acrylic fiber production would be concentrated in Dormagen, which was also soon to be the site of Bayer's and British Petroleum's petrochemical joint venture, Erdölchemie. Acrylonitrile was going to be produced there and fed directly into the polymerization unit, thus avoiding a long transport route. And second, acrylic fibers, under

the new name of Dralon, were to be made the core of the company's synthetic fiber program.

Why had the company chosen acrylics? In the 1950s, the polyamides Nylon and Perlon were still considered luxury articles, and it was chic to wear synthetics. A shirt made from the new material cost around DM 50, compared with about DM 10 for a cotton one. There were some drawbacks though. The synthetics of the day tended to turn yellowish, and faulty fabric structure resulted in retention of heat. These disadvantages dampened the enthusiasm for polyamides.

From the very start, the processing of acrylic fibers was focused on loosely woven fabrics similar to wool. Admittedly, there were also initial problems with Dralon, but quality was soon significantly improved thanks to progress in polymerization technology. In addition, the development of Astrazon dyestuffs led to a decisive improvement in the penetration-dyeing of the acrylics during the spinning process.

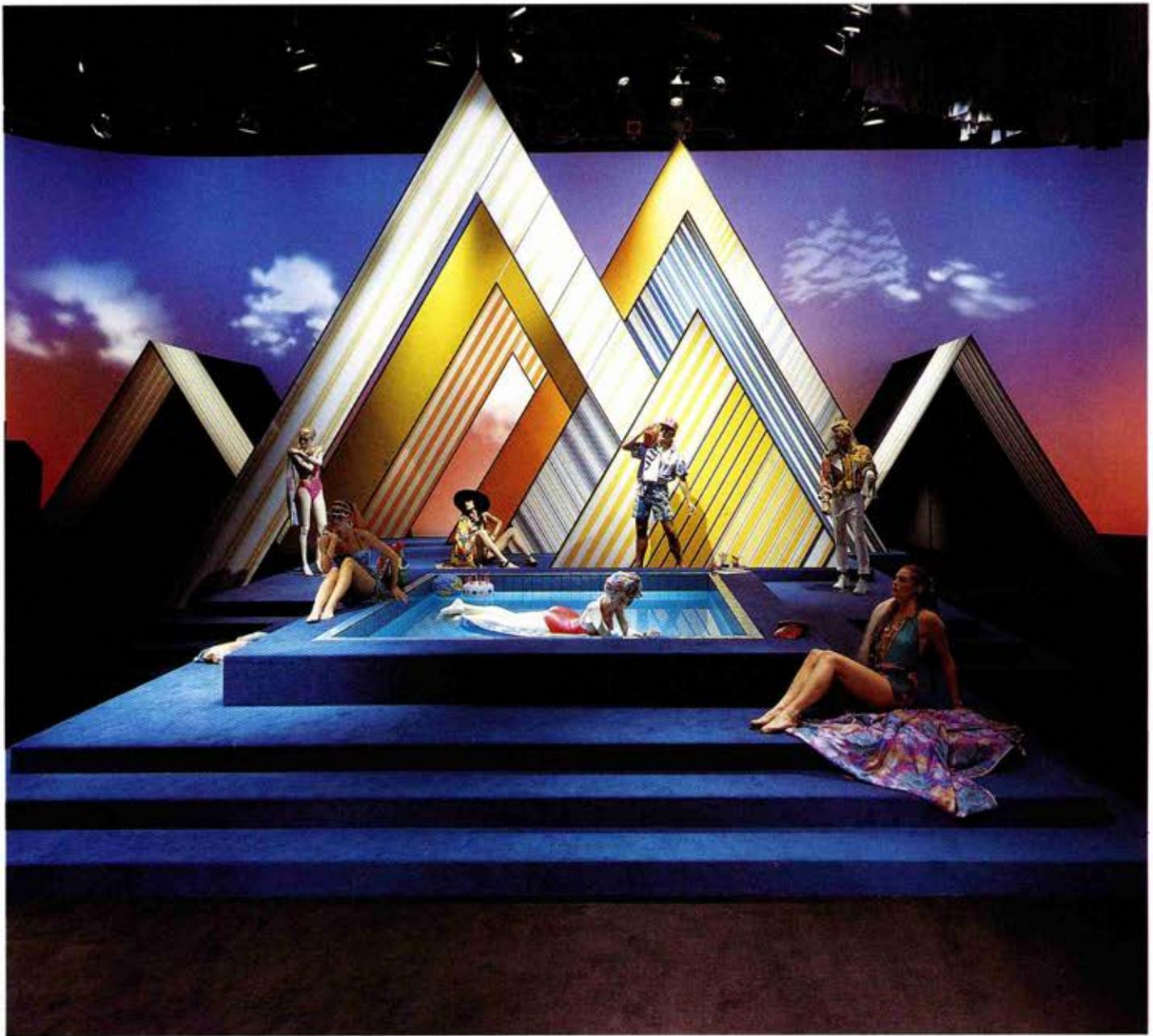
The enormous effort that Bayer put into the product information for its synthetic fibers has rarely been matched. Obviously, silky synthetics with a luxury appeal were much easier to promote than products that boasted comfort alone. Bayer advertising thus stressed the "easy-care" aspect, where Dralon definitely had an advantage over natural fibers. Another slogan was "Synthetic fibers set the style." The company organized fashion shows in European cities and invited leading couturiers to enter a competition to win Bayer's "Golden Scissors."

One of the most important events for the home furnishings industry is the annual "Visiona." This special Bayer exhibition started off as a part of the Furniture Fair in Cologne in 1969 and has since moved to the "heimtextil" Fair in Frankfurt. Over the years, top designers from all over the world—among them Joe Cesare Colombo from Milan, Verner Pantón from Basel, Oliver Mourgue from Paris and Jack Lenor Larsen from New York—were given the chance to let their imagination unfold.

The Dormagen plant supplies textile fibers in the form of raw materials for further processing. Bayer's customers turn them into anything from high-fashion garments to elegant home furnishings. The technical pictures on the opposite page were taken in the Dralon unit

and in the Applications Technology Department of the Fibers Business Group.





They set trends in interior decorating that pointed far into the future.

Every "Visiona" had its own sensations. In 1986, for example, visitors at the Frankfurt show were confronted with such unusual objects as "The Hanging Pyramid," "The Floating Cube," "The Kaleidoscope" and "The Infinite Room." These eyecatchers focused attention on the latest collections of Western European Dralon processors, presenting upholstery velours, draperies, garden fabrics, carpeting and blankets. The following year, Bayer created an entire "Dralon City," and the Cologne mime group "Living Dolls" modeled the newest fashions in Dralon and Dunova, Bayer's most recently developed

textile fiber. Some 450 creations from the collections of 150 Bayer customers were shown.

On such occasions, Bayer's fibers specialists had every right to be satisfied. They remembered all too well that not so long before, the European fiber manufacturers had had no reason to smile. Who would have thought back in the early days of synthetic fibers that the market situation could become so critical?

In 1950, the world market produced a total of 8.4 million metric tons of fiber. Cotton accounted for 66.9 percent of this output, wool 13 percent, regenerated cellulose fibers 19 percent and synthetic fibers less than one percent. With a share

Bayer's special "Visiona" exhibition has been a major attraction at Frankfurt's "heimtextil" Fair for fabrics in home furnishings for years now. Leading designers from around the world use their creativity to demonstrate possible applications for the company's fibers.

of only 0.23 percent, natural silk was already out of the running.

By 1967, world consumption of textile fibers had not only doubled, but there was also a radical change in the proportions of the different product groups. Cotton was still in the lead with 57.5 percent (today, it has a share of no more than 40 percent), but artificial fibers had reached 34 percent, of which fully synthetic fibers represented 14 percent.

The United States, Japan and Western Europe accounted for some 80 percent of the production volume of synthetic fibers. In Western Europe, 16 companies were producing chemical fibers in 200 different plants. The Federal Republic was the leading European producer and with a nine-percent share of the global market, the third biggest in the world after the United States with 31 percent and Japan with 16 percent. By 1969, Bayer was not only producing fibers in Dormagen, it was also operating a Dralon plant at its Peruvian subsidiary, Bayer Industrial S.A.

Spirits were high in the fibers industry. It was estimated that demand for chemical fibers would triple by 1980. A worldwide tug-of-war for capacities, market shares and prices began. The situation was complicated by frequent government intervention; subsidies, customs barriers and other restrictions prevented the market from dictating the course of events. All this led to overproduction and a sharp fall in prices. As a Bayer manager in the fibers business put it, *"The rug was pulled out from underneath us in 1974."*

Obviously, the industry had to change its way of thinking. For its part, Bayer concentrated efforts on those businesses where the company had a leading position. In a painful restructuring plan, Bayer

dropped polyester, Cuprama, Cupresa and acetate from its program. The wide range of existing brand names was replaced by the overall trademark "Bayer Textile Fibers." By stressing Dralon in the various types needed to meet the requirements of the market, Bayer secured its place among the world's top acrylic producers.

The company has maintained this position by capitalizing on its product technology. For example, in 1978, Bayer introduced Dunova, an acrylic fiber based on Dralon. This remarkable fiber absorbs perspiration without losing its shape. It also dries quickly, does not easily feel damp and has a low specific weight. It is the ideal fiber for sports and leisure wear.

In addition to the stars Dralon and Dunova, other fibers eventually established themselves in specialty uses. Long appreciated in the form of Perlon stockings, polyamides have now branched out into completely new applications, such as nearly unbreakable fishing lines, zippers, fishing nets, ropes used on ships, carpeting and floor coverings, brushes, and stay wires for orchards and vineyards.

When polyurethanes were first invented, scientists believed that they would open the door to a new class of fibers comparable to polyamides. As it turned out, polyurethanes' strengths lie elsewhere. Nevertheless, elastic fibers based on polyurethane do play an important role in certain specialized uses. In applications ranging from stretch weaves for foundation garments and bathing suits to elastic bands for socks and panty-hose, they have proved superior to natural rubber when it comes to aging, the duration of their elasticity and their dye affinity.

In 1974, the company's large number of trademarks in the fibers field was replaced by the general term "Bayer Textile Fibers." With the help of Dralon, Bayer has since become one of the world's leading producers of acrylic fibers.



Fragrances, flavors and aromas from Holzminden

Haarmann & Reimer, a Bayer subsidiary since 1954, has thousands of flavors and fragrances in its sales program. The production volume of a single product can range from a few kilograms to hundreds of tons. If all of the possible combinations of components are taken into account, the product spectrum knows no limits.

Geneva and Holzminden—one a cosmopolitan metropolis in Switzerland, the other a small town in northern Germany—may not seem to have much in common, but both are leading centers in the world's flavor and fragrance industry. Each of them has two firms belonging to the top ten of the branch: Givaudan and Firmenich in Geneva and Haarmann & Reimer and Dragoco in Holzminden.

With their distillation columns, pipes and tanks, the factories look much like any other chemical plant. But they smell very different. Depending on the project at hand, the odors emanating from the plants can smell like violets and roses, strawberries and apples or sometimes like bouillon and freshly baked cakes.

When perfumers start their day at Haarmann & Reimer (H&R), their first task is a workout for their noses. The "training" takes place with a sampling of almost 2,000 fragrance components used in the creation of even the most exotic perfumes. Two perfumers exchange twelve strips whose ends have been dipped into various components and then quiz each other as to the substances in question.

Perfumer, or "parfumeur" as the French say, is an extremely rare profession. There are an estimated 400 genuine experts in the whole world. Seventy of them are working in Germany, including 24 "noses" at Haarmann & Reimer. A further 19 are employed at the company's foreign plants.

This vocation calls not only for a keen sense of smell, but also for handicraft skills, a creative touch and an artistic aptitude. After five years of training, and if one is lucky enough to have all these talents, the perfumer can start his fascinating career.

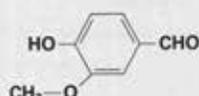
Perfume manufacturers that want to market a new creation take their idea to Haarmann & Reimer. On the basis of this initial briefing, the perfumer begins to mix the various components in a painstaking effort to come up with the desired fragrance. It may take months for the perfumer to work his way up to the right combination. Before the customer's perfume wish can be created, the scent may have to be altered by just an infinitesimal amount of one

Perfumers at Haarmann & Reimer "compose" their creations from hundreds of different fragrances, whereby they mainly rely on their trained noses for their work. New substances for fragrances are constantly being extracted and analyzed in the company's laboratories.

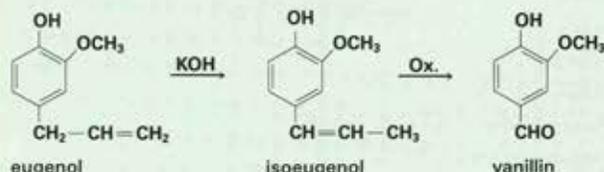
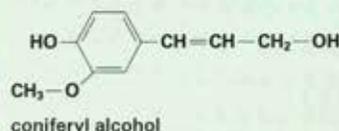


Vanillin and menthol

Vanillin is 3-methoxy-4-hydroxybenzaldehyde:



Cambium is the viscid layer of formative cells between the wood and bark of trees. This substance, which is very hard to extract, contains coniferin, a sugar compound of coniferyl alcohol (3-methoxy-4-hydroxycinnamic alcohol):



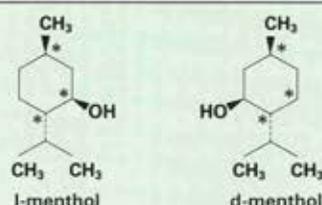
In the years to follow, a considerable number of further syntheses were developed; some of them have turned out to be technologically significant. Lignin, which, together with cellulose, is a main component of wood, has recently become a very cheap raw material. It is obtained from the sulfite waste liquor that is found in pulp mill production.

Despite their totally different origins, there is a striking chemical similarity between these substances. In the first method of synthesizing vanillin to be developed, coniferyl alcohol was converted to vanillin by oxidation with bichromate. A much cheaper synthesis was discovered later. In this process, vanillin is gained from eugenol, the main component of clove oil. The resemblance between these two natural substances is again quite remarkable. The eugenol molecule is rearranged to form isoeugenol by an alkaline process. Vanillin is obtained after oxidation:

The main component of peppermint is l-menthol, which is the only one of eight optically active menthol isomers with the desired refreshing taste. Due to the three "asymmetric" C atoms marked with an asterisk in the formula, there are four isomeric menthols. Each of these occurs in two optically active forms. The (+) or d-form ("d" stands for

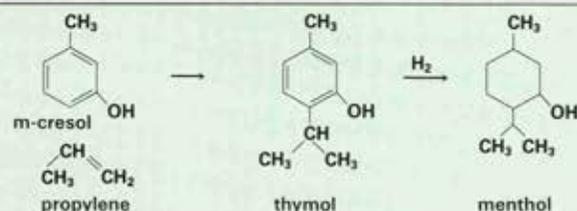
the Latin word "dexter," which means "right") turns the plane of oscillation of the polarized light to the right, while the (-), or l-form (the latin word "laevus" = left) turns it to the

left. All other physical and chemical properties are identical. The 1:1 mixture of d- and l-type menthol is known as the racemic, or d,l-form.



In the case of the menthol synthesis mentioned in this chapter, m-cresol is converted into thymol under pressure and in the presence of propylene. Catalytic hydrogenation of thymol with hydrogen yields the four isomeric men-

thols in different proportions. The d,l-menthol is isolated by distillation: after isomerization, the remainder is available for other uses. Bayer employs these manufacturing processes:



At Haarmann & Reimer, d- and l-menthol are separated from one another and the mixture is then esterified with benzoic acid. The menthyl ester of benzoic acid tends to form supersaturated solutions.

When such a solution is "inoculated" with a small particle of pure l-form, only

this will crystallize. It is then filtered off and transformed into pure l-menthol by saponifying the ester. The d-form can be obtained in a pure state by a similar process. This so-called "seesaw" method allows completely synthetic, industrial-scale production of the natural substance l-menthol.



individual component. And several hundred may be included in a single composition.

In a popular German television program in 1984, two young people wanted to prove that they could identify 50 men's and 50 women's perfumes by their smell. They failed to win the bet, but one of them was so fascinated by the subject matter that he gave up his geology studies and started training as a perfumer at H&R.

From time immemorial, people have been extracting, and then later distilling, fragrances from flowers, fruit, roots or herbs. The process was tedious, and the yields were small. For many years, the search went on in vain for some sort of substitute. By the second half of the last century, there was only one artificial fragrance: nitrobenzene. It was used under the name of mirbane oil for the production of almond soap.

In 1872, Wilhelm Haarmann, a chemistry student at the University of Göttingen, handed in his doctoral thesis on coniferin, a substance contained in the cambium of fir trees. Haarmann had observed

the formation of aromatic crystals during a particular chemical reaction. Working with Ferdinand Tiemann, a friend from his days as a student, he subsequently identified this substance as vanillin. He wasted no time in setting up a factory for the production of synthetic vanillin in his hometown of Holzminden in 1874. Two years later, chemist Karl Reimer joined the firm, which was then renamed "Haarmann & Reimer, Chemische Fabrik." Tiemann, later a professor in Berlin, remained a silent partner.

The vanillin from Holzminden was the first natural flavor and fragrance to be manufactured synthetically on an industrial scale. The man-made vanillin was chemically identical to the main aroma component in the vanilla pod. At 7,000 marks a kilogram, the synthetic vanillin started off almost as expensive as gold. Production became much cheaper when the raw material was changed from cambium to eugenol, which was extracted from clove oil. By 1902, the price per kilogram had gone down to 60 marks.

The existence of H&R is based on a patent of the Imperial Patent Office in Berlin issued in 1877 for a "process for the synthesis of vanillin." Today, the company supplies flavors and fragrances for use in everything from perfumes and soaps to baked goods.



Haarmann & Reimer expanded into further areas. In 1893, they isolated ionones, substances producing a violet-like scent. Important components of other popular fragrances, such as ambrette seed oil and oil of angelica, were soon to follow. These components were used as the individual building blocks of scents required to create new perfumes.

Today, thousands of fragrances have been defined, but only a limited number have come to play an important role in perfumes. Some of these are natural products, like patchouli oil from Indonesia, which has never been replaced by an industrial equivalent. But many of them are synthetic substances which, like vanillin or l-menthol, are identical with the natural product. Others are wholly artificial, without any model in nature.

A large number of modern perfumes use these man-made substances to determine the fragrance. For example, the familiar smell of lily-of-the-valley can only be enjoyed in perfumes thanks to the creative talents of chemists and perfumers: nobody has ever succeeded in extracting a usable essential oil from the plant itself.

Before the war, I.G. Farben produced flavors and fragrances at its Agfa plant in Wolfen. After 1945, Bayer started production in Uerdingen. In the newly created Farbenfabriken Bayer, management soon realized the potential of this product group. On the other hand, a heavy chemicals company did not exactly have the ideal prerequisites for a business with thousands of specialty products. Imagine calculating sales volumes in kilograms per quarter!

For this reason, Bayer seized the opportunity when Haarmann & Reimer started to look for a suitable partner in 1954. H&R was acquired, and the entire company's efforts in this field were concentrated in Holzminden. Haarmann & Reimer contributed its know-how and well-established reputation, and Bayer provided the wherewithal to carry out large-scale research and development.

In 1974, exactly a century after the company's founding, Haarmann & Reimer and Bayer achieved a particularly rewarding success. A plant was

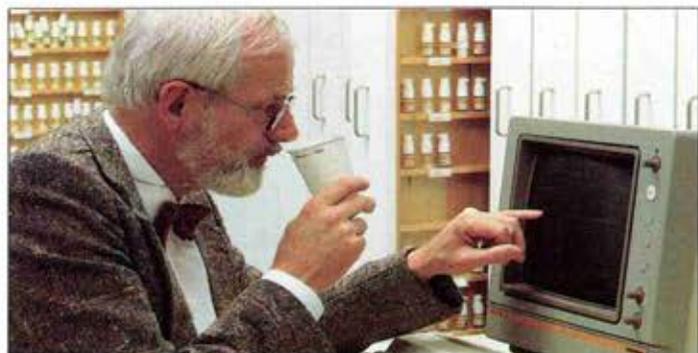
inaugurated in Holzminden for the industrial-scale manufacture of fully synthetic l-menthol, the main component of peppermint oil. It was not the first time that menthol had been produced in industrial synthesis, but up until then, the resulting products had had only half the value of natural menthol.

The reason for this is that there are two versions of the menthol molecule, and they react to one another like opposites. Only the one form occurs in nature, and only this version has the typical cooling effect that makes menthol so valuable in cosmetics, pharmaceuticals and the tobacco industry. Up until now, synthetic production had always turned out both versions inseparably connected in a fixed proportion. The new H&R plant was finally able to manufacture the "pure" menthol.

In the past, whole Brazilian forests had been felled to make room for peppermint plantations. Now the synthetic product could compete with the natural product it was modeled on. In Bushy Park, South Carolina, not far from the center of the American tobacco industry, Haarmann & Reimer's U.S. subsidiary opened the world's biggest and most modern l-menthol plant in 1978. It has an annual capacity of 700 metric tons.

H&R's fragrance products appeal to the senses, and they are by no means only destined for perfumes to be used on special occasions. Today's consumer wants pleasant-smelling fragrances in shampoos, skin creams, after-shave lotions, toothpastes, paper napkins, detergents and many other goods. Coming up with the right products calls for great versatility and originality on the part of Holzminden's Applications Department for fragrances. On-site product tests are conducted in fully equipped bathrooms and hairdressing salons. Unconventional jobs requiring unusual skills await the H&R researcher, such as washing one half of the test person's head with "product x" and the other half with a new creation.

Flavors make up about one-half of all the company's business. Almost all of these are produced on the basis of natural products. H&R operates



Smelling is a fine art at Haarmann & Reimer. Highly trained perfumers use their sense of smell to determine the combination of fragrance components in a shampoo (above), in bakery goods (right) or to see whether computer data agree with an expert nose (left).

large-scale units for the processing and concentration of flavors extracted from fruit, vegetables, spices and other food products.

The importance of this business is illustrated by the simple example of a fruit yoghurt. Two or three strawberries would not be sufficient to create the necessary taste in a single-portion container. The concentrate is thus supplemented with the aromatic substance from many more berries. The right recipe has to be worked out, and great deal of time is required to test it. H&R's application labs for aromatics have at their disposal a real cornucopia of all the ingredients needed to satisfy modern man's appetite for food and drink.

The company's scientists also analyze flavors. They have done pioneer work in sensorial smell and taste analysis and have gathered a great deal of experience in quality testing. Since tastes vary, some 18 testers work together under laboratory conditions. In order not to be led astray by the look of a product, they work under colored lights that, for example, make red substances white and white ones red.

From the start, Haarmann & Reimer also served customers beyond the home market. It has subsidiaries of its own in 15 countries and agencies in 97, including special firms for such major customers as the soft-drink industry. The company also runs perfume studios in Paris and on the 88th floor of New York's World Trade Center; and when H&R refers to the New York studio as the "height of creativity," they mean it in more ways than one.



Bayer chronicle 1954

Although Bayer has already reestablished itself in numerous countries, this year can be seen as the start of large-scale international expansion.

— Mobay Chemical Company is founded as a joint venture with Monsanto Chemical Corporation of St. Louis.

— A plant for the manufacture of raw materials for polyurethane plastics is set up in New Martinsville, West Virginia.

— As a joint project with Chemagro, a research station is opened at Vero Beach, Florida, for the testing of agrochemicals under tropical and sub-tropical conditions.

— The company Fabrica Argentina de Anilinas is formed in Buenos Aires.

— Production units are opened in Chile for synthetic tannins and agrochemicals.

— The Brazilian company Chimica Bayer Ltda. is returned to Bayer.

A waste water and emission control laboratory is installed in Leverkusen. Continuous SO₂ measurements begin.

Otratren, an antacid penicillin in tablet form, is marketed.

Construction starts of the isotope laboratory in Elberfeld.

Baygen program of lacquers based on polyurethane opens new perspectives for patent leather manufacturers.

World events 1954

American Secretary of State John Foster Dulles promotes "massive retaliation" as the country's nuclear strategy.

Federal German Parliament amends the constitution to enable national rearmament. French Parliament rejects the 1952 Pleven Plan for the creation of the European Defense Community. Following the Paris Treaties, the Federal Republic becomes a member of NATO.

Meeting of foreign ministers in Geneva ends the First Indo-Chinese War: Vietnam is divided, Laos and Cambodia become independent nations.

South East Asia Treaty Organization (SEATO) is set up in Manila on September 8.

Abdel Nasser deposes General Naguib in Egypt. On June 23, Nasser is elected president by 99 percent of the voters.

On December 2, Joseph McCarthy is dismissed from his post at the head of the Senate Committee on un-American activities.

On June 27, the Soviet Union's first nuclear power station is opened. Worldwide there are 41 nuclear reactors in use, 29 of which are located in the United States, five in the United Kingdom, two each in France and Canada and one each in Sweden and Switzerland.

Power stations at full steam ahead

In November 1955, a boiler that used a high-temperature turbine and produced steam at 650° C went on steam at the “G” south power station in Leverkusen. Temperatures this high and the accompanying pressure demanded the utmost from plant and materials. Bayer engineers made a major contribution toward this achievement.

The history of the in-house power supply at Bayer falls into three distinct periods. The first began in 1892 with the planning and construction of the Leverkusen plant. In compliance with the state-of-the-art safety regulations, this energy concept allowed for a separate boiler house for every production unit. Such precautions were taken because it could not be excluded that a boiler could explode. A total of 13 boiler houses with 113 individual boilers were built over a period of time. Each boiler produced industrial steam with a pressure of six bar; reaction boilers were, and still are, steam-heated.

Electricity was supplied to the production units from the public network and from a small power plant. It was initially equipped with a steam engine and then, from 1909 onwards, with turbines. This system was used for over 20 years.

With energy requirements constantly growing, this power system gradually proved to be insufficient. The boilers were getting old. They caused high maintenance costs, especially since different spare parts were required for the various boiler types. This situation prompted Bayer to decide in favor of a centralized power supply. A power station was set up in the middle of the plant in the G block, which is how it got its name.

In 1926, the “G” power station was ahead of its time. It worked with boilers that operated with 30 bar pressure and at a steam temperature of 380° C. This was a real technical breakthrough, and a lot of people were convinced that it would not work. But they were wrong. Its 12 boilers turned out 240 metric tons of steam per hour. It may have been only half of the total output of the individual boiler houses, but it was nevertheless preferable because energy was now produced and distributed more efficiently. Fuel consumption also declined as a result.

But the most important advantage of the new unit was that it introduced the coupling of power and heat. Steam was no longer produced solely for industrial use, it also served as a means to generate electricity. While this did not make Leverkusen





completely self-sufficient in electricity, steam production became much more economical, and the amount of money spent on buying electricity from outside could be substantially reduced.

The coupling of power and heat was significantly improved during the second phase ten years later, when a new power plant was built in the block. Steam conditions in this plant were increased to 130 bar and 510° C. This coal-burning power plant was not only way ahead of its time from a technical standpoint, but also because of its architectural design. It served the energy needs of the works for five decades until it was torn down in the spring of 1987.

The coupling principle was put into practice at all Bayer plants and also at all its other industrial facilities that needed steam. The first overhead pipelines were installed, initially to transport steam; by 1950, the Leverkusen works alone had over 11 miles of overhead pipelines and 80 miles of other piping.

Production continued to expand, and more and more electrically operated plants and equipment began to be used. This situation hastened the introduction of more sophisticated high-temperature technology in Leverkusen and Dormagen between 1951 and 1958. In cooperation with Bayer's

engineers, steelworks and pipe manufacturers developed materials that allowed steam to be produced at pressures of 160 bar and temperatures of 650° C. In addition, high-pressure units functioning at 300 bar and employing the principle of reheating were built in Uerdingen.

In the late 1950s, heavy fuel oil entered the market as a low-price alternative to the prevailing hard coal. This source of energy was taken into account when work began on the construction of a new power station complex on the Rhine. Since this fuel was not suitable for the high steam temperatures of the "G" power station, the company made do with 560° C and pressure of 210 bar.

Today, in the third phase of development for Bayer's energy supply, it is no longer simply a question of optimum efficiency in the production of power. Ecological aspects have also come to play a central role.

Since 1986, a total of DM 600 million have been spent on bringing all of Bayer's power stations up to the latest standard of environmental technology. The fluid bed process was introduced in one of the boilers of the "G" power station in May of 1988. By adding lime and keeping low combustion temperatures, harmful substances can be substantially reduced in this process.

Early in this century, steam for production purposes came from several decentralized boiler-houses. When the central "G" power station (left) came into use in Leverkusen in 1926, the steam it produced was also used to generate electricity. In the fifties, efficiency was

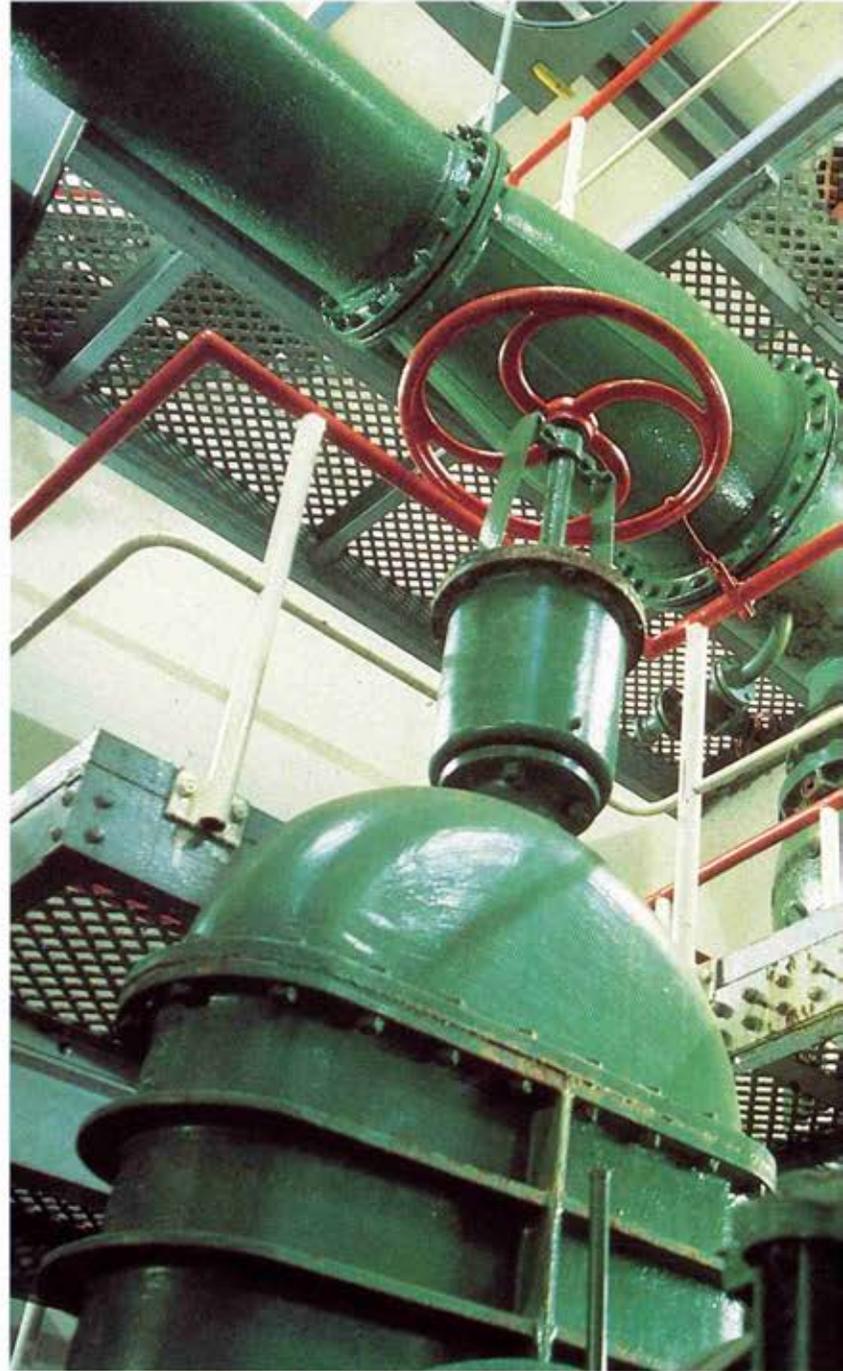
further improved by the introduction of high-temperature technology. The biggest of the turbines to be seen on the above picture have a capacity of 20 megawatts.

While steam is needed for heating, large quantities of water are needed for cooling in chemical plants. In the industry as a whole, 80 percent of overall water consumption is for this purpose; the remainder is used mainly as a solvent. This means that very different demands are made on water quality. The goal of an environmentally acceptable and cost-saving water supply policy is to provide, as far as possible, water qualities that are made to measure for every use. Untreated water is therefore processed into various classes and distributed to users via separate pipeline systems.

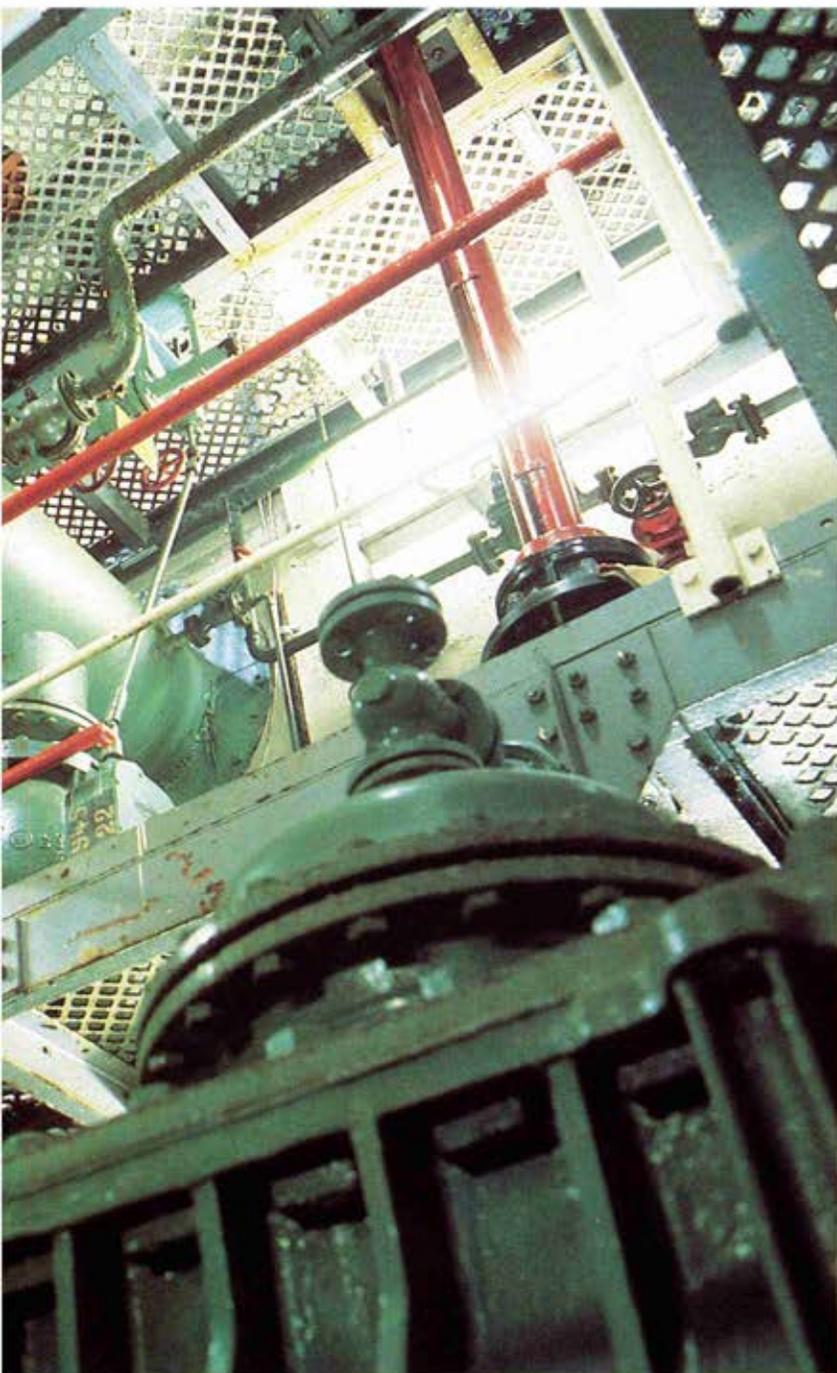
The greatest share takes the form of industrial water, which is primarily used for cooling but also employed in all other areas where potable water is not required. The Bayer plants on the Rhine draw their water either as a filtrate or directly from the river.

In order to keep water consumption from growing as fast as industrial output, cost-cutting measures were introduced at an early date. The chemical processes were first modified so that they would need less water for reaction and produce less waste heat. This meant that consumption of cooling water could be reduced. Cooling circuits were also installed to permit repeated use of the same water. These circuits have been improved to the point where, today, every cubic meter of water is used twice on the average.

Energy is expensive. This is why it is particularly important not only to save on fuel in the generation of power, but also to keep energy losses down to a minimum. For example, by burning waste material from chemical production, consumption of coal, oil and gas in the power stations can be reduced. Energy losses can be avoided by heat-insulating the pipelines and applying modern methods to detect heat leaks.



Increasing production capacities created a greater demand for potable and process water. In the early days of the century, the water works "X1" was built near the river on the Leverkusen site. The picture shows the slide valve that regulates the supply of drinking water.



Bayer chronicle 1955

Bunawerke Hüls GmbH, manufacturer of styrene-butadiene rubber, is founded.

Resolin dyestuffs program for polyester fibers is introduced.

Agfa film works is completed. Agfa introduces black-and-white films Isopan FF 13 DIN and Isopan Ultra 25 DIN. The "definition" made possible by these films becomes a sign of quality.

Bayer adds the broad-spectrum antibiotic Tetracyclin to its pharmaceutical program.

Range of silicic acid and silicate fillers is expanded to include Baysical.

Ulrich-Haberland-Haus, a home for the elderly, is opened in Cologne's Stammheim Castle Park.

World events 1955

On January 25, the Soviet Union declares the official end of the war with Germany. Moscow regards Germany as consisting of two separate states and believes reunification is a matter for the Germans themselves to decide. The government of the Federal Republic claims the sole right to represent the German people.

Occupation ends when the treaties of Paris of 1954 come into force on May 5. Chancellor Konrad Adenauer proclaims at 12 noon on that day, "The Federal Republic of Germany is a sovereign state."

As a counterpart to NATO, the Warsaw Pact is formed by the Socialist states on May 14.

Allies officially recognize Austria as an independent nation on May 15. The occupying troops leave the country.

Chancellor Adenauer visits Moscow. The two countries establish diplomatic relations, and the remaining prisoners still held in the USSR are released.

General Juan Perón, in power since 1945, is overthrown in a military coup d'état in Argentina.

Bell Laboratories in the United States introduces the first transistorized calculator.

Brazil: South America's most important market

Brazil is one of the world's most fascinating countries. It has a variety of attractions, including the Amazon, huge tropical forests and pulsating cities. With its 140 million inhabitants, it is also by far the biggest nation and the most important market in South America.

It all started off with the Brazilian company Walty, Lindt & Cia., which sold Bayer dyestuffs. A delegation from Elberfeld went to Rio de Janeiro in 1896 to set up a Brazilian sales office. Fred. Bayer & Cia was finally established in Rio in 1911. Pharmaceuticals and other Bayer products were soon added to the dyestuffs and dyeing auxiliaries already distributed by the new firm. Production began in 1921 with the founding of "A Chimica Industrial 'Bayer' Weskott & Cia." During the I.G. Farben era, "Aliança Comercial de Anilinas Ltda." assumed responsibility for all sales except for pharmaceuticals, whose production and distribution were taken over by "A Chimica Bayer Ltda." Both these companies were confiscated and sold during World War II. When Bayer bought back Aliança Comercial in 1952, it was the company's first foreign subsidiary to be established after the war. Two years later, A Chimica "Bayer" was returned to the Group. After acquiring a majority stake in "Companhia de Acidos," Bayer amalgamated its production operations in "Bayer do Brasil Industrias Quimicas S.A." in 1956.

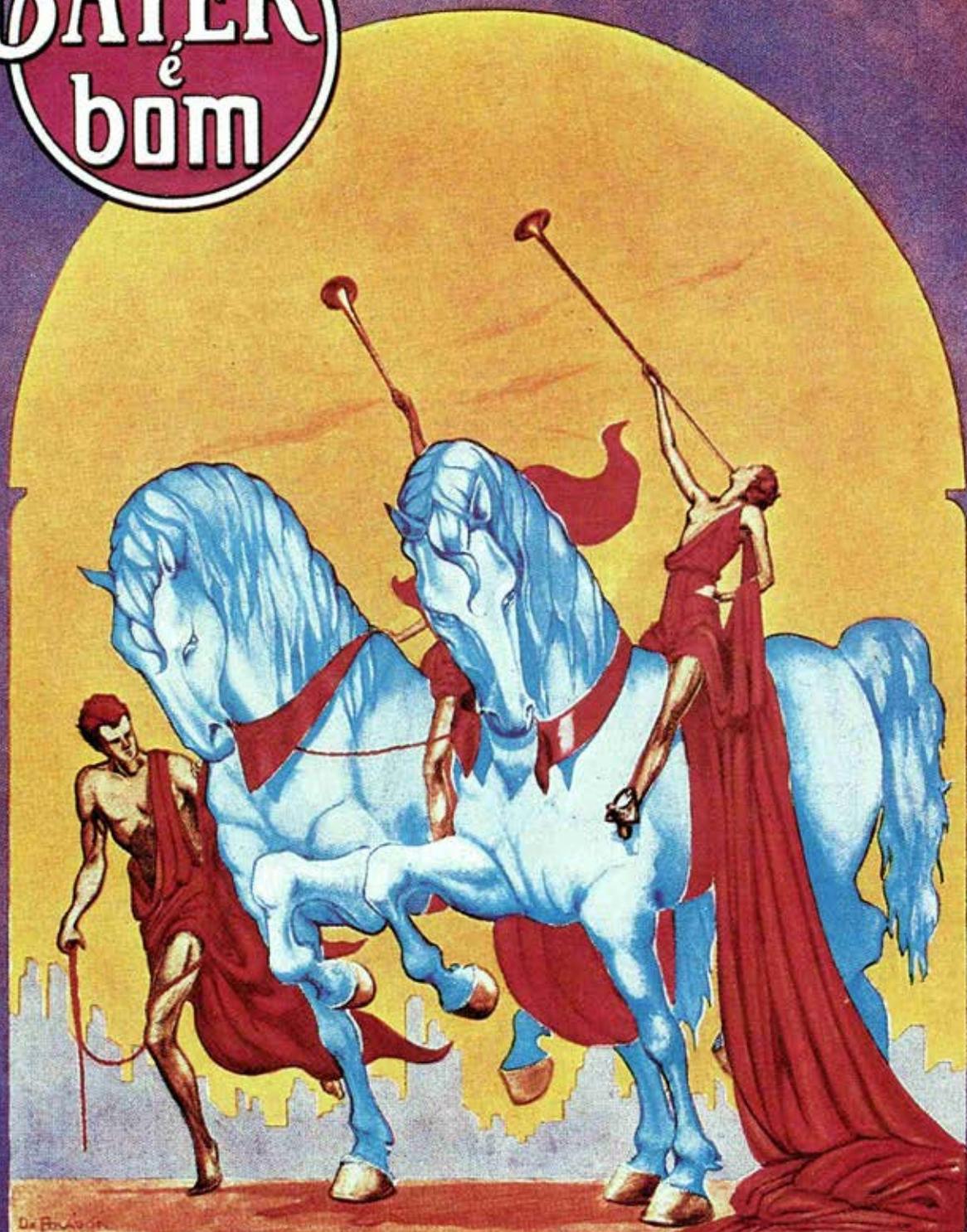
As Brazil had become such an important market, Bayer decided to build its own production plants there. Belford Roxo near Rio de Janeiro, where Companhia de Acidos already operated a production unit, was chosen for the site. Bayer constructed a modern facility that was adapted to the conditions and needs of the country, and it has continued to follow this policy to this day. Brazil's leather processors wanted tanning agents and dyestuffs; its agriculture, crop protection chemicals; its industry, modern materials. And its population required pharmaceuticals.

Opening up new production capacities overseas is nothing special today; about one-third of the company's capital is invested in fixed assets abroad. Things were different when the decision was made to build a plant in Belford Roxo. It was the company's first major project in a threshold country on a different continent, and there could be no guarantee of its success.

The purchasing department secured raw material supplies, while sales executives calculated market

Stylized figures blew fanfares in honor of Bayer in a 1930 Brazilian advertising campaign. Advertising styles have since changed, but the motto is still valid: "If it's from Bayer, it's good."

Si é
BAYER
é
bom



LONGOS anos de esforços empregados pela
CASA BAYER no intuito de dar allivio aos
que soffrem, fizeram com que a CRUZ BAYER
se tornasse em todo o mundo, não apenas uma
marca commercial, mas tambem um symbolo do
que ha de mais respeitavel e seguro no dominio da
sciencia. E por isso os clarissimos da Fama apregoam
esta phrase simples e incisiva como um axioma:
Si é Bayer, é bom!

Plant planning by Central Engineering

For most people, the word chemistry conjures up pictures of white-coated researchers in laboratories. In fact, the outward appearance of a chemicals works is determined by the large-scale industrial units built by engineers. They provide the technical prerequisites for inventions to be developed into finished products.

As process engineering became increasingly complex in the chemical industry, Bayer's engineers grew in number and importance. Today, many of them are assigned to independent units of the individual Business Groups. Their job is to guarantee a smooth operation of the respective production facilities under the supervision of the engineer who is responsible for the plant.

All of those responsibilities that are not specifically tied to a Business Group are concentrated in the Service Division known as Central Engineering. These tasks include the supervision of the power supply, central workshops, process control systems, industrial safety and plant inspection, and project engineering.

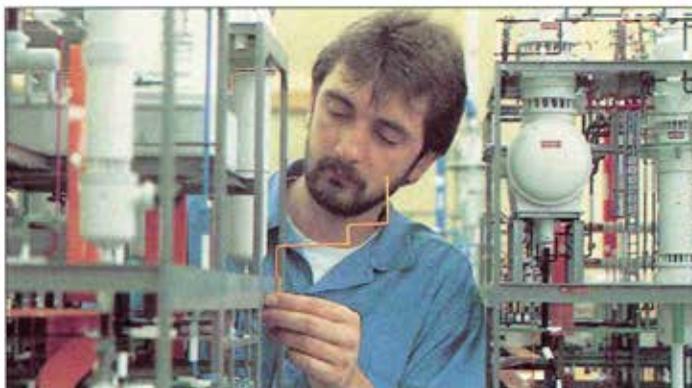
When a group intends to build or expand a production unit, a laboratory block or a storage tank, it delegates the task to the project engineering department. A team is formed consisting of architects, construction engineers, process engineers and logistics experts, plus specialists from such other fields as process control, plant safety and fire

protection. Experts from outside planning firms may also be called in.

The work of the project team can generally be divided into nine phases:

— The basic conception is discussed with the "client" Business Group, and all of the necessary data are collected.

— In the subsequent preliminary planning stage, an initial technical proposal is drawn up. This includes basic flow sheets, plant and building



Large factory units are initially built to scale as models.

drafts and estimated construction time and costs.

— In design planning, the corresponding drafts are then developed. This encompasses process flow sheets with material and energy balances, equipment lists, assembly plans and models.

— The approval stage then begins with the preparation of documentation for the authorities. The building permission and technical data for the concession application are of particular importance.

In these applications special consideration has to be given to all environmental protection measures required by law. A specific plan covering all aspects of this subject is necessary for discussions with both the authorities and the public at large.

— For the credit application, the costs of all supplies and services have to be determined. When this is finished, and the approval process has been completed, the Board

— coordination and inspection of plant assembly.

The works engineer of the respective Business Group gradually takes over "his" new facility.

— The task of the project team ends with the beginning of production. The team then hands over all documentation, together with the operating manual.

Bayer's international experience has shown that local industrial structures, climate and mentality have to be taken into account when striving to maintain high technical standards outside Germany.

The traditional drawing board has long been banished from its central position in the planning process. Today, no project could be finished on time without the use of computers. Computer-aided engineering (CAE) and computer-aided design (CAD) are now absolutely indispensable tools for engineering work.

The computer calculates everything from the thickness of a boiler wall to the estimated date of completion, and it drafts everything from pipeline networks to construction data. The use of a special menu allows pumps, valves or engines to be incorporated into drawings in their entirety and in any desired size, thus obviating the need for tedious redrawing of an element in all its details. Mechanical work can be cut down, and in its place more time can be devoted to expert planning skills.

of Management can carry out its final discussions on the project.

— At this stage of design planning, countless drawings and descriptions of all specifications are finalized in the full detail necessary for production, purchasing and assembly.

— After all deliveries and services have been secured with the aid of the individual purchasing departments, construction can begin. The project team then assumes responsibility for

The Belford Roxo plant was Bayer's first major investment in Brazil. It was inaugurated in the presence of Brazil's President Juscelino Kubitschek in 1958. The picture on the right shows the MDI plant, which manufactures methylene diphenylisocyanate for use in the production of polyurethanes.

opportunities. The finance department was to arrange the necessary funding, and the company lawyers worked on the contracts. Using well-established technology, the company's engineers and production experts designed the works. Local know-how was incorporated into the plans to permit operation under the prevailing climatic conditions and under the supervision of native staff. The result was a "Brazilianization" of Bayer technology with no shortcuts taken in quality or safety.

Bayer also had to ensure the necessary infrastructure for the plant. The site had to be properly developed, and roads had to be built. Sufficient power supplies had to be provided. Waste treatment and environmental protection measures needed to be planned. And social services and institutions were required.

All in all, the project in Belford Roxo went remarkably well. After only a few years of construction work, modern manufacturing units for sulfuric acid, chromium derivatives, synthetic tannins,

dyestuffs, organic intermediates, textile auxiliaries and active ingredients for agrochemicals were completed. In the presence of Brazil's President Juscelino Kubitschek, Professor Ulrich Haberland officially inaugurated the complex on June 10, 1958.

Belford Roxo was substantially expanded in subsequent years. In 1974, production began of the newly developed antibiotic Ampicillin and the ion exchanger Lewatit, which is used in various technical applications. A hydrofluoric acid unit followed in 1977, and facilities for the manufacture of base substances for analgesics and for agrochemicals were added a year later.

The year 1979 saw the opening of a rubber chemicals plant and a polyurethanes unit for polyols and modified isocyanates, while a factory for various intermediates went on stream in 1980.

In the same year, a large plot of land was bought near Belford Roxo to accommodate the new environmental facilities that had become necessary. At the request of the Organic Chemicals and Polyurethanes Business Groups, new plants for the



Bayer in Latin America

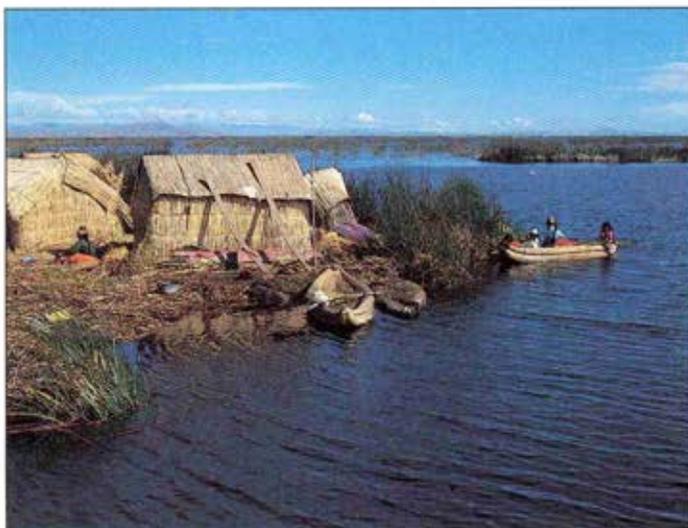
Economists estimate that in the coming decades, economic growth in Latin America will be faster than in any other area of the world, other than the Far East. Considering this prediction, it is no wonder that Latin America will play an increasingly important role in the world economy. This region has been constantly gaining ground as a business partner for Bayer since the 1890s.

The first step was taken in 1894, when a Bayer representative from Elberfeld visited Mexico. As a result of negotiations, the local firm Fedco. Ritter & Cia. was appointed sales agent. It took until 1920 for the group to set up a subsidiary of its own, which was then called "La Química Industrial Bayer, Weskott & Cia."

In 1898, a Bayer envoy started making inquiries about sales opportunities in Ecuador, Bolivia, Chile and Colombia and set up agencies in Bogotá, Lima and Arequipa. The first fact-finding mission to Argentina had taken place two years earlier. A local agent was subsequently appointed for this country and its neighbor Uruguay. On January 1, 1911, Federico Bayer & Cia. was established in Buenos Aires and then renamed "La Química Industrial Bayer Weskott y Cia." ten years later. Only a month after the founding of the Argentinian company, Bayer set up a firm of its own in Brazil.

From the turn of the century to the 1930s, Bayer's

business, and that of I.G. Farben, developed well in Latin America. The Second World War turned the tide, but as early as 1948, steps were taken to restore commercial links in this region. With transport connections to Europe long and difficult and proper infrastructure at a local level barely existent, pioneering work was required.



For many years now the Latin American market has played an important role for Bayer (above the Titicaca Lake).

But Bayer's "old friends" in Latin America used their imagination and made a concerted effort to create a new foothold.

The first foreign firm that Bayer was able to buy back after the war was "Aliança Comercial de Anilinas" in Rio de Janeiro. The sale was closed in July of 1952. Only a year later, several Argentinian

companies could be acquired, and interests in the other countries were soon to follow.

Today, Bayer is represented in almost all of Latin America. Its most important operations are located in the most highly populated countries; there are major production facilities in Brazil, Argentina, Mexico and Peru. In other countries, Bayer also runs facilities for

and Zárate in Argentina. The production program in Zárate includes, among other important products, synthetic tanning agents.

An excellent example of technology transfer is illustrated by Bayer's textile fibers facility in Lima, Peru. In order to manufacture acrylic fibers in Peru, Bayer Industrial was set up in 1969. Production started only a year later. Today, the plant is one of Peru's biggest and most modern industrial units.

Bayer's Latin American presence was considerably broadened by the 1978 acquisition of the U.S. company Miles Inc. and its substantial overseas holdings. Other subsidiaries with a good position in this region include Agfa-Gevaert and Haarmann & Reimer.

All of Bayer's Business Groups supply the Latin American market, and many of them operate their own plants there. Bayer trade names play a major role in agriculture and health care. The longstanding interests of the company in Latin America have created firm ties that will pave the way for a promising future in the Central and South American markets.

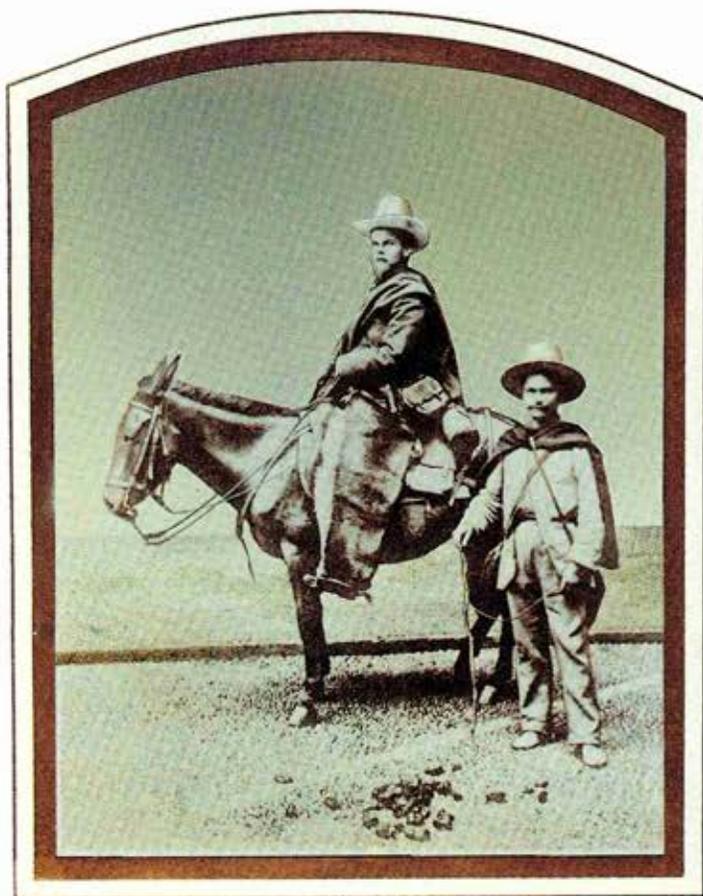
Since the 1920s, the group has been operating in Latin American countries with the slogan "Si es Bayer, es bueno" or, as the Brazilians say, "Si é Bayer, é bom." Translated this means, "If it is Bayer, it's good." The company is determined to continue to live up to this reputation in the future.

Bayer's first traveling salesman in Brazil was Max Hasche, who used to cross the Andes by mule in the 19th century to sell dyestuffs.

production of nitrobenzene, aniline and MDI were built in the early 1980s. These units called for particularly careful design in connection with process technology, occupational safety and, most of all, environmental protection.

Bayer do Brasil's operations are extremely varied today, ranging from chromium ore and fluorspar mining to the production of pharmaceuticals and consumer goods. The Brazilian subsidiary has interests in such affiliated companies as Bayer-Dental, titanium dioxide manufacturer Tibrás, foams producer Trorion, as well as the domestic branches of Haarmann & Reimer and Miles. All of these factories and holdings are managed and coordinated by Bayer do Brasil, whose central administrative headquarters moved from Rio to São Paulo in 1973.

With its long tradition and promising future, Brazil is a very important flag on the Bayer map. At Bayer do Brasil's 90th birthday celebrations in October of 1986, Hermann Strenger, Chairman of the parent company's Board of Management, assured Brazil's President José Sarney that a further \$150 million would be invested in the country by 1991.



Bayer chronicle 1956

Production units for technical plastics based on Novodur and for Makrofol polycarbonate foils go on stream.

Extremely lightproof Astrazon dyestuffs for Dralon and other fibers are introduced to the market.

At the "photokina" Trade Fair in Cologne, Agfa presents its Automatic 66 that features automatic exposure control.

A special sales department is created for agrochemicals, which have been marketed by the pharmaceuticals staff up until now.

Retengan line of resin tanning agents is introduced. Production begins of Perbunan C chloroprene rubber, today known as Baypren.

Bayer de México Industrias Químicas S.A. is reestablished with its own production facilities.

Bayer buys chromite mines in South Africa.

World events 1956

First units of the Federal German Army begin their service in January. At the same time, the National People's Army is set up in the GDR from organizations of the People's Police.

Addressing the 20th Congress of the Soviet Communist Party in Moscow, Nikita Khrushchev condemns the cult surrounding Joseph Stalin and Stalin's misuse of power.

In August, the Federal Constitutional Tribunal of Karlsruhe declares the Communist Party of Germany (KPD) unconstitutional.

On October 23, a popular uprising breaks out in Hungary and is crushed in November by Soviet troops.

Israeli, British and French troops occupy the Suez Canal Zone on October 29, after Egyptian President Gamal Abd el Nasser nationalized the international waterway. The occupation ends a few days later after intervention by both superpowers.

The three American inventors of the transistor—William Shockley, John Bardeen and Walter Brattain—are awarded the Nobel Prize in physics.

Erdölchemie is established in Dormagen

The chemical industry underwent a fundamental change in the 1950s when mineral oil and natural gas replaced coal as the most important feedstock in organic chemistry. This marked the beginning of the petrochemical era. Together with Deutsche BP, Bayer set up the petrochemical joint venture Erdölchemie GmbH in 1957.

Up until the 1950s, the production of organic chemicals was largely based on two groups of feedstocks: natural substances and coal. While use of the first group was limited to only a few products, coal could be processed to make just about anything. Bituminous coal tar played a particularly important role because it contained a whole range of aromatic hydrocarbons, such as benzene, toluene, xylene, naphthalene and anthracene.

Coal tar is formed during the production of coke. The chemical industry's demand for tar products grew at a faster pace than the coke requirements of the steelworks so it became necessary to look around for alternative raw materials. For example, ethylene had been obtained by the heating of hydrocarbons in the I.G. Farben plant at Uerdingen as early as 1930. However, these experiments were soon scrapped since it was possible to produce ethylene more cheaply by other methods.

The petrochemical industry had its roots in the United States. In the 1920s and 1930s, American companies had begun to obtain base organic materials from oil and gas. Capacities were greatly expanded during the Second World War because of the enormous demand for products, in particular toluene, required for the explosives industry.

Processes for modern petrochemical products were not even developed in the United States until after the war. And European companies were a long way off from these developments. It was not until February 1953 that a German law granted freedom from customs and taxation for mineral oil that is "used in new conversion processes by the chemical industry." This was intended to promote utilization of what were still new raw materials.

At the end of 1957, Bayer decided to enter the petrochemicals business. It seemed like a logical step to join forces with an oil company. Both sides would benefit from cooperation: the oil industry would obtain an important new market and the chemical industry would secure the supply of a promising raw material. Bayer found its partner in "BP Benzin and Petroleum AG," the Hamburg subsidiary of

This evening scene of Erdölchemie, a petrochemical joint venture of Bayer and Deutsche BP, conveys a touch of industrial mystic. The plant is immediately adjacent to Bayer's Dormagen works. In its crackers, Erdölchemie breaks down the light gasoline frac-

tions that are obtained from the distillation of petroleum to produce valuable raw materials for further processing in the chemical industry.



What are petrochemicals?

Organic chemistry's most important raw material, mineral oil, is basically made up of saturated hydrocarbons whose chain lengths vary to a considerable degree. The share of branch or cyclic chains can differ to a greater or lesser extent depending on the geographical origin of the oil.

The first phase of processing is carried out by the oil refineries. In huge distillation units, the crude oil is separated into fractions according to the different boiling ranges:

- liquid gas (for household use, engines and lighting)
- gasoline (motor and aviation fuel, solvents)
- diesel oil
- light fuel oil (for household and commercial use)
- heavy fuel oil (for industrial and navigational use).

These examples show that almost all fractions are intended for use in generating energy. The quantities

destined for processing as a raw material for the chemical industry are derived from the light gasolines and utilized in the petrochemical industry as naphtha.

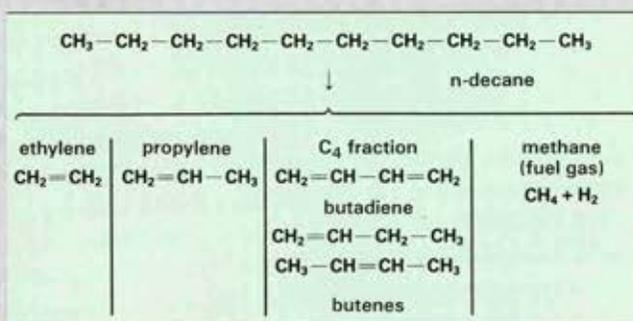
The key installation in a petrochemical plant such as Erdölchemie is the cracker. Its name is taken from its function "to crack" the hydrocarbons contained in the naphtha. From their original form with some ten carbon atoms per molecule, the hydrocarbons are then split at temperatures of 820° to 840° C into smaller fractions with up to four carbon atoms. Before further use, these are then separated from one another by distillation.

This process takes place in a tube furnace, into which the gaseous gasoline is introduced together with carefully calculated quantities of water vapor. Exposure to high temperatures is limited to a very short period, otherwise the resulting unsaturated

fractions would break down further. The furnace is connected to a heat exchanger for subsequent energy recovery and to equipment that withdraws the water vapor. The reaction mixture then passes on to a series

of distillation columns for separation into individual products.

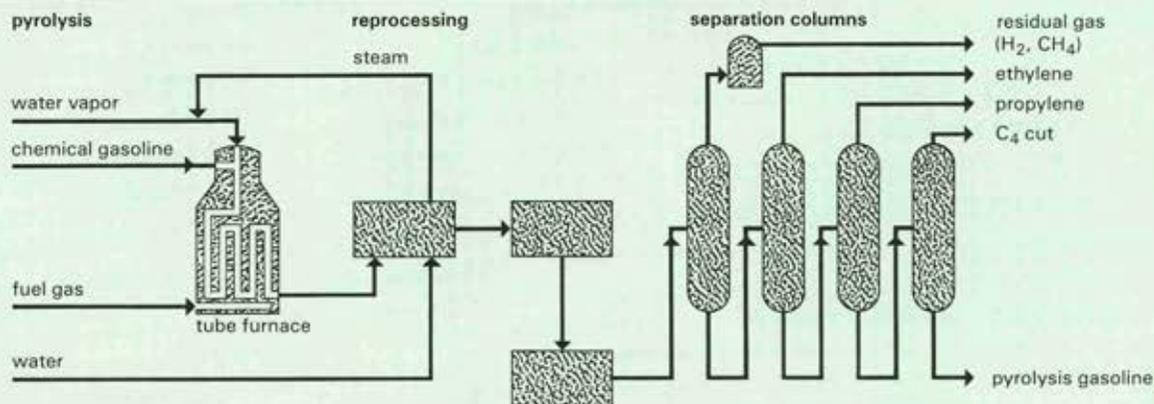
The chemical process is shown below, using the example of an n-decane molecule:



These unsaturated hydrocarbons C₂ to C₄ are themselves valuable starting materials for organic chemicals. In most cases, however, they are further processed at Erdölchemie into such

products as ethylene oxide, glycol, acrylonitrile or propylene oxide.

Flow sheet of the thermic cracking process



British Petroleum. They set up Erdölchemie GmbH (EC) as a joint venture with initial capital stock of DM 320 million. Other chemical companies entered into similar agreements.

The EC plant is located in the Worringen suburb of Cologne, immediately adjacent to Bayer's Dormagen works. There were a number of reasons for the choice of this site. First of all, Bayer owned an available piece of land that could be leased to EC. Another consideration was the fact that the acrylonitrile needed for the production of the textile fiber Dralon at the Dormagen plant could be obtained from the new EC unit. And finally, neither Leverkusen nor Uerdingen were far away.

A substantial area had been set aside for the EC plant, which was from the start designed to accommodate large capacities. In fact, it soon turned out that even more room and still larger capacities were required. Some 90 percent of Dormagen's production program is now based on petrochemicals.

Today, EC has almost 3,000 employees and annual sales of DM 2.8 billion.

Among its products are propylene and ammonia. Acrylonitrile is made from these basic materials and then used to produce Bayer's Dralon, Perbunan N and Novodur. Benzene and toluene go into the production of plastics, fibers, dyestuffs and agrochemicals. Butadiene is processed into synthetic rubber. Propylene, upgraded into propylene oxide, is used for the manufacture of detergents and wetting agents; large quantities are also employed in the production of polyol components needed for polyurethanes.

Besides its crackers, pipelines and tank installations dominate the picture of a petrochemical plant like Erdölchemie. The company tanks hold many different products, such as benzene, toluene, butadiene and propylene, before they are sent on to customers for further processing.

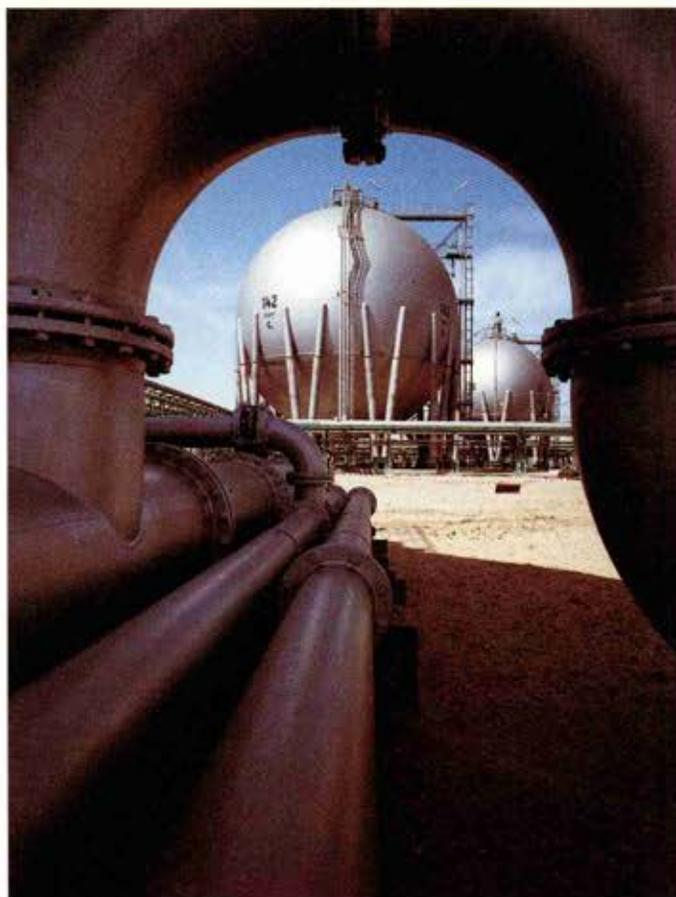
And this list could go on and on. In only 30 years, mineral oil has become the single most important raw material of the chemical industry.

When the petrochemical era started, oil was cheap; hardly anyone could have imagined that the day would come when oil would become scarce and expensive. The oil crisis of 1973 proved a rude awakening. All countries that were dependent on oil imports were affected, but the industrialized nations were hit particularly hard. In previous years, all sectors of the economy had switched over to oil so that reducing consumption or choosing an alternative could only be achieved gradually.

In 1984, the chemical industry used only eight percent of the total consumption of mineral oil in Germany for the manufacturing processes of its products. This compares with 38 percent used up by the transportation sector, 31 percent burned up by heating systems in private homes and 23 percent used to generate power for industrial production.

Let the following analysis illustrate where this

valuable raw material is really "wasted": With 100 kilograms of mineral oil, a two-bedroom apartment can be heated for seven days at an outside temperature of zero, or a medium-sized car can be driven only 1,000 kilometers. But the same 100 kilograms can be processed by the chemical industry into 13 fuel tanks for medium-sized cars or 11,500 aspirin tablets or blue dye for 330 dresses or 12,000 disposable syringes or the entire plastic needs of a building with six apartments or half the sewage pipes in the same house or 50 square meters of carpeting.



Turning black into white with titanium dioxide

White paints and lacquers are white thanks to titanium dioxide. And the multiplicity of shades in colored coatings and plastics would not even be possible without this white pigment.

When Bayer opened a titanium dioxide pigment plant in Uerdingen in 1957, world consumption of TiO_2 was calculated at 800,000 metric tons. Today, it has risen to some 2.5 million metric tons. Titanium dioxide has become virtually synonymous with white pigment.

Pigments are insoluble powders, mainly originating from inorganic bases. In combination with suitable binding agents, they are used to add color to paints and varnishes, plastics, building materials and paper. Since titanium dioxide is physiologically harmless, it can also be utilized in pharmaceuticals, cosmetics and cigar tobacco.

As a white pigment, titanium dioxide serves not only in the manufacture of white colors but also as an optical brightener to lighten and to give nuances to colored pigments. Some 60 percent of titanium dioxide production currently goes to the paint, varnish and printing-ink industries, 16 percent to the plastics sector, 13 percent to the paper industry and the remainder to various other markets.

A titanium dioxide plant was established in Leverkusen as early as 1928. The "Deutsche Titangesellschaft" was a joint venture of the I.G. Farben and National Lead Company of the United States. As a result of the dissolution of I.G. Farben, the factory became a wholly owned U.S. company in 1952. It now operates as the only 100-percent non-Bayer unit on the works site.

Up until the 1950s, Bayer was able to sell limited quantities of TiO_2 from this facility. In 1956, management decided to build its own plant at the Uerdingen works. Twenty-one months after the Board's decision, the titanium dioxide plant went on stream.

The naturally occurring titanium ores ilmenite, rutile and anatase are the raw materials for TiO_2 pigments. All of them are black, or at least dark. Also known as titanite iron ore, ilmenite is a compound of titanium with iron and oxygen. It can be converted into titanium slag and pig iron by a metallurgical process. The resulting slag, which is also black, can be used as a starting material for titanium dioxide pigments as well.





To turn black into white, these ores or slags must be chemically decomposed. The classic way to achieve this decomposition is by the sulfate process. Bayer began production with this method in 1957. The raw materials are broken down with concentrated sulfuric acid. The result is a titanyl sulfate solution. After dilution with water, the solution produces titanium dioxide hydrate as a white precipitate. When filtered off, the recovered sediment is then treated by calcination to yield titanium dioxide pigments. What remains as a waste is diluted sulfuric acid—the subject of a widely discussed environmental issue in Germany.

When Bayer started up its titanium dioxide facility in Uerdingen, it was the usual practice of European TiO_2 producers to release the diluted sulfuric acid into surface waters. It was not until the 1960s that

the so-called dumping process was adopted from the United States—and hailed as an ecological improvement. In this process, special ships take the diluted acid out to authorized areas of the sea and expel it via the ship's propeller into the sea, where it is further diluted and well distributed.

The Uerdingen TiO_2 factory never made use of this process; an on-site acid recovery plant was in operation from the very start. Here, the water was evaporated by submerged burners and the sulfuric acid was, step-by-step, concentrated up to 96 percent for reuse. The residual salts were broken down in dissociation units that yielded further quantities of sulfuric acid.

In July 1982, Uerdingen introduced an improved method of recovery, in which the submerged burners were replaced by a vacuum evaporator. Less energy is necessary in this process, too.

Bayer set up its own titanium dioxide production at the Uerdingen plant in the 1950s because its unit in Leverkusen had been taken over by the Americans after the war. In a highly complex process,

black titanium ores are converted into bright, whiter-than-white pigments.

Titanium dioxide as a white pigment

The first substance used as a raw material for the production of titanium dioxide pigments was ilmenite, a ferrotitanium with the formula FeTiO_3 . In the sulfate process, this ore is decomposed by using concentrated sulfuric acid and converted into a solution of iron sulfate and titanyl sulfate.

After evaporating this solution, most of the iron sulfate precipitates as greensalt: ferro(II)-sulfate heptahydrate, $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$. This is removed and the remaining titanyl sulfate solution is diluted with water, brought to a boil and hydrolyzed, whereby titanium dioxide hydrate is produced as a white precipitate:



The titanium dioxide hydrate is filtered off and the resultant diluted acid is reprocessed.

The large quantities of iron sulfate created in this process have always proved a major ecological and economic disadvantage when ilmenite is used as a starting material. Titanium dioxide also occurs in its natural form in the ores anatase and rutile, which are distinguished by their crystalline structure. Due to coloring caused by impurities, they have to be chemically treated before further use. This is only possible with the chloride process.

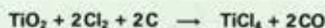
Anatase ores could become important raw materials considering the major deposits of the ore in Brazil, whereas rutile reserves are running out. Increasing use has been made of synthetic rutile and special titanium slag in the

chloride process, both of which are based on ilmenite. In the production of slag, most of the iron is removed in a metallurgical process.

Both titanium slag and ilmenite are used in the sulfate process.

Since a pigment's whitening ability, covering power and stability to light and weather depend, to a large degree, on its purity, its crystalline form and its particle size, the titanium dioxide hydrate that has been obtained hydrolytically is subjected to washing processes and a calcination heat treatment at 800° to $1,000^\circ$ C.

In the fundamentally different chloride process, rutile ore is converted into titanium tetrachloride by using coal and chlorine:



After rectifying by distillation, the TiCl_4 , a heavy, clear liquid, is burnt with pure oxygen to give titanium dioxide.

The chlorine is separated off and can be reused for chlorination.



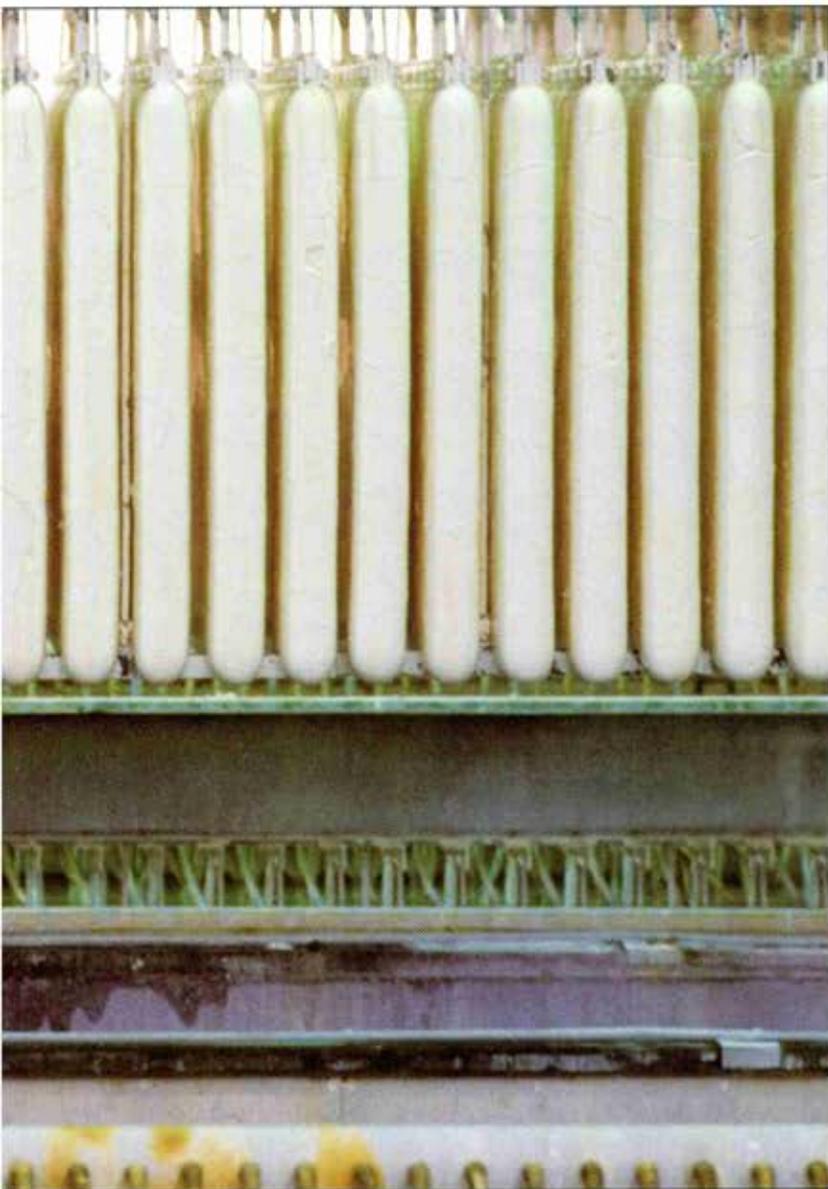
Production of titanium dioxide pigments at the Antwerp works began in 1971. Its diluted sulfuric acid waste is dumped in the North Sea. From 1989 onwards, the acid will also be reprocessed.

This form of diluted sulfuric acid as a waste does not result solely from titanium dioxide production. It also occurs in small quantities as a by-product in the manufacture of organic dyestuffs and intermediates.

As a major producer of such materials, Bayer dumped acid at sea within the bounds of legal requirements for some years. However, by modifying production processes and introducing new recovery methods, it was possible to stop dumping by the spring of 1982.

According to the expectations of the German federal government, domestic chemical works will

The titanium dioxide hydrate that is initially obtained in the production process is separated from the diluted sulfuric acid by Moore filtration.



have to stop all dumping of this kind by 1989. The EC Commission laid down guidelines for the treatment of waste from titanium dioxide plants as early as 1978. Its aim was to reduce waste quantities and to harmonize rules within the Community in order to insure equality in waste management and thus avoid competitive advantages on the part of one or another member country.

Possibilities for new kinds of applications of titanium dioxide have still not been exhausted. In the fall of 1986, Siemens AG signed a cooperation agreement with Bayer for the development and production of catalytic converters that will remove nitric oxides from waste gases emitted from large-scale furnace installations. Bayer is supplying a starting product based on titanium dioxide as a raw material.

Bayer chronicle 1957

Bayer Foreign Investments Ltd. (Bayforin) is established in Toronto as a holding company for all Bayer's affiliated companies in America, Africa and Western Europe.

Dyestuffs producer Verona Corporation of Union, New Jersey, is acquired in the United States. With this move, Bayer resumes its business in this market under the name of Verona Dyestuffs.

Multivitamin product Edinol and the geriatric drug Gresuton are introduced.

Neguvon and Asuntol are marketed to combat parasitic diseases.

Agfa AG für Photofabrikation takes over Agfa Camera-werk AG and alters its name to Agfa AG, with headquarters in Leverkusen. A photography school is set up for in-house training and to serve customers around the world.

Bayer introduces the 43.75-hour workweek. In comparison, the collective wage agreement still calls for a 45-hour workweek.

Julius-Drucker-Haus at Falkau in the Black Forest opens as a recreation home for employees of the Uerdingen plant.

World events 1957

Federation of German Trade Unions (DGB) calls for practical measures to guard against negative effects of automation on the workforce.

On March 9, President Dwight D. Eisenhower announces a guarantee of protection for all Middle Eastern countries that perceive themselves threatened by communism (Eisenhower Doctrine).

The Federal Republic, Belgium, France, Italy, Luxembourg and the Netherlands sign the Treaty of Rome, thus setting up the European Economic Community.

The National Guard protects nine black students entering a school in Little Rock, Arkansas.

On October 4, the Soviet Union despatches the first earth satellite, Sputnik I, into space. Sputnik II is launched on November 3 with a dog named Laika on board to test survival possibilities.

Germany's first nuclear reactor starts up at Garching, near Munich.

Felix Wankel develops the rotary compression engine in Neckarsulm.

New raw materials revolutionize coatings

On April 24, 1958, Bayer registered a patent for a new polyisocyanate, which under its subsequent trade name of Desmodur N was to become a key product in the manufacture of DD coating systems.

At the same time, Bayer was working on another range of raw materials for coatings in Uerdingen. This Roskydal program attained particular importance for wood and furniture finishes.

During the period of recovery after the war, Bayer reviewed its strategy for raw materials used in surface coatings. Regardless of the short- or long-term prospects, one thing seemed clear: coatings and finishes would be needed in large quantities.

Those buildings, furniture, machinery and other items that had survived wartimes or made it through the years with only minor damage were in such a battered and unkempt state that they had to be refurbished and protected from further decay. As the economy improved, the coatings industry and its suppliers also had to meet new demands for both the protection of materials and modern decorative uses.

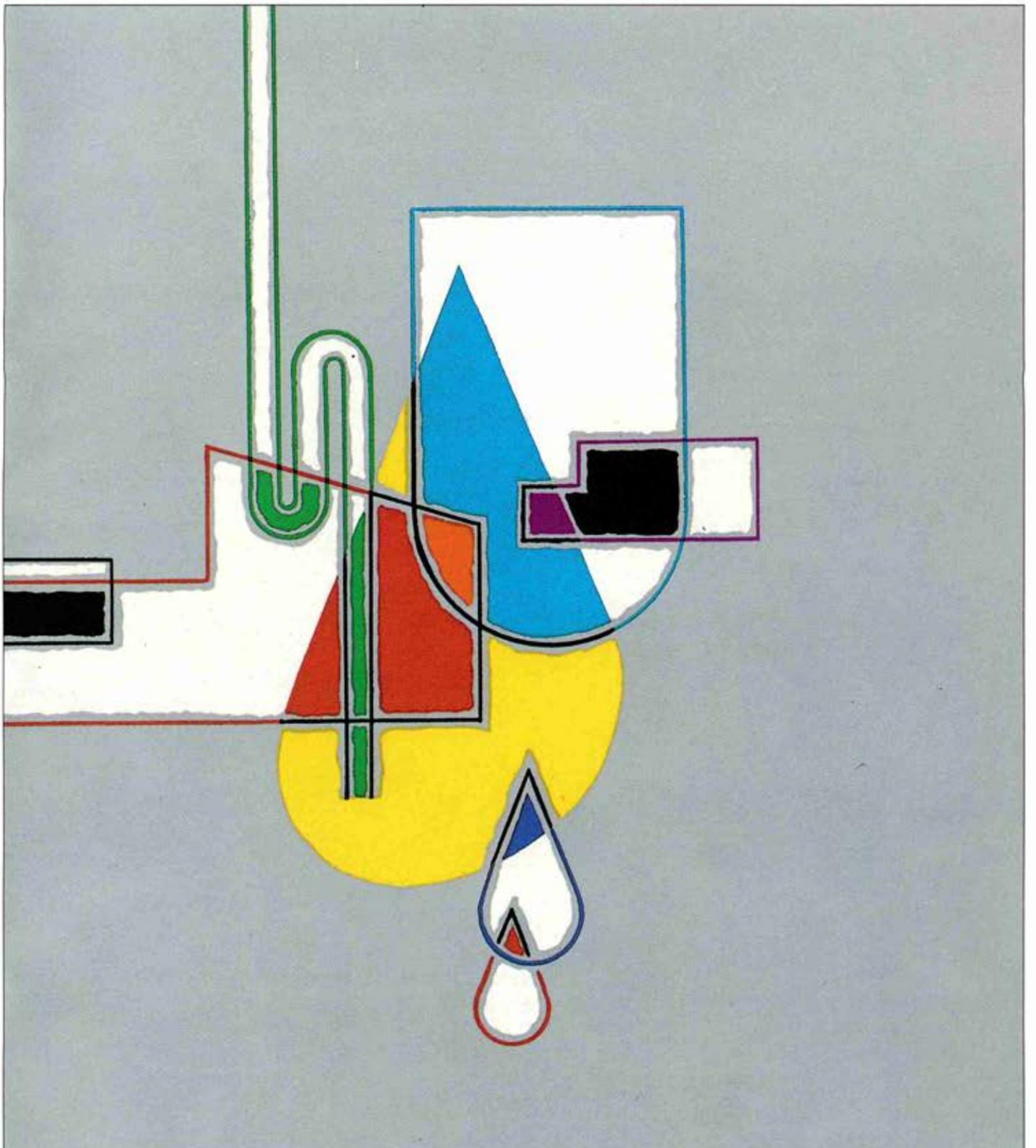
The existing alkyd resins and chlorinated rubber formed the basis for the resumption of business. In the late 1930s, two new resin systems were already judged to be potentially interesting raw materials for the coatings sector by applications experts. They were the unsaturated polyester resins and the polyurethanes, the latter having been discovered by Otto Bayer in 1937.

Both classes of substances not only allowed the production of scratch-proof and chemical-resistant paints and lacquer layers, but each one also opened up new perspectives in processing technology. The polyurethane system was far from being restricted to use in plastics and foams; it also paved the way for the development of dual-component coatings. Polyol and polyisocyanate, the two components in question, were initially kept separate. The finish hardened only after they had been mixed. The advantage over conventional coatings was that the drying period could be adapted to the various applications.

The second raw material system for coatings, the unsaturated polyester resins, also had its beginnings in the prewar era. Although this system had not been discovered at Bayer, work on its

Bayer has always been a manufacturer of dyestuffs—after all, the company was first founded as a dyeworks. In fact, the German term for dyeworks remained in the company name until only recently. Originally, this business only referred to textile dyes, but Bayer also began producing

pigments and raw materials for coatings quite early on. The title page of a product leaflet on raw materials for coatings that is shown on the right stems from the 1960s.



LACKROHSTOFFE

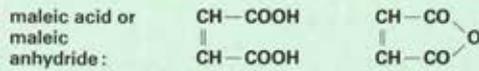
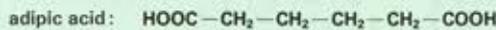
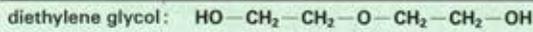


Unsaturated polyester resins and DD coatings

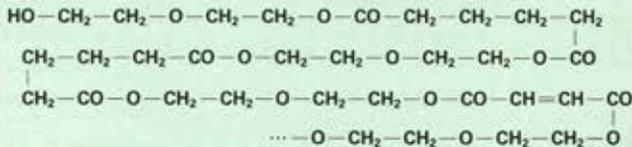
Unsaturated polyester resins:

The production of saturated polyester resins is described in a previous chapter in which polyurethane chemistry is explained in detail (see page 286). For example, a higher-molecular polyester is formed from adipic acid and diethylene

glycol. If part of the adipic acid is replaced by an unsaturated dicarboxylic acid such as maleic acid, the resulting polyester can react further with the C=C double bonds in its chain and can, for example, polymerize:



polyester from adipic acid, diethylene glycol and maleic acid:

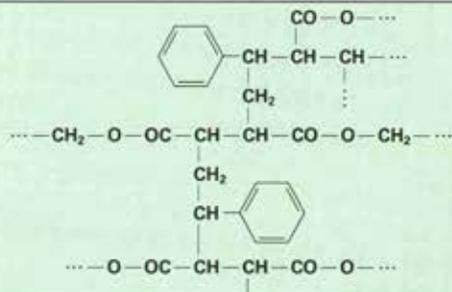


Resins of this kind are, in their natural state, very tough or firm. They must therefore be dissolved for further processing. The solvent used is styrene, $\text{C}_6\text{H}_5\text{CH}=\text{CH}_2$, which also possesses a polymerizable double bond.

The polymerization process can be set off by organic peroxides that form free radicals when exposed to hardening conditions:

$\text{R}-\text{O}-\text{O}-\text{R}' \rightarrow \text{R}-\text{O}\cdot + \cdot\text{O}-\text{R}'$
These radicals activate the C=C double bonds to polymerization.

In the polymerization process, a cured lacquer layer is created that is no longer soluble. The polyester chains are connected by the styrene to an endless, three-dimensional structure with the following pattern:



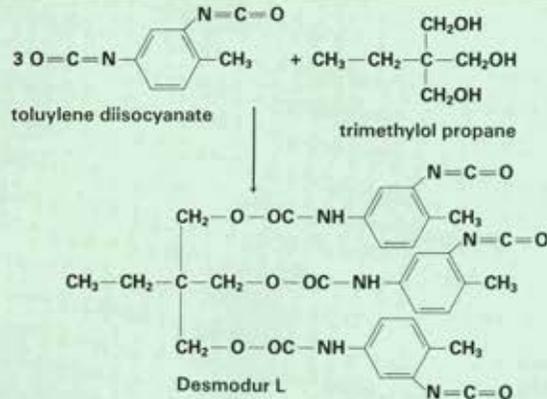
In industrial finishing, for example of furniture, the coatings have to dry particularly fast. This can be achieved by coating systems with added photoinitiators;

they are stable under normal light, but decay in ultraviolet light, and thus initiate the polymerization process.

DD coating systems

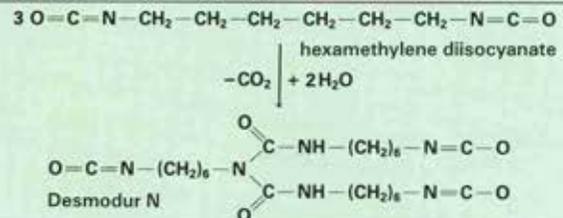
The principle of polyurethane chemistry is described in the chapter on 1937. Since the processing of Desmodur T (toluylene diisocyanate) in the open, for example when applying coatings, posed dangers, the molecule was initially enlarged by an addition agent

that had practically no vapor pressure, such as trimethylol propane. The resulting Desmodur L showed much better properties, but the coatings were insufficiently lightproof for certain applications.



The problem of fastness to light was solved by the use of an aliphatic diisocyanate,

which, for molecular enlargement, was converted with water into a trimer with a biuret structure, $\text{R}-\text{NH}-\text{CO}-\text{NH}-\text{CO}-\text{NH}-\text{R}'$:



development had been entrusted to the Uerdingen plant by the management of I.G. Farben. Development work remained there.

Like polyurethanes, unsaturated polyester resins are suitable for the manufacture of plastics and coatings. The important point about the latter class is that the coatings contain certain additional elements that permit controlled drying of the lacquer layer. Applied in liquid form, the lacquer layer can be dried by heat treatment or irradiation, as desired. This process proved particularly attractive for such rapid manufacturing processes as those necessary in the furniture industry.

For a time, difficulties arose because air oxygen hindered the hardening of conventional polyester resins. The result was that the surface remained sticky. There was a process in which the surface was covered with paraffin that solved this problem, but the real solution did not come until Bayer's air-drying Roskydal L program was introduced.

This product group, which was further improved over the years, came to play an important role in Bayer's range of coating raw materials. While the emphasis is still on industrial woodworking applications, Roskydal types have also won recognition in other applications, for example, as mastic for use in car repairs.

The raw materials for coatings that were made from polyurethanes also had their problems. Although people may be willing to put up with a great many things during wartime that would not otherwise have been acceptable, the danger resulting from fumes given off by Desmodur T could certainly not be tolerated. But before the war ended, it had been possible to develop a series of usable

Today, DD coating systems based on polyurethanes are used all over the world. For example, the Airbus (above) and the German Federal Railway's high-speed train, "Intercity Experimental" (right), are coated with these special systems.



protective coatings by modifying the isocyanate components. Because of their high resistance to seawater, they were especially suitable for ship paints.

In the first years of recovery after the war, it took some time for sales of DD coating systems to get going: neither the coating manufacturers nor the public was used to handling the dual-component system. The higher price was accepted because of the special properties of the product, but the coatings were not sufficiently resistant to light. A sarcastic joke of the day claimed that the coatings were "*not lightproof enough to paint a cellar with and too slow to use as a photosensitizer.*"

Since 1955, Desmodur L has established itself in the coating industry, and this range as well as all of its succeeding products are considered hygienically irreproachable by industrial standards.

But the real breakthrough came with Desmodur N, which met all demands in respect to light fastness. The patent granted in 1961 was a comparable turning point in the history of this class of coatings as the transesterification patent had been for the alkyd resins 34 years earlier.

When they were introduced to the market, DD coating systems based on Desmodur N showed an unprecedented range of qualities. They dry at room temperature; and their hardened finish is chemical-, abrasion- and impact-resistant, retains its gloss and does not change color under the influence of light. For these reasons, the various forms of this reaction resin system are suitable for a wide range of applications.

Manufacturers in the United States quickly realized the potential of the new product. Boeing soon started treating its aircraft with polyurethane coatings.



New raw materials
revolutionize coatings



Another milestone in the marketing successes of polyurethanes was in 1968, when the Federal German Railroad management decided to coat its cars and locomotives exclusively with DD systems. Numerous other railroads followed this example, among them the French SNCF for its TGV super-express trains between Paris and Lyons, which travel at a speed of 168 miles per hour.

Today, DD systems are found in almost all sectors of everyday life. A Bayer advertising leaflet lists some of these application areas: buses, construction components, the chemical industry, railroads, prefabricated elements, building facades, wood coatings, interior furnishings, jumbo jets, plastic articles, food containers, machine paints, commercial vehicles, oceangoing ships, parquet floors, quality furniture, refineries, low-flammable paints, storage tank installations, UV-resistant paints, packaging paper and cardboard, water pipes, all kinds of sporting goods, yachts and cement floors.

For years now, sales of conventional coatings have increased only slightly. At the same time, production of raw materials for DD coatings has more than doubled since 1973. They have shown themselves to be superior to other finishes both from an environmental and from an economic standpoint.

In 1984, a leading German car manufacturer obtained approval for a new plant only on the condition that emissions resulting from the coatings work could be kept at low levels. In the meantime, this plant has started up production. The company chose low-solvent polyurethane coating systems to meet the environmental regulations. This example is certainly a signal to other branches of industry.

Looking back at how the DD systems became established on the market for a wide range of practical uses, a quote of German philosopher Arthur Schopenhauer comes to mind. He said: *"Every new development goes through three stages. In the first phase, it is smiled at and ignored. In the second, it is bitterly opposed, and in the third, everyone has had the same idea a long time ago and has always been in favor of it."*

The quality of DD coatings in various applications is tested at a special pilot plant in Leverkusen. In addition to the technical analysis in the laboratory, this also involves careful inspection of the coated surface by an expert (left).

Bayer chronicle 1958

Production begins in Uerdingen of the polycarbonate polymer Makrolon.

In cooperation with Chemische Werke Hüls and Erdölchemie, large-scale production of Perbunan N starts up. A new range of specialty rubber types, Perbunan C (later Baypren), comes on the market.

With Agfacolor CT copy paper, colored pictures can be made directly from color transparencies. In Agfa's Physics Department, a new range of measuring instruments for the chemical and plastics industries is developed. Agfa moves into a new laboratory in Leverkusen.

Metastox is airlifted to South Africa to protect the wheat crop from aphids.

Low-toxic phosphoric acid ester Lebaycid is synthesized.

New subsidiaries are set up: Verona Dyestuffs Ltd. in Montreal (later Bayer Canada Ltd.) as well as the Bayer China Company and Bayer Far East Company in Hong Kong.

An enamel factory, in which Bayer has a 50-percent stake, opens near Lyons, France.

Annual sales of Farbenfabriken Bayer exceed DM 2 billion; exports account for some 42 percent of this total.

World events 1958

On January 31, the United States launches its first earth satellite, Explorer I, into space.

Constituent assembly of the European Parliament meets in Strasbourg on March 19.

Unrest breaks out in Algeria in May. The French settlers call for integration with France, but the native Algerians want equal rights. The disturbances extend to France itself, and there is a threat of civil war. On May 29, General de Gaulle becomes Prime Minister and is given special powers. On September 28, 85.1 percent of the French electorate votes in favor of the presidential constitution; the Fifth Republic is thus born.

On November 27, the Soviet Union issues an ultimatum demanding that West Berlin be declared a demilitarized "Free Zone" within a year and that the German Democratic Republic be recognized.

Unemployment in the Federal Republic falls to 1.8 percent, its lowest point since the currency reform in 1948.

Bayer anticipates the law on employee participation

The employment agreement of September 21, 1959, laid down the rules that still govern the working relationship between Bayer's management and works councils. Bayer's arrangement went much further than the Federal Republic's first Industrial Democracy Act of 1952 and anticipated the act of 1972.

In 1959, a committee of the works council was formed whose members consisted of the chairmen and vice-chairmen of the works councils of all Bayer plants. Its function was to represent the employees in negotiations with management. The employees were also given the right to elect their spokesmen in secret ballots. The Bayer agreement, which is still in force, attracted a good deal of attention in German business circles and was considered ahead of its time.

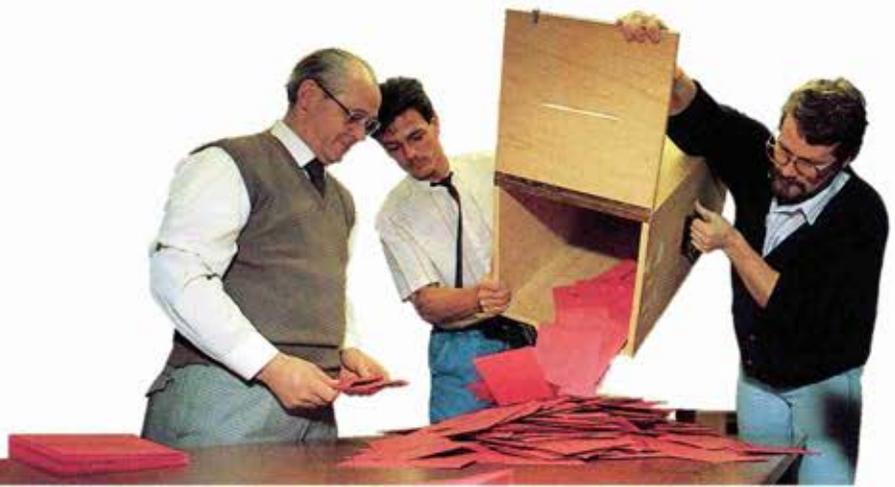
As long ago as 1905, a "General Workers' Committee" had been set up at Bayer to represent the interests of employees vis-à-vis management. When the "Patriotic Auxiliary Service Act" was passed in 1916, which stipulated that workers' committees were to be formed in all corresponding corporate units with more than 50 employees, Bayer already had had eleven years of experience with such a program.

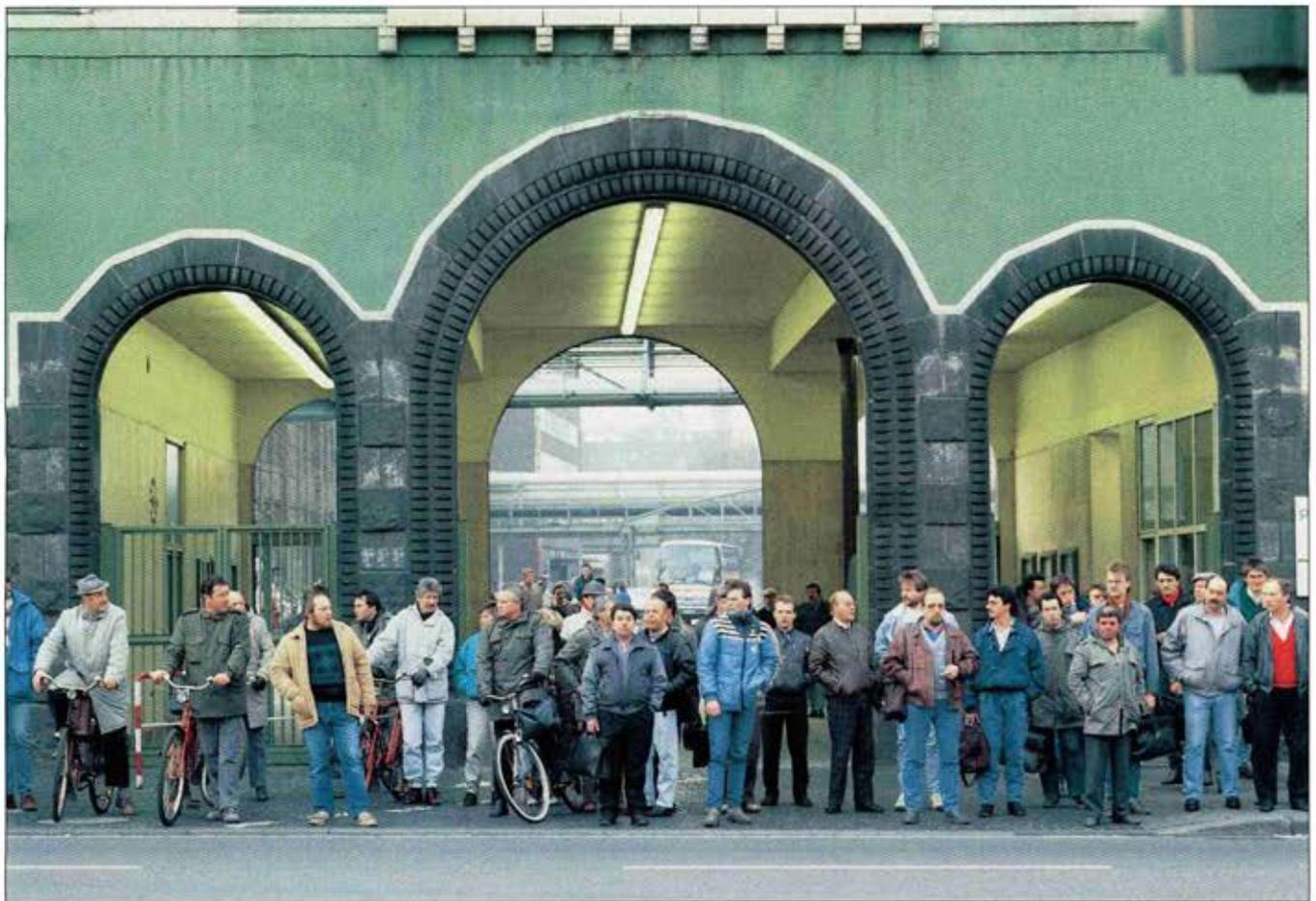
In 1920, the Weimar Republic passed an overall Works Council Act, and employee representation became a permanent institution; the Third Reich subsequently dissolved independent employee organizations. But after the war, Bayer revived the positive tradition of cooperation between management and employees. Its contribution toward the company's postwar success should not be underestimated.

In 1952, the Federal Parliament passed the first Industrial Democracy Act, which was expanded by the amended version of January 19, 1972. The Co-Determination Act followed on July 1, 1976.

The 1972 act retained the principles of the first law, while adding a number of important provisions. These included:

- comprehensive social safeguards for employees by expanding and strengthening co-determination rights;
- increased participation of the trade unions and a broadening of unions' rights and authority in the industrial relations code;
- extension of the individual freedom of each employee;





- greater protection for employees' activities in connection with questions of wages, socio-political conditions and economic concerns;
- facilitating the work carried out by members of work councils, in part by giving employees more time off to pursue these activities and by improving social safeguards.

Over the years, the works councils have shown that they can handle this law very well. The mutual trust that has arisen from this cooperation is underlined by the fact that in eleven years, there were only four cases of arbitration proceedings. This is clear evidence that proper use of existing legislation is more important than a constant flow of new laws.

The works councils have never waived their rights to co-determination and participation when it comes to looking after employees' interests. With the aid of the elected spokespersons, who particularly in large plants have played a key role as a link between the works council and the "shop floor," internal problems could be solved quickly.

Members of the works councils are not only active in the statutory works and business committees. At Bayer, they have also formed another eleven committees covering such fields as a labor law, workplace safety, personnel, culture and new technology. They belong to such organizations as the pension fund, the works health insurance fund, the relief fund or the housing committee.

Apart from the local works councils, Bayer AG has set up an umbrella council for its five domestic plants and various sales offices. When casting a vote in this council, each member has as many votes as there are employees in his or her home unit. This joint council is responsible for matters that concern the company as a whole and cannot be negotiated at the local level.

Within Germany there are also a number of companies that belong to the Group but are separate legal entities and thus not part of Bayer AG. As a result, a special corporate works council has been formed for all of the German operations. Personnel policy and business decisions are among its respon-

Cooperation, not confrontation: this maxim has a long tradition in Bayer labor relations. In 1959, a commission of the works council was formed to uphold this principle. At the same time, employees were also given the opportunity to vote for their spokesmen by secret ballot.

In those days, this Bayer system, which is still in effect, was considered to be well ahead of its time.



sibilities, as are setting up and managing the welfare institutions that serve the entire domestic organization.

The Supervisory Board of Bayer AG is selected on the basis of equal representation for the employer and the employees. The law requires that at least three of the ten representatives from the employees' side be supplied by the trade union.

The highly complex technology in the chemical industry demands cooperation rather than confrontation. The responsible union, "Industriegewerkschaft Chemie, Papier, Keramik," shares this opinion, and Bayer's works councils also cooperate according to this principle. Management and labor have basically the same interests at heart, and both groups know that if a company does not reach its corporate goals, jobs are at stake.

The concrete results of this cooperation are the various employment agreements that cover matters not specifically regulated by the law. Since 1972, agreements have been reached on cashless wage

and salary payments, guidelines governing choices for employees in case of a plant closure or a transfer, bonuses for work under difficult conditions, flexible working hours, employee suggestion programs, payments in excess of agreed wage rates, the length of vacations and pre-retirement vacations.

In 1986, a corporate agreement was reached concerning new technologies. It provides for employee participation in early planning stages and is intended to guard against possible disadvantages for employees as a result of new technologies. At the same time, the agreement is designed to aid the introduction of technological improvements.

An agreement signed on January 1, 1988, regulates the handling of personal data on employees. This company statute is in line with previously and recently instituted laws protecting the individual's privacy of personal data, and it outlines Bayer's own practices and principles.

On April 1, 1987, a new company policy covering the subject of jobs and children came into effect.

The Supervisory Board of Bayer AG is made up equally of employer and employee representatives. The law provides that three of the ten employee representatives on the board be appointed by the labor union. The above picture shows the Supervisory Board before

the shareholders' meeting in the jubilee year 1988. Seated (from left to right). Honorary Chairman Kurt Hansen, Chairman Herbert Grünewald, Deputy Chairman Paul Laux. Standing (from left to right): Walter Simmler, Robert A. Jeker, Constantin Freiherr Heereman

von Zuydtwyck, Hans Drathen, Manfred Lennings, Heinz A. Staab, Walter Seipp, Hermann Rappe, André Leysen, Gerhard Dittmar, Peter Klug, F. Wilhelm Christians, Karlheinz Kaske, Heinz Gester, Hans Unger, Adolf Busbach, Peter Purwien, Hans Hoffmann.

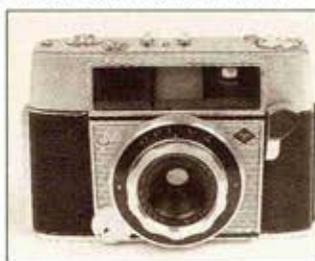
It is now possible for mothers—or fathers—who are raising infants to give up his or her job for a period of up to seven years with a guarantee of reemployment. This guarantee is coupled with the employee's obligation to participate in occupational training during his or her absence, in order to retain the necessary qualifications for the job.

In 1975, management and works council agreed to introduce the monthly salary for all employees. This was a first step in the final abolition of a differentiation between "workers" and other company staff. Under the present circumstances, these terms have long since become meaningless: somebody able to handle modern process control systems is hardly to be regarded as a "worker" in the traditional sense, whereas a colleague who uses a typewriter is, in the German nomenclature valid up until now, hardly to be considered a member of "staff."

More than ten years later, the 1987 wage agreement achieved a second step in this decision to eliminate differences between the two groups of employees. After six years of negotiations, the so-called "century agreement" was reached, which meant that all employees, regardless of their status, were to be subject to pay rates on the basis of their actual activity. This agreement, which covers the whole of the West German chemical industry, has also set an example for other branches of the national economy.

Bayer chronicle 1959

The Agfa Optima, the world's first fully automatic camera, makes headlines in the inter-



national press. In the following three years, Agfa sells a million cameras.

Provisions of an employment agreement include equal representation in company committees and secret elections of works spokesmen.

Water-biology laboratory to examine the degradation ability and toxicity of liquid chemical wastes is installed.

Bayer discovers a biological process for the large-scale production of semisynthetic penicillins.

Trasyol, a new product for the treatment of pancreatitis, is introduced to the market.

First courses for young people who have not completed apprenticeships are launched.

Leverkusen Air Sports Club (LSC) is given its own airfield on the Kurtekotten site near the plant.

World events 1959

Alaska becomes the 49th and Hawaii the 50th state of the United States.

Conference in Geneva regarding Germany fails to reach an agreement.

In September, Nikita Khrushchev becomes the first Soviet leader to visit the United States.

As of April 25, oceangoing ships are able to go from the



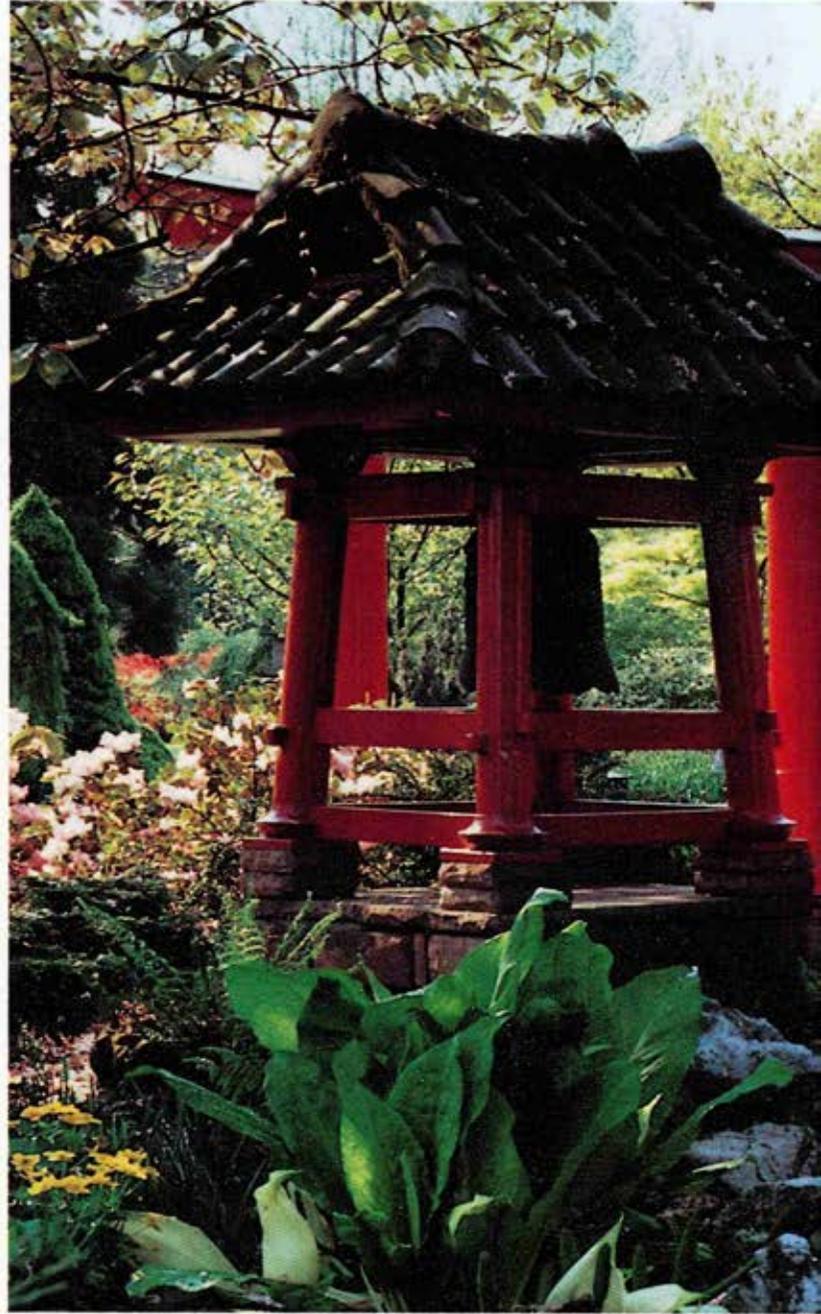
Atlantic straight through to Great Lakes ports via the newly opened St. Lawrence Seaway.

Between October 4, 1957, and the end of 1959, a total of 22 earth satellites or space probes are successfully launched.

Cuban Prime Minister Fulgencio Batista goes into exile. Fidel Castro assumes power.

The Japanese Garden

When Carl Duisberg made a trip around the world in 1926, one of the countries on his itinerary was Japan. He was particularly fascinated by the Japanese garden culture so when he came home, Duisberg decided to expand the Japanese Garden next to his villa, which was adjacent to the Leverkusen works. The area was landscaped according to Japanese principles into an oasis of peace and beauty.



When work began on the new high-rise office building in 1960, the Japanese Garden had to be relocated. Although it lost something of the original Japanese style in the process, it has remained a major attraction in all seasons for visitors from near and far.



Silicones offer products for a variety of purposes

Bonded to oxygen, silicon is quite literally as plentiful as the sand on the beach. Sand is in fact nothing other than silicon dioxide. Silicones are organic silicon compounds, whose remarkable properties were discovered in the early forties. They have been produced at Bayer since 1952.

After oxygen, silicon is the most common element in the earth's crust. The pure element itself was first obtained from sand in 1823. In the early days of this century, scientists discovered polysiloxanes containing silicon. They are the compounds that actually determine the properties of silicones. When the electrical industry needed a heat-resistant synthetic material for insulation purposes in the late 1930s, polysiloxanes provided the answer.

Two American companies, Corning Glass and Dow Chemical, formed the joint venture Dow Corning in 1943. Its production program to this day is centered on silicones.

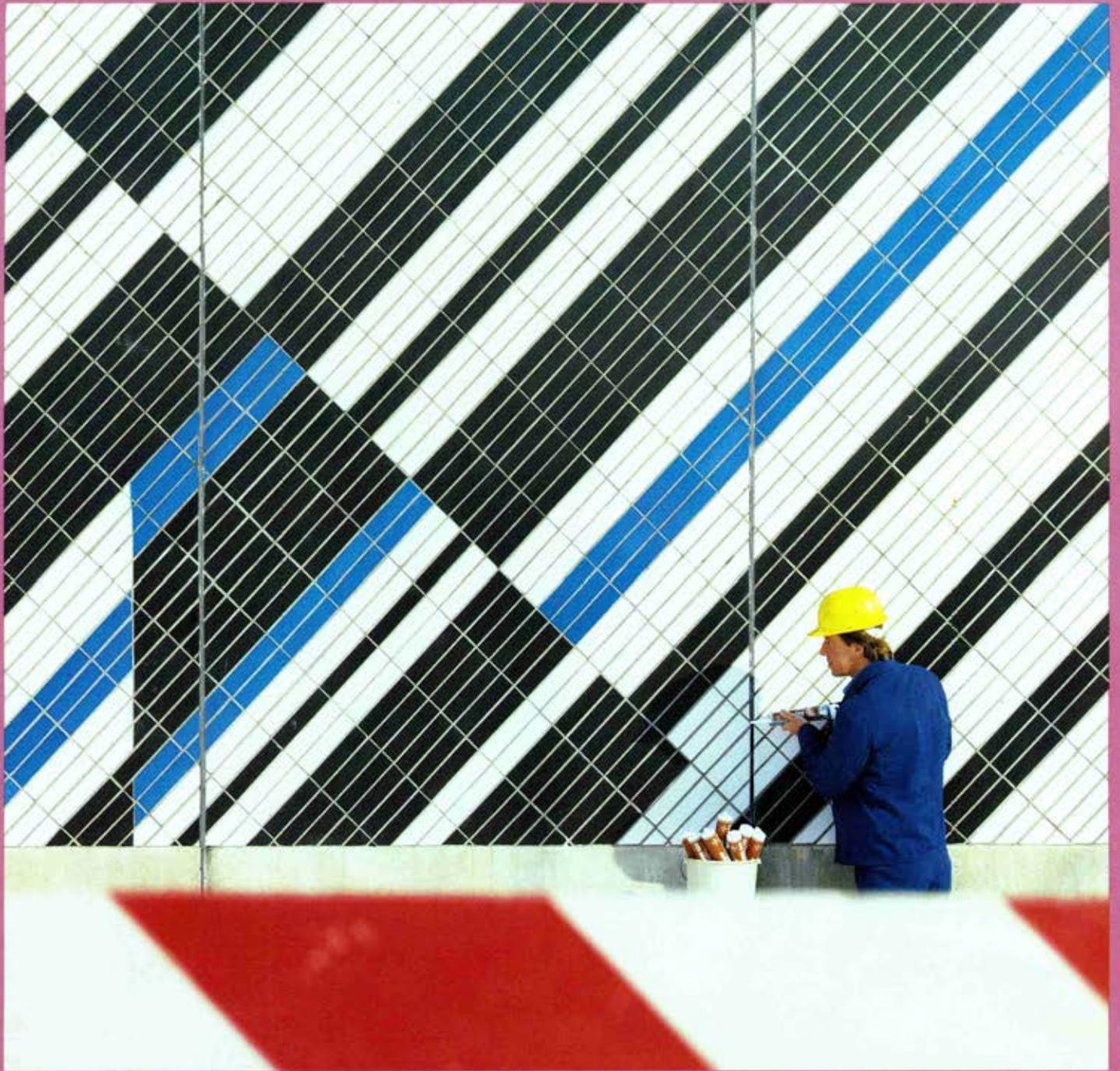
The key discovery in this field had taken place two years earlier when E.G. Rochow of the U.S. company General Electric worked out a direct method of synthesizing methyl chlorosilanes. At about the same time, German researchers were also investigating the direct synthesis of methyl chlorosilane, but in contrast to the situation in the United States, the industrial-scale application of this process was held up by the war.

When scientific congresses and seminars started up again in the universities and corporations of postwar Germany, lectures on organic silicon compounds were frequently accompanied by presentations of samples of a plastiline-like substance that was as pliable as chewing gum. When molded into a ball and dropped on the ground, it bounced up as though it were made of rubber. It was unexpected properties like these that made the silicones so interesting for new technologies.

Bayer soon recognized the potential of this new product group, and a cooperation agreement with General Electric led to Bayer's first silicone range as early as 1952.

Professor Walter Noll was put in charge of the company's research in this promising field and succeeded in making silicones an important business for Bayer. His book on the chemistry and technology of silicones is still an internationally recognized standard work.

Silicones are used today wherever joints have to be sealed. Silicone rubber has particularly proved its worth in joints that have to "give." It remains elastic in both heat and cold and thus adjusts to movements in building materials without cracking.

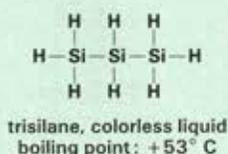
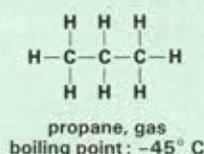


Silanes, siloxanes and silicones

The element silicon is situated immediately below carbon in the Periodic Table. This would indicate certain chemical similarities between the two elements which are not apparent at first sight: carbon dioxide is a colorless gas and silicon dioxide an insoluble white powder. In nature, silicon occurs in remarkable, hexagonal columns in the form of rock crystal, but its most common form is that of simple sand.

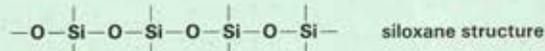
While carbon, with its incalculable number of organic compounds, is the basic element of life itself, silicon, as SiO₂ or one of the silicates, can be considered the basis of inanimate nature.

Despite these fundamental differences, there are parallels between the two elements. For example, the saturated hydrocarbons (alkanes) correspond to the silanes:



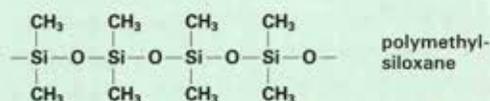
Unlike the relatively inactive alkanes, the silanes are highly reactive compounds. Silicon compounds whose basic structure is a

chain of oxygen and silicon atoms (siloxane structure) have, however, become much more important:



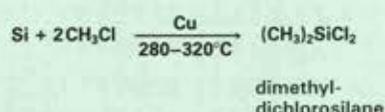
When the valences that have remained free on the silicon atoms are occupied by carbon radicals such

as methyl groups, polyorganosiloxanes, known simply as silicones, are produced:



The route to such compounds starts with elementary silicon, which reacts at 300° C in the presence of copper

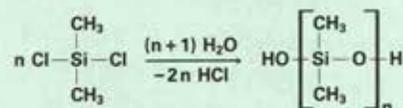
as catalysts, for example with methyl chloride, to yield methyl chlorosilanes:



Apart from dimethyldichlorosilane, other substances occur, such as methyl trichlorosilane, trimethylchlorosilane and further by-products, some with higher molecular weight. The silanes are separated from one another by fractionation.

The hydrolysis of methyl chlorosilane leads to the polymethylsiloxanes and thus

to the technically important silicones. To obtain the wide range of corresponding products, quite diverse processes are necessary. For example, the hydrolysis of (CH₃)₂SiCl₂ leads to chains with a siloxane structure ending in OH. What all of these have in common is the chain formation, for instance, by polycondensation:



By introducing certain quantities of such monofunctional chlorosilanes as (CH₃)₃SiCl, trimethylsilyl chain ends can be created during the hydrolysis of (CH₃)₂SiCl₂, instead of the

hydroxyl terminal groups. Trifunctional silanes like CH₃SiCl₃ permit the inclusion of branches in the chain. Resinous substances, in particular, are produced in this way.

An impressionistic picture is created in a photographer's studio with a drop of silicone oil. In fact, this picture also depicts a typical characteristic of this substance, which contracts rather than spreads over the glass surface onto which it has been sprayed.



The economic success of a technically interesting product group depends on the development of reliable and cost-effective production processes. Bayer was able to make a substantial breakthrough in the difficult synthesis of methyl chlorosilanes in 1960, when fluid-bed technology was introduced. Today, the whole production process is operated in a fully computerized plant.

In further processing stages, silicones are formed from methyl chlorosilanes. The current Bayer program includes about 1,000 of these versatile products, which are custom-made for the most varied applications by carefully planned control of the individual reactions.

The versatility of silicones is illustrated by the breadth of their properties, which include resistance to heat and weathering, flexibility (even at low temperatures), film-forming ability, water-repellent effect and good electrical insulation qualities.

Since silicones are physiologically neutral, they can also be used for such medical or cosmetic applications as molding compounds for dentures, artificial vein inserts and even cardiac valves. Because they do not accumulate in the organism and are environmentally unobjectionable, silicones are also suitable for the production of articles that come into contact with food.

The most important and widest opportunities, however, are offered in construction and technical applications. For example, they make excellent sealing compounds, which are needed for joints of all kinds. Bayer sealants manufactured on the basis of silicone rubber have proved their value, even for joints that are subject to movement. This ability to "give" is particularly important when materials with different coefficients of expansion, such as glass, metal, concrete, wood and plastic, have to be combined.

In the electrical industry, silicones are used as heat-resistant cable insulation and also in applications where sensitive electrical parts have to be permanently protected against heat and dampness. The automobile industry makes use of silicone rubber in

ignition cables, sparkplug bases, rotary shaft seals and many other parts. The fluid emulsion Baysilone M 50 EL is becoming more and more popular in the application as a coolant in transformers, replacing the once commonly used polychlorinated biphenyls (PCBs).

With silicone-molded parts that absorb vibrations, sensitive measuring instruments can be protected from shocks when mounted. Since silicones repel water and oil, silicone oils are added to car, floor and shoe polishes and cleaners for ovens and ceramic surfaces.

Special silicone oils are used for the impregnation of textiles and to make plaster of Paris boards repel moisture. When added to coatings, they improve the leveling property.

Manufacturers of molded plastic goods use silicone oils as release agents to keep the plastics from sticking to the molds. In the fibers industry, these oils prevent jets from clogging, and polyurethane producers use them to stabilize foams during hardening.

The paper industry requires silicones to help make paper or foil repel adhesives. Pharmaceutical and cosmetic manufacturers include silicone oils in ointments, creams and lipstick. They are also used as an antistick agent to permit the complete emptying of ampules.

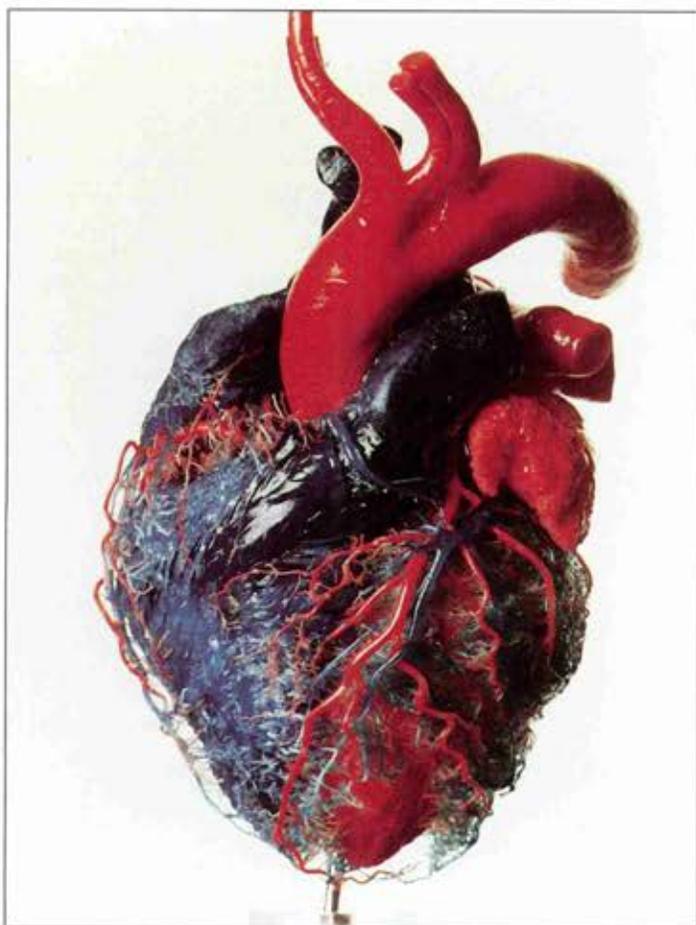
As raw materials for coatings, silicone resins protect metal flues, hot-air conduits and vents from corrosion. Mixed with pigments, they are a decorative shield for ovens and stoves.

Silicone elastomers stand up to temperatures of 180° C or, for short periods, as high as 400° C. They also keep their good properties at low temperatures and remain elastic even at -50° C. Special types can withstand temperatures as low as -100° C, which is the reason why silicones play an important role in the aerospace and aircraft industries.

Silicones have also proved helpful in solving problems in the scientific field. For example, Gunther von Hagens in Heidelberg invented the so-called

“plastination” process for the preservation of animal or plant specimens. He replaced the cell fluids with Bayer silicones, which subsequently hardened. Objects retain their natural appearance and color, but can be easily handled—whether they are as hard as a rock or as soft as leather.

Until only a few years ago, silicones were not much more than a footnote in chemical textbooks. Today, the tall distillation towers of Bayer’s methyl chlorosilane plant are an impressive addition to the Leverkusen works’ skyline and visible proof of the fact that the former “novelty” has come a long way in achieving both technical and business significance.



Silicones are also used for scientific purposes. In the so-called plastination process, cellular fluid is replaced by Bayer silicone. When the latter hardens, durable objects are produced, such as the molded model of the heart pictured above.

Bayer chronicle 1960

Construction begins of the high-rise office building in Leverkusen.

Bayer starts using high-capacity computers.

The first semisynthetic penicillin is introduced to the market under the name of Oralopen.

Dental Division introduces the local anaesthetic Baycain.

At the “photokina” Trade Fair, Agfa presents its first magnetic tape for video recordings.

Pilot plant for polyurethanes is opened on the Flittarder Feld site.

Insecticides Baytex and Lebaycid are introduced to the market.

Federal German Post Office begins using mailbags made of the Bayer fiber Perlon. They weigh less than the conventional bags.

Number of graduate engineers employed at Bayer has risen from 116 to 247 since 1949, while the number of other engineers has increased from 189 to 490.

Bayer opens a subsidiary in Morocco, a dyestuffs plant in Pakistan and a photographic paper unit in India. Construction of a pharmaceuticals facility begins in Colombia.

World events 1960

On January 4, the European Free Trade Association (EFTA) is set up in Stockholm as a counterpart to the European Economic Community. Member nations are Denmark, the United Kingdom, Ireland, Norway, Austria, Portugal, Sweden, Switzerland and Liechtenstein.

The United States signs a security agreement with Japan on January 21.

Soviet-style collectivization of agriculture is introduced in the German Democratic Republic. As of April 14, all farmers belong to agricultural production cooperatives.

On May 1, an American U-2 reconnaissance plane is shot down over the Soviet Union. The resultant crisis leads to the breakdown of the East-West summit in Paris.

American physicist Theodore H. Maiman presents the first laser on July 7.

Iran, Iraq, Kuwait, Saudi Arabia and Venezuela set up the Organization of Petroleum Exporting Countries (OPEC).

A total of 18 former colonies—of the United Kingdom, France and Belgium—gain their independence.

The fascinating world of modern colors

A hundred years after the first synthetic dyestuff had been produced by William Henry Perkin, the industry received a new impulse with the invention of reactive dyes. For the first time ever, it became possible to form a chemical bond between dyestuffs and fibers. After marketing its Permafix dyestuffs in 1959, Bayer introduced Levafix Brilliant Red E-2B in 1961 as the basis for a broad range of reactive dyes.

Bayer was originally founded in 1863 as a dyestuff producer, hence the use of the word "Farben" in its corporate name. It was not until 1972 that the name was changed from Farbenfabriken Bayer to simply Bayer AG. The new name made better sense considering the much more widely diversified production program that the company had developed in the meantime. Dyestuffs have, however, never ceased to play an important role in overall business.

Synthetic dyestuffs are a particularly good example of how a precisely aimed synthesis can result in products that complement, or even equal, natural substances. And with the help of synthetic materials, man has been freed from his dependency on nature as a supplier of important products. In fact, synthetic products are now frequently superior to their models in nature—in variety, quantity and quality.

This also applies in respect to other sectors. For example, the 1930s saw revolutionary developments in the field of textile fibers. Traditionally, the textile industry has been the biggest single user of dyes. For thousands of years, mankind had had to rely on plant and animal fibers for textiles; the most prominent among these are wool, silk, cotton and linen. This situation changed when the chemical industry was able to develop synthetics on the basis of such compounds as polyamide, polyester and polyacrylonitrile. The result was that an almost unlimited supply of synthetic fiber was made available, independent of climatic and crop considerations. But this welcome development posed a host of difficult problems for dyestuffs and applications experts. For each of the new fiber types, it was necessary to come up with corresponding dyes because synthetics have a different constitution than natural fibers.

Every branch of industry, no matter how modest, is constantly faced with the task of streamlining and improving both product ranges and production processes. Often enough, it has proved impossible to go it alone, and partners have to be found.

Customers of the dyestuff producers demanded new dyeing techniques, which were to be computer-controlled, fully automatic and designed to save

Levafix reactive dyestuffs are one of the most recent Bayer developments in this field. Certain atom groups of these dyestuffs react with other groups of atoms in the cellulose fibers. Thus, an actual chemical bond is formed between the two materials.



Reactive dyes and specialties

A colored chemical compound is far from being synonymous with a dyestuff. All sorts of special characteristics are necessary if it is to meet this requirement. The dyeing—in other words, the combination of the dyestuff with the substrate to be dyed—must be able to withstand the varied influences on a lasting basis. In the case of textiles, fastness to light as well as to water and washing belongs to the most important properties demanded of a dye. The extent to which a dyestuff truly “penetrates” a fiber depends on the nature of the fiber concerned and the chemical constitution of the dyestuff.

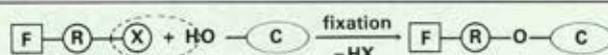
The amino acid-based polypeptide chains of wool and silk, also known as albumen or protein fibers, contain amino groups that are positioned at regular intervals and other groups whose acid or alkaline character enables them to serve as points of attachment for the dyestuff molecule. The classic synthetic dyestuffs incorporate mainly acid or alkaline atom groups that are able to interact with oppositely charged areas in the fiber.

In the case of plant fibers, which are based on a cellulose framework and whose best known example is cotton, only the much less polar hydroxyl groups of the glucose rings occur. This is the reason why these fibers are much more difficult to color. In former times, cotton had to be “pickled” or mordanted in order to bring about

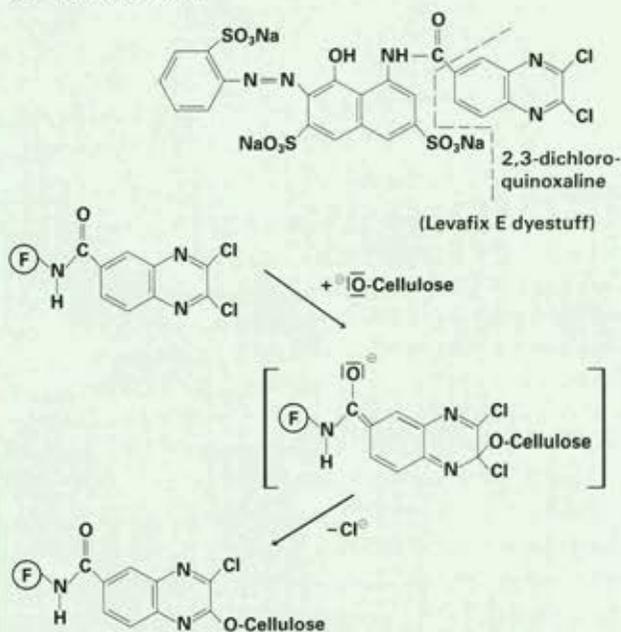
a lasting bond between dye and fiber. The introduction of the first substantive dyestuffs that could be applied to cotton without this preliminary impregnation process was obviously a major step forward.

Other ways to make dyeing more water-resistant include various methods of subsequent treatment, or in making the dyestuff insoluble after its application to the fiber. Such processes take place when using vat dyes or by creating metal complexes. The common aspect of all these techniques is that fiber and dyestuff remain chemically separate entities.

In contrast, the reactive dyestuffs form a real chemical bond with the fiber. Their molecules contain the reactive groups that react during the dyeing process with functional groups of the fiber material, in particular with the hydroxyl groups of cellulose. Electrophilic heterocyclic compounds are generally used as the reactive radical R; the Levafix dyestuffs contain primarily pyrimidine or quinoxaline radicals. The general principle of this process and an example of one of the dyestuffs are shown above right:



- F = main body of the dyestuff molecule
R = reactive radical is selected so that it releases the attached group X as an anion during dyeing
X = Cl, F, -SO₂-CH₃ or others
C = cellulose radical



During the dyeing process, not all of the dyestuff reacts with the fiber. Together with the water in the alkaline dye liquor, part of it forms the so-called hydrolyzate. This inactive compound has to be washed out of the fabric.

The products Levafix Navy Blue E-BF and Levafix Royal Blue E-FR, each of which have two reactive groups in the molecule, have proven to be promising new developments. While the first reactive dye-

stuffs resulted in fixing yields of only 60 percent or less, the bifunctional reactive system of the Royal Blue shows one of 90 percent.

Using Bayer's Levafix Royal Blue E-FR meant that for the first time the depth and brilliance of color achieved with synthetic fibers were also matched when dyeing cottons blue. And very good fastness properties were possible, too.

The range of reactive dyestuffs developed in Bayer's laboratories and later sold under the trade name of "Levafix" first came on the market in 1961. The picture on the right shows the cover page of a brochure for customers in the textile industry.

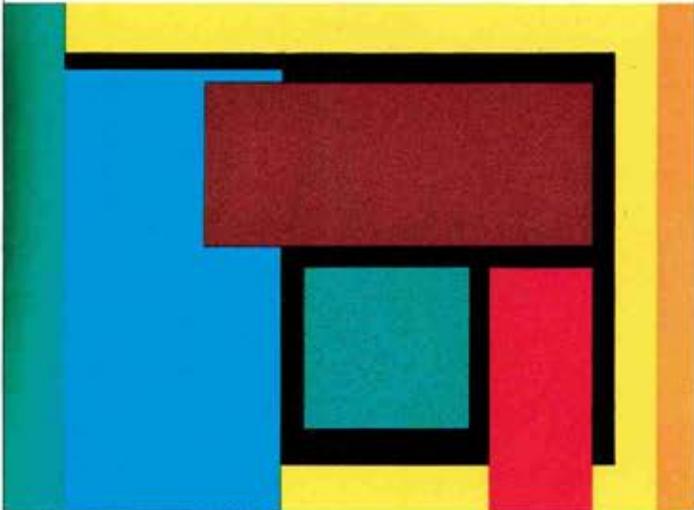
on energy, time and labor. They also demanded dyestuffs with more and more coloring strength, greater brilliance and increased fastness.

In the search for fundamentally new classes of dyestuffs, ICI's Ian Durham Rattee and William Elliott Stephen made an important breakthrough in 1956, when they developed the first reactive dyes. In the dyeing process using these substances, a chemical reaction takes place between the dye-stuff molecule and the reactive groups of the textile material. The chemical bonding to the fiber thus obtained is of the utmost significance in enhancing color fastness.

Both the inventors themselves and chemists of other companies expanded on this initial discovery. Bayer for one launched a research program based on the same chemical principle. By 1959, the company began introducing several assortments of reactive dyes; at first they were marketed under the name of Permafrix and then under the Levafix trademark beginning in 1961.

Today, there are many different dyestuffs and pigments, but still more are needed every year.

Levafix-Farbstoffe
Im Textildruck



Color has, after all, an important role to play in enhancing the quality of life. Bayer has concentrated its efforts on developing colors for textiles and leather, paper and plastics as well as paints and coatings. This has not only been a question of finding the right coloring substance; the so-called textile auxiliaries act as essential "companions" to every dyestuff. A single recipe can call for several of these ingredients in addition to the actual coloring agent.

An example of one range of Bayer's textile chemicals is the group of dispersing agents. As the name implies, they are responsible for a homogenous dispersion or distribution of the dyestuffs in the dye bath. Certain products prevent undesirable foaming in the coloring process, while others make it possible to dye fabrics evenly.

Over and above this, fabrics for a number of uses must be repellent against water, oil and dirt. Textile floor coverings have to be treated to avoid electrostatic charges. Woolen goods are treated with Eulan to protect them against moths and certain kinds of beetles. The textile printer requires thickening agents for the production of print paste, as well as binders for fixing pigment onto textiles in the pigment-printing process and a number of other textile auxiliaries.

For the leather industry, tanning agents are absolutely essential for the conversion of perishable animal skin into durable leather. Tanning alone, however, does not result in the final leather product; the leather still has to be dyed and finished for its protection and its attractive appearance.

A wide range of auxiliary materials is also used in the paper industry. Fixatives, for example, strengthen the bond between the dyestuff and the cellulose fiber and prevent, or at least reduce, subsequent fading. Preservatives increase the paper's resistance to bacteria and fungi, while sizing agents make the paper firmer and easier to print or write on. Many paper products need to be able to withstand dampness or even wetness—maps, teabags and handkerchief tissue, for example. Therefore, there are special agents to guarantee fastness to wetting.

**Kurt Hansen, Chairman of the Board of Management
from 1961 to 1974**

Following the unexpected death of Ulrich Haberland on September 10, 1961, the Supervisory Board appointed 51-year-old Kurt Hansen to succeed him as Chairman of the company's Board of Management.

Kurt Hansen was born the son of a Hamburg merchant on January 11, 1910, in the Japanese port of Yokohama. He came to Hamburg at the age of ten and attended high school there before going to Munich in 1929 to study chemistry. He received his doctorate in 1935 under Nobel Prize laureate Hans Fischer and then stayed in Munich to obtain a degree in business administration the following year. He joined I.G. Farben's Wolfen film works as a chemist that same year, but moved after only a few months to the photographic paper plant in Leverkusen. In 1938, he transferred as factory manager to the Alizarin Department. Hansen was called up by the army and released again several times before being posted in 1943 to I.G. Farben's Berlin office responsible for the procurement and distribution of raw materials. After temporary internment, he returned to Leverkusen in 1945.

Haberland planned to reforge links to the United States and entrusted this assignment to Hansen. Kurt Hansen made it his job to learn all he could about the country whose petrochemical activities were ten years ahead of those in Germany. It was no easy task to convince the Americans that Bayer never-

theless had something to offer them. One trump in Hansen's hand was Bayer's know-how in the field of isocyanates for the production of polyurethane. The German company did not have the foreign currency to go it alone in the United States, but this technology was of considerable interest to American manufacturers. Accompanied by a small

nections were of great significance for the company, he favored a man with experience abroad. He spotted Hansen as the right choice and put the candidate, who was ten years his junior, through a comprehensive "training" program.

Kurt Hansen recalls how he was exposed to a virtually nonstop form of job rotation.

Elberfeld plant in 1956. That same year, he assumed responsibility for Bayer's pharmaceuticals and agrochemicals. In 1957, he was appointed to the Board of Management, whose chairman he became on Haberland's death four years later.

In the late fifties, Bayer enjoyed a period of rapid expansion and international growth. The Leverkusen company had become a truly multinational operation. Management recognized that this called for corporate adjustments and launched the complex reorganization project that came into force in 1970.

On the domestic front, the late sixties were a time of tumult. A wave of unrest hit the world—from the Cultural Revolution in China to the May disturbances in Paris and the student riots in Germany. The younger generations everywhere seemed to be questioning the values of their parents, and with this political trend came increasingly sharp criticism of the industrial society. Authority was rejected; "achievement" as such was denounced. Hansen commented on the predicament: *"One of the most decisive factors of corporate success is the spirit that inspires its personnel and the attitude each individual has toward fulfilling a task. If the dedication to give one's best in the effort to achieve a common goal is not present on the shopfloor, the best top management is worthless."*



Professor Kurt Hansen

team, Kurt Hansen visited firm after firm. Monsanto Chemical Corporation proved to be the partner Bayer had been looking for. Hansen was also able to make promising contacts in other business areas.

This success impressed Ulrich Haberland. As an efficient organizer, he began to search for a possible successor at an early stage. Since he had recognized that foreign con-

In 1955, he was sent as a one-man delegation from the German Department of Commerce to India in order to advise the Indian government on the creation of a dyestuffs facility for textiles. In the same year, Haberland sent him to Uerdingen with the possibility of his becoming works manager. In the end, however, he took over the management of the

In addition to the traditional users, such modern industries as plastics processing are of growing significance as customers. The plastics sector is a good example to illustrate the two major dyeing processes: coloring with soluble dyestuffs and coloring with insoluble pigments. Although pigments dominate in the dyeing of plastics, the soluble dyestuffs offer some decisive advantages because of their extreme heat resistance, particularly for technologically advanced plastics. Bayer's Macrolex dyestuffs are highly regarded in the trade for this reason.

Coatings and paints also need to be colored because they have an aesthetic and decorative purpose as well as serving as a protective layer. High-grade pigments based on perylene and quinacridone are particularly important in achieving the high gloss finishes needed in the automobile industry. A great deal of experience was necessary in the development work and production of pigments required to obtain the brilliant, stylish metallic coatings while also offering their high degree of translucency and weather resistance.

Outside the realm of the actual "coloring" products are the whitening agents. These colorless dyestuffs have the very special function of making whites even whiter. Thanks to their chemical structure, they are able to convert the ultraviolet rays, which are not perceptible by the human eye, into longer-wave, blue rays that can be seen. This "blue rinse" offsets the almost invariable, yellow tinge present in white materials. At the same time, more white light is reflected than is absorbed. Bayer's Blankophor program of whitening agents includes products for all sorts of textiles, as well as for paper, detergents and many other materials.

Bayer chronicle 1961

Desmodur N is patented; DD coatings become a rapid success.

Dralon receives the "Le Coup d'Or du Bon Goût Français" award in Paris, which has been won only once before by a German product.

Ethylene vinyl acetate copolymers are developed and subsequently introduced on the market under the trade name of Levapren.

Crop protection product Namacur proves its efficacy in tests carried out in Germany, Italy, France, the United States and Peru.

Bayer buys a plant site in Antwerp.

With a capacity sufficient to meet national needs, production of the aspirin base salicylic acid begins in San Nicolas, Argentina.

World events 1961

On January 20, John F. Kennedy becomes the 35th president of the United States. At 44, he is the youngest man ever to hold this office.

Soviet cosmonaut Yuri Gagarin flies around the Earth in one hour and 48 minutes on April 12 in his spacecraft Vostok 1. On August 6, German Titov makes 17 orbits.

To stop the flow of refugees into the West, the Berlin Wall is erected by the German Democratic Republic on August 13.

In line with the destalinization movement in the Soviet Union, the body of Joseph Stalin is transferred from the Red Square mausoleum and buried near the wall of the Kremlin.

A century after Philipp Reis' first experiments with the telephone, there are now some 142 million connections around the world, 52 percent of them in the United States alone.

Polyurethane foam penetrates a variety of markets

The inside of a refrigerator has to offer a maximum of space, while the appliance itself should take up a minimum of space. Polyurethane foam technology has provided the answer. Without the new generation of refrigerators made possible after 1962, the supply and variety of fresh and exotic foodstuffs available today would be unobtainable.

The food refrigeration chain starts with the producer. Deep-sea shrimp, for example, are caught off Greenland and processed on board. They are then chilled until they can be flash-frozen. If they are to remain fresh, the shrimp must be kept cold in every further stage of their journey to the consumer, which means in initial storage, in the container, en route by ship, truck or railroad, in the distributor's warehouse and vehicles, in the supermarket and finally in the freezer of the refrigerator at home. The same thing applies to food that is not frozen, but must be kept cool.

The forerunner of the refrigerator was the icebox, whose hollow walls held crushed ice. This thawed, and the water had to be drained off periodically. The electric refrigerator was a considerable advance. Until the early sixties, this model had double walls filled with glass wool or cork and had a wall thickness of some 50 millimeters and more.

Today's modern refrigerator with about the same external dimensions but filled with rigid polyurethane foam needs a wall only about 32 millimeters thick. Not only is the space inside markedly increased, energy is saved, too. This advantage is very important since six to seven times more electric energy is needed to produce cold air than warm air.

Rigid polyurethane foam has the lowest thermal conductivity of any insulating material. In production, it adheres firmly to all surface layers and makes them so stable that, for example, a prefabricated refrigerator cabinet consisting of a thin metal exterior and a thin-walled plastic container inside can stand unsupported. The foam fills every corner and cavity, holds hinges and locks in place and has a very low specific weight.

The great success of rigid polyurethane foam in refrigeration and many other applications would have been impossible had it not been for the development





of block foaming technology. Bayer and Maschinenfabrik Hennecke worked together to come up with the necessary equipment to put this technology into practice. The solution was a new kind of foaming machine that permitted the raw materials to be injected into cavities in the form of a foaming compound or to be sprayed as foam onto exposed surfaces.

The new process made it possible to use rigid polyurethane foams for other applications; the construction industry is a prime example. An important technology for this sector is foam spraying on large surfaces such as flat roofs, where the fast-reacting spray compound solidifies immediately after foaming. This process can be repeated until the desired thickness in the foam layer has been attained.

In fact, a natural disaster was the impetus for the initial use of spray foams in the construction industry. Two application specialists were listening to a car radio in 1962 when they heard of the plight of homeless people following an earthquake in Iran. *"It must be possible to do something to help,"* they said. Their efforts resulted in a polyurethane "igloo" as an emergency shelter.

When another earthquake occurred on Easter Sunday in 1970 in the Gediz River area of Turkey, an airlift included not only paramedics, medicine, food and blankets, but also a number of "houses in barrels" from Bayer. Accompanying personnel built up a series of turntables several meters in diameter on the site and used them as a revolving base for inflated plastic-foil domes. They sprayed foam onto these domes and within a very short

time, rigid igloos were formed from which doors and windows were cut out. Some 400 of these wind- and weather-proof shelters were set up at the rescue site, providing a temporary home for many of the victims of the quake.

Polyurethane igloos were used in two later earthquake disasters, but as successful as they were, the igloo application has remained something of an exception.

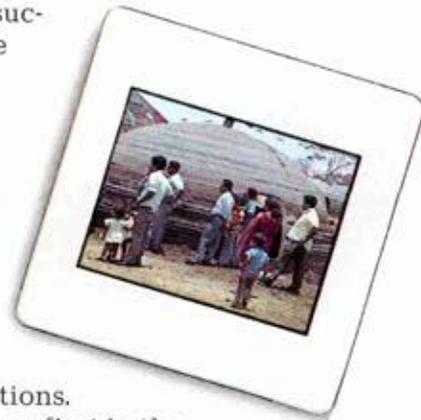
The real breakthrough in the building industry's use of sprayed rigid foam came with the development of heat insulation for flat industrial roof constructions.

This technology caught on first in the United States and later in Europe, and led to the introduction of much simpler and cheaper roofs.

What came to be even more important, however, was the use of foam spraying in the production of prefabricated wall elements for factory halls or other industrial buildings. These so-called sandwich constructions consist of a rigid-foam layer between two layers of sheet metal or other materials. To show what possibilities this application opened up for architects, Bayer had a domed hall built at the 1970 Hanover Industrial Trade Fair. Constructed with 42 huge rigid polyurethane foam shells and sheet steel surface layers, the diameter of the dome was bigger than that of St. Peter's in Rome.

Prefabricated polyurethane sandwich sheets have long since become firmly established in the construction market. It has been calculated that the fuel oil saved in a single year by foam insulating materials with a plastic base exceeds the quantity of oil needed for the entire plastic production.

It was not only rigid polyurethane foams that experienced a rapid upswing in the 1960s. Flexible polyurethane materials suddenly became popular



Polyurethane foam has excellent insulating properties. Without its help in refrigeration units, it would be virtually impossible to supply today's modern supermarkets with exotic foods from all parts of the world. Goods can be kept fresh and protected from spoiling only when

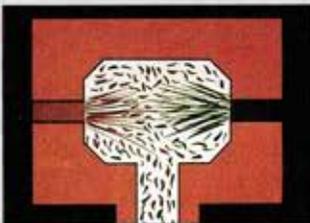
temperatures in refrigerators and freezers can be maintained at a stable level. This applies not only to free-standing units but also to entire containers (above), which are fitted with polyurethane foams for transportation over very long distances.

**New technology for molded parts
made from polyurethane foam**

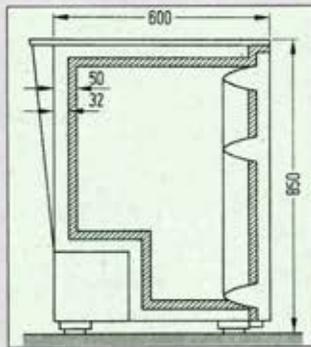
The first foaming machines to be developed were only able to turn out foam blocks, from which complicated shapes subsequently had to be cut. This led to a great deal of waste.

For the mass production of such molded-foam parts as seats, a metering device was constructed for the waste-free injection of the foaming substance into hollow cavities. The former mixing head, with its internal stirrer, was replaced by a new unit. With this construction, polyol and polyisocyanate components are injected under pressure of up to 300 bar into tiny mixing chambers. The exact amounts of the components are gauged by quick-action stop valves that feed in countercurrent directions. After immediate and intensive mixing, the compound is expelled through an outlet into the mold. After this "shot," the mixing chamber is cleaned with compressed air or a pestle.

This principle, which was developed by Maschinenfabrik Hennecke, has since been subjected to numerous variations. The following diagram shows the construction of a mixing head:



This fully automatic processing system has, among other things, enabled the mass production of polyurethane insulating elements for refrigerators:

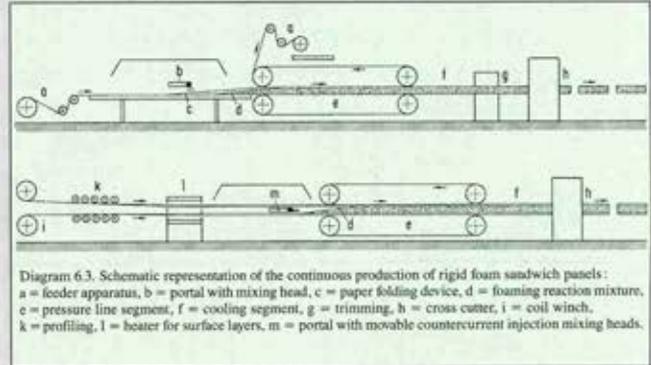


It allows not only form molding, but also the application of foam onto given surfaces, as in the manufacture of the foam igloos mentioned in the main text. Even more important is the now widely used heat insulation system for flat roofs:



The combination of the block-foaming principle with the injection mixing head

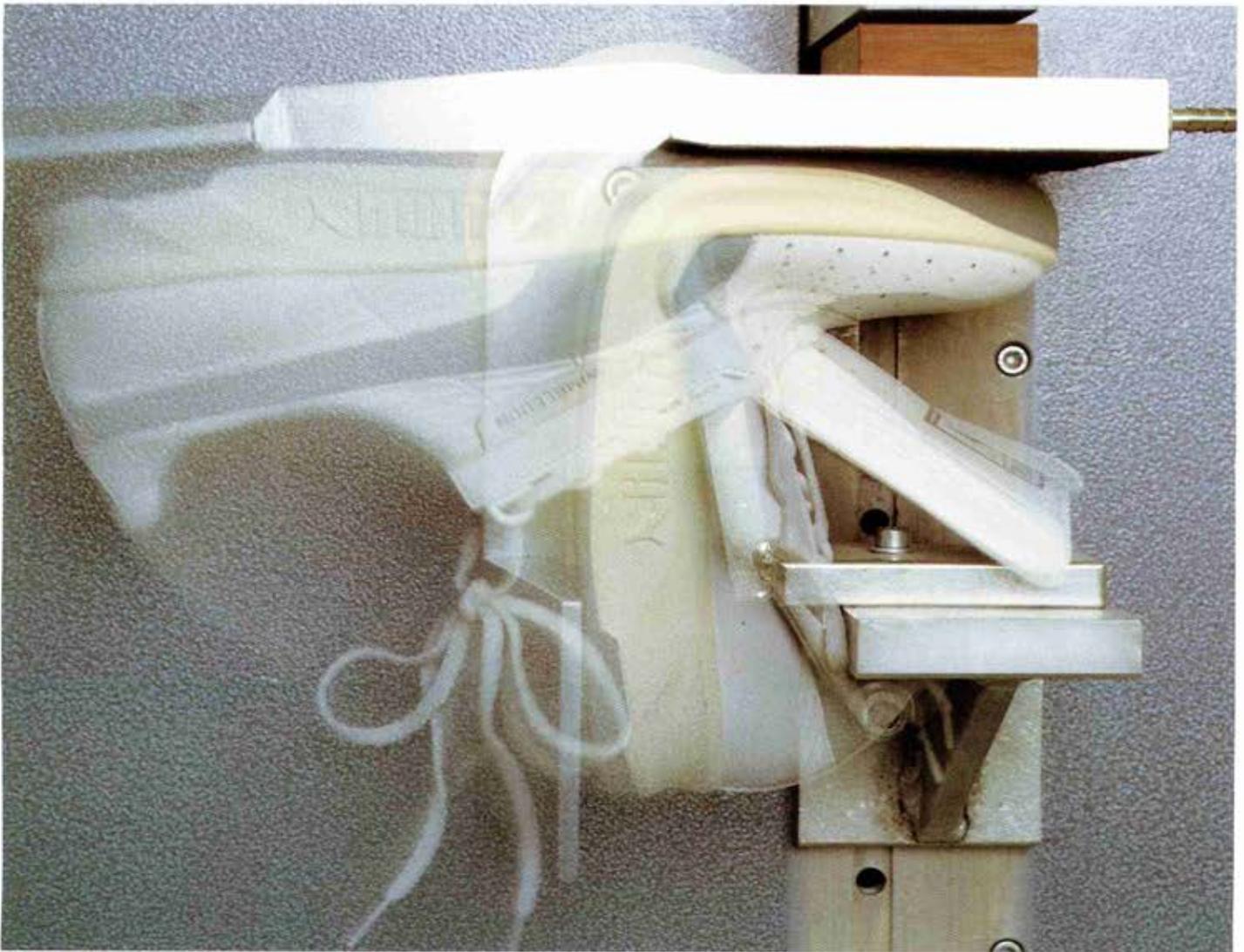
permits the continuous production of sandwich elements:



This method can be used in the manufacture of insulating boards with a paper surface

layer or even of entire industrial wall units with coated steel sheets:





for shoe soles. It all began in the postwar era, when Bayer workers sprayed the soles of their worn-out shoes with polyurethane. This makeshift repair job initially earned no more than a smile or two from colleagues; the material was far too expensive for large-scale use in industrial sole production.

A change in fashion tipped the scale. Around 1968, a new style was introduced; the so-called wedge shoes, with a heel several centimeters thick made of wood or cork. The trouble was that wood is heavy and cork wears down easily. Bayflex, the integral foam that had just been developed by Bayer, had neither of these disadvantages and allowed single-stage manufacture of the foam base and an abrasion-proof outer layer.

Although "wedgies" soon went out of fashion, the shoe producers had become familiar with the new material. Working with their own polyurethane foam injection machines, they started to apply polyurethane directly to the upper part of the shoe

in 1976. The days of twine, nails and glue were finally over; Bayflex and leather or other upper materials were able to be bonded into a durable whole. Thanks to polyurethanes, the soles of sports and leisure shoes are now more flexible, weigh only half as much as before and are twice as resistant to abrasion.

Polyurethanes have become a major group of engineering materials whose importance continues to grow. Together with other Bayer plastics, they are used in a wide range of applications: in furniture and mattresses, packaging materials and containers, as housings for televisions and computers, in plumbing installations, for skis and other sporting equipment, as coatings for pavement, gymnasium floors and sports grounds and even in works of art. Their most significant use, however, has been in the automobile industry, which will be the subject of a later chapter.

A sports shoe whose foam sole has been directly applied by injection molding is being subjected to tough physical testing in Bayer's polyurethane pilot plant. Testing until destruction by constant extreme movements such as those shown above provide necessary data for experts

in the shoe manufacturing industry and at Bayer—and helps them develop even more durable materials.

Synthetic rubber — a product with a future

In 1962, Bayer introduced a range of rubberlike elastomers to the market. This group of thermoplastics was sold under the trade name of Desmopan. Other developments also pointed to greater progress in rubber technology.

In the immediate postwar period, there was no production of synthetic rubber in Germany because it had been forbidden by the occupying powers. This ban was not lifted until 1951, when resumption of output was permitted at a monthly level of 500 metric tons.

Today, synthetic rubber is used throughout industry. The automotive industry is the biggest customer; tire production alone accounts for more than half of total consumption of synthetic rubber. Apart from tires, an average car has about 500 different elastic components made of rubber products. But rubber is found in a wide range of other industrial applications, too.

This was far from being the case in the early 1950s. The economy was still recovering from the war and just starting to expand. There was a growing demand for elastic materials with all kinds of different properties. As an important supplier of raw materials, Bayer tried to keep up with the new demand. In order to be able to compete on an international scale once the domestic economy had stabilized, existing Buna types had to be made available again in substantial amounts.

The successor companies of I.G. Farben initially chose to form a joint venture in this field. In 1956, Bunawerke Hüls (BWH) was set up on a 36-acre site in Marl, near the town of Recklinghausen. Its four parent companies were Chemische Werke Hüls AG, Bayer, BASF and Hoechst. At the time of its founding, BWH was the biggest and most modern synthetic rubber plant in Europe.

As a consequence of structural adjustments, BASF decided to leave the joint venture in 1968, and Hoechst followed two years later. The result was that Bayer ended up having a 50-percent stake in Bunawerke Hüls. Today, the Marl plant has an annual capacity of 180,000 metric tons of styrene-butadiene rubber, which is much more than the whole of I.G. Farben had manufactured at the peak of its rubber production. Together with other types of synthetic rubber, the company's overall capacity amounts to 275,000 metric tons per year.



Bayer resumed production of the nitrile rubber Perbunan N as early as 1952 and was able to build up business rapidly in this sector thanks to the development of markedly improved new types of rubber.

Cars not only needed tires, but also gasoline and oil. Natural rubber and conventional types of synthetic rubber were not resistant against either of these materials; they swelled or even disintegrated after exposure. For this reason, Perbunan N, with its high degree of resistance to swelling, soon established a foothold in the market—and not only in the automobile industry. This type of synthetic rubber is used in those applications where the two formerly incompatible materials, rubber and oil, come into contact, for example, in tubes used in oil and motorfuel pipes, in conveyor belts for products containing fat, such as fatty foods, and in many more applications.

Bayer's sales program was expanded by improving on the polychlorophrene rubber that Du Pont had developed. The range was introduced under the trade name of Perbunan C (later to be changed to Baypren) in 1957. This type, too, is intended for special applications. Its high resistance to weathering and

ozone, combined with excellent aging properties and low flammability, has made polychlorophrene rubber an ideal material for heavy-duty applications. Some examples are hydraulic tubing in bulldozers, anticorrosive protective linings, conveyor belts above and below ground and cable covers. Special types of Baypren are used in large quantities as an adhesive base.

With these products, it was possible to fulfill a large number of the customers' wishes, but not all of them. Further progress still had to be made in the field of polymer chemistry and the raw material base had to be improved in order to meet the sophisticated demands made on rubber products. Two main developments made the difference.

The first was the shift from coal to mineral oil as the major feedstock for the chemical industry. For the plastics and rubber sectors in particular, this opened up a wide new range of raw materials. Ethylene, propylene, butadiene and other olefins now became low-cost starting products.

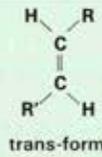
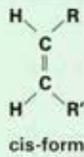
Advances in catalyst research were at least as important. New perspectives were provided in particular by the work of Karl Ziegler, chemistry

Standardized samples are pressed out of unvulcanized crude rubber compounds dyed in different colors. They are then passed on to a test laboratory, which examines composition, properties and homogeneity of the mixture.

New polymers in the rubber sector

Stereorubber (Buna CB): Natural rubber and classic synthetic rubber types all retain C = C double bonds that serve as a base for the vulcanization process. However, compounds with the

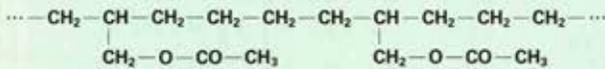
general formula R-CH = CH-R' can occur in two forms, since the double bond prevents free rotation between the two C atoms:



Natural rubber is cis-polyisoprene. In polymerization processes already mentioned in this book, the cis- and trans-forms occur at random. Use of Ziegler-Natta catalysts, particularly aluminum trialkyls, permits

the controlled production of cis-polybutadiene, the so-called stereorubber.

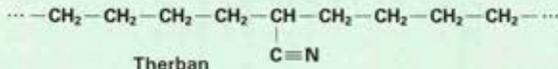
The Levaprene program consists of copolymers made from ethylene and vinyl acetate:



Levapren

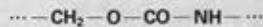
In cross-linking, the hydrogen atom at the branch points reacts with the peroxide. The resultant "radical" can join up with corresponding points in the neighbor-

ing molecule via the so-called carbon bridge. Therban is selectively hydrogenated nitrile rubber:



Therban

Polyurethane elastomers such as Desmopan incorporate several urethane groups in the chain, as already explained on page 328.

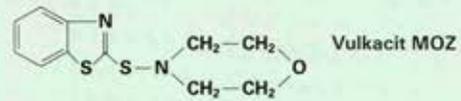


These thermoplastic elastomers can be made into a viscous molten mass by heating and then can be pressed through jets or can be injection molded.

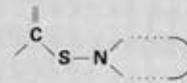
In the course of cooling, they retain their intended form.

Only three of the various kinds of rubber chemicals are presented here:

Vulkacit MOZ is a vulcanizing agent.

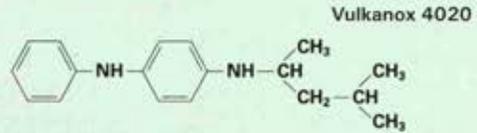


The left heterocyclic ring system is a benzothiazole nucleus. The grouping



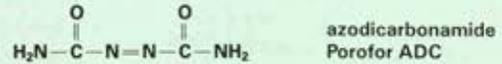
is a sulfenamide deriving

from the sulfenic acids, R-S-OH, which are unstable in free forms. This class of compounds was discovered by Bayer as vulcanizing agents. Vulkanox 4020 is an aging inhibitor:



Porofor ADC (azodicarbonamide) is a blowing agent that splits off nitrogen and

which is used in the manufacture of porous rubber goods:



The ingredients of the batches of the various synthetic rubber mixtures are combined in exact volumes, as shown on the right, before the batches are fed into the kneader.

professor and head of the Max Planck Institute for Carbon Research in Mülheim on the Ruhr, and Giulio Natta, a professor at Milan's Polytechnic. Using special catalysts and relatively "gentle" reaction conditions, it was possible to manufacture products with very unique technical properties. The two researchers received the Nobel Prize for their discoveries.

Important innovations in the synthetic rubber industry followed these discoveries. Thus, the polymerization of butadiene without styrene, which as the so-called "numbers Buna" had been less than successful thirty years earlier, now posed no problem. Furthermore, the use of the new catalysts allowed decisive improvements in the properties of butadiene rubber. The spatial structure of the resultant polymer chains gave these new types the name stereorubber. This product has been in production in Dormagen and Hüls since the mid sixties. Another unit has since been opened at Port-Jérôme in France. While production is under the supervision of Bunawerke Hüls, the product itself is marketed by Bayer under the trade name of Buna CB.

The most important characteristic of Buna CB, which is attributed to its special structure, is its excellent abrasion resistance. This property makes it particularly interesting for use in the tread of automobile tires, especially since it also shows good aging qualities and high elasticity, even at low temperatures.

A totally different form of elastomers came into being when it was discovered that conventional sulfur vulcanization could be replaced by other cross-linking processes. The first product in this category was presented by Bayer in 1961. With the trade name of Levapren, this class of rubber was easy to process and to cross-link either with peroxide or by ultraviolet treatment. Its mechanical properties, in addition to excellent resistance to weather corrosion, ozone and hot air, have made it a particularly important engineering material for use in such products as flame- and corrosion-resistant cable sheathing.

The rubber industry had long wanted to reduce the number of complicated processes involved in production. The development of "thermoplastic rubber" has made compounding and vulcanization superfluous for a whole range of special applications.

In 1962, Bayer introduced an interesting program of thermoplastically processable elastomers that were put to use in many applications to fill the gap between hard plastics and rubberlike materials. These so-called Desmopan types have an unusual chemical base for the rubber industry: polyurethanes. They are yet another example of the remarkable versatility of modern polyurethane technology. In the 50 years since their discovery, polyurethanes have firmly established themselves in almost all imaginable areas of application.

The hardness and flexibility of Desmopan products can be adjusted within a wide spectrum, and they can retain their stability over a vast range of temperatures. The resultant materials are found in all kinds of applications from small injection-molded products such as rollers, housings or hammers right up to such weather-resistant consumer goods as sports shoes or ski boots.

A completely different chemical basis for a new polymer range offers a sophisticated answer to the problem of how to combine the processing ability of thermoplastics with the properties of rubber, but without cross-linking. In this program, terpolymers are embedded like microscopic islands of rubber in a surrounding polyethylene substrate. When exposed to heat the exterior melts, which permits subsequent processing similar to that of thermoplastics. The rubberlike character of the interior reemerges as the mass cools and solidifies. Bayer bought the rights to use the corresponding patents from Uniroyal Inc., Middlebury, Connecticut, in the 1970s. With the help of Bayer's own patented developments, the substance has since been marketed as the Levaflex range. For this relatively young product, the company expects growing use in the manufacture of elastic hoses, foils, seals, profiles and other molded technical parts.





There have also been further developments in the field of "classic" synthetic rubber. In the late seventies, new materials were discovered through the hydrogenation of nitrile rubber. They showed excellent resistance to oil at high and low temperatures, as well as good resistance to wear and tear. Marketed under the name of Therban since 1984, they have sold well despite their considerably high price. The product has proved itself particularly well in applications subject to extremely arduous conditions, such as those in and around automotive engines or in the especially difficult conditions of oilfield production.

All of these new polymers within the field of synthetic rubber are products designed for applications that require very specific properties. This highly complex development work needed to produce these sophisticated qualities is reflected in their price. They are not intended to compete with time-tested natural rubber or SBR rubber, used primarily for tire production.

As far as its construction and its chemistry are concerned, a simple tire is, in technical terms, a work of art. To guarantee optimum safety to drivers

and their passengers, even under the toughest driving conditions, a whole range of different types of rubber, textile fabrics and steel cord has been combined to give a high-performance composite material. Every one of these complicated rubber mixtures incorporates not only natural and synthetic rubber, but also carefully dosed fillers and auxiliary chemicals. Without these chemicals even the best rubber could not develop its qualities to the best extent possible.

Bayer recognized the importance of these auxiliary products long ago and assigned the same priority to the development of a comprehensive range of rubber chemicals as that given to the synthesis of new polymers. Its first anti-aging agent for rubber appeared as early as 1908; today, the company's assortment of rubber chemicals includes some 150 different products.

Some 80 years separate the development of the first methyl rubber from Bayer's present Rubber Business Group with its polymers, latices, adhesive bases and rubber chemicals. And despite many a setback, development has been remarkably successful over this time span.

Tires for vehicles are also subjected to tests and careful scrutiny in the rubber pilot unit. Above, a durometer is being used to check the tread of a tire, whose cross section can be seen on the right.

In retrospect, there have been three phases of development. The first, which lasted from about the start of the century to the years after World War I, was an era of ambitious basic research aimed at identifying the structure of an interesting natural material and producing a synthetic copy. This trend was accompanied by the attempt to become economically independent of the risks involved with importing natural rubber.

The second phase, which spanned from the late 1920s until the end of the Second World War, saw the breakthrough of technically advanced products and their manufacture on an industrial scale. But the main goal remained the replacement of natural rubber. It is interesting to note that both of these first two phases, and in particular the second, were decisively influenced by the political circumstances of the times.

Such influences do not play a role in the current, third phase of development. Despite the countless types of synthetic rubber that have been invented, producers are no longer preoccupied with the goal of replacing the natural product. On the contrary, with the help of natural rubber the range of applications can be further extended. This is one reason for the great success and the excellent prospects for synthetic rubber.

Bayer has gained an excellent position on the world market for synthetic rubber not only because of its long history of intensive research, but also through the wide diversity of its products and its immense reservoir of experience and know-how.

Bayer chronicle 1962

New subsidiaries Bayer Thailand, Bayer Yakuhin (Japan), Bayer Philippines Ltd. and Bayer Pharmaceuticals (Australia) are formed.

Bayer buys the Laacherhof estate near Monheim for use as an agrochemicals testing station.

Pharmaceuticals Department introduces the semisynthetic penicillins Baycillin, Stapenor and Binotal to the market.

Bayer develops a technology to reduce the leather tanning process from several weeks to a few days or even hours.

Drugofa markets its artificial sweetener natreen.



Preventol K₁ is introduced to combat bacteria und fungi in plastics.

The improved version of the Agfacolor CT 18 first produced in 1956 is to be the most successful Agfa color film for many years to come.

Bayer's own comprehensive old-age pension scheme is established.

World events 1962

On February 20, the first American astronaut, John H. Glenn, orbits the Earth in the spacecraft called "Friendship 7" in four hours and 56 minutes.



The U.S. news satellite "Telstar" permits intercontinental television broadcasts.

Ludwig Erhard, Federal German Minister for Economic Affairs, warns employers and unions to "observe moderation" and thus ward off an overheating of the economy.

The Cuban Crisis almost leads to war. The Soviet Union installs missile bases in Cuba, and President Kennedy demands their removal. At the last minute, Khrushchev relents on October 22.

World production of synthetic fibers exceeds one million metric tons.

Bayer's centennial marks a century of progress

The Bayer cross above the Leverkusen plant gave the signal for the company's centennial celebrations. In addition to the letters B-A-Y-E-R, the dates 1863 and 1963 had been mounted on the illuminated landmark. For the first time on the evening of July 31, 1963, the years alternately shone out alongside the familiar trademark.

On the following morning, flags flew in front of the new high-rise office building, along the Kaiser-Wilhelm-Allee and on both sides of the road leading to the Cologne exhibition center, where prominent guests from politics, business and science were to participate in the celebration. The town of Leverkusen had hoisted flags as well—to celebrate its 100,000th inhabitant.

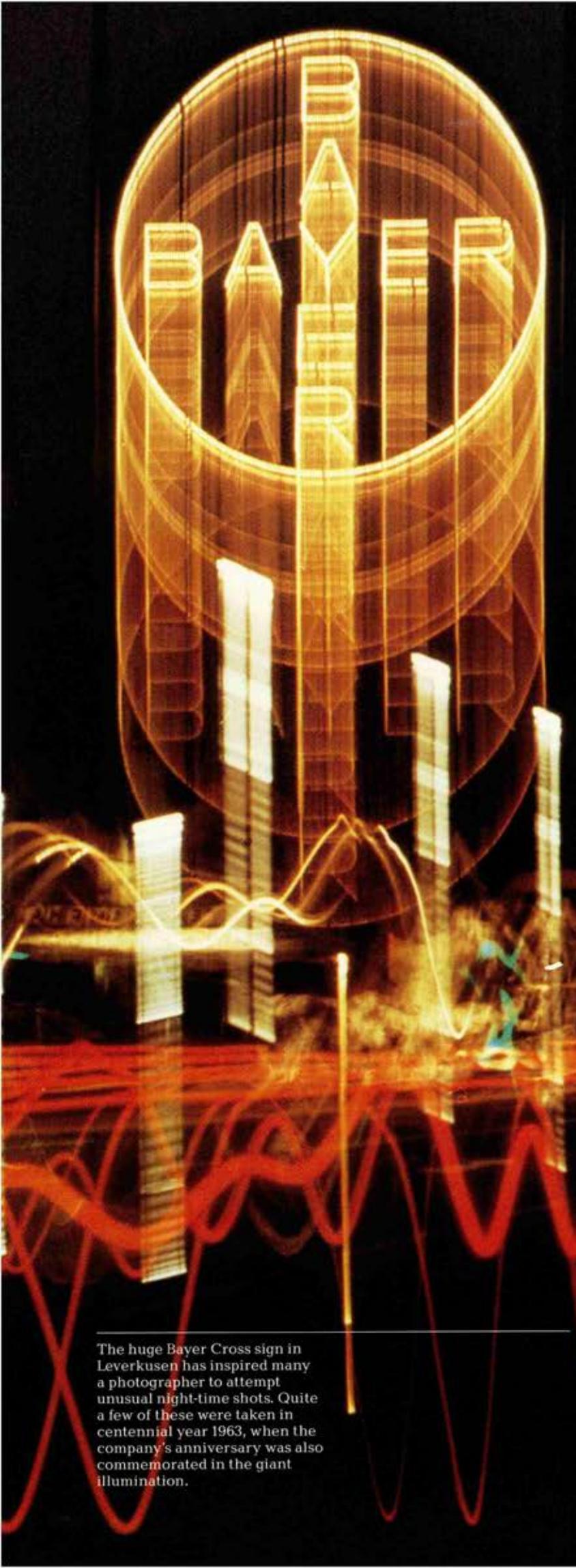
"It is far from being a matter of course that a company survives a hundred years. Considering the century of economic and political crises, it is a genuine accomplishment when, at the end of the road, the company can count itself among the leading firms in the world—in size, in its performance and in its reputation," wrote Kurt Hansen, Chairman of the Board at the time of the centennial, in the preface of the publication entitled "Contributions to a Hundred Years of Company History." This collection of articles outlined the development of the various areas of Bayer's activities over the years.

Although the firm still bore the name *Farbenfabriken Bayer AG*, it was far from being just a dye-stuffs producer. Its production program now spanned almost all organic and inorganic chemistry, and included many product groups that the founders could not even have dreamed of in 1863.

In 1963, this program included 8,500 different products: some 3,500 dyestuffs and related chemicals; 2,500 chemicals, synthetic rubber products, plastics and polyurethane raw materials; 700 pharmaceutical, dental and veterinary products; seven fibers; 130 agrochemicals and 1,620 Agfa products. There were more than 40,000 domestic and foreign patents as well as some 2,000 registered trademarks.

Bayer and its subsidiaries employed some 61,500 people in Germany. If the 11,000 employees in the 439 sales offices in 152 countries and a further 5,500 in the 29 foreign subsidiaries and affiliated companies are included, Bayer had some 78,000 people on the payroll worldwide. Bayer and its 100-percent subsidiaries achieved total sales of DM 3.27 billion; exports to more than 150 countries accounted for 46 percent of this figure.





The huge Bayer Cross sign in Leverkusen has inspired many a photographer to attempt unusual night-time shots. Quite a few of these were taken in centennial year 1963, when the company's anniversary was also commemorated in the giant illumination.

Bayer chronicle

1963

High-rise administration building is inaugurated in this centennial year. It has 31 stories above the ground floor



and three basement-levels, is 400 feet high, has interior space of about 5 million cubic feet and workplaces for 1,200 employees.

Training center is opened for scientific and technological professions. At the end of the year, Bayer has a total of 2,028 trainees.

A new auditorium is added to the Main Scientific Laboratory. A medical-mycological laboratory is opened at the Institute for Chemotherapy in Elberfeld. In Leverkusen a SO₂ measurement network is installed with computer processing of recorded data.

Bayer Dyestuffs Ltd. is reestablished in Sale, near Manchester, as are Bayer Nederland N.V. in Arnhem and Agfa Australia.

World events

1963

President Charles de Gaulle and Chancellor Konrad Adenauer sign the "Elysée treaties" in Paris on January 22. They are aimed at guaranteeing friendly cooperation between France and the Federal Republic.

On June 16, cosmonaut Valentina Tereshkova of the Soviet Union becomes the first woman in space.

Led by Martin Luther King, 200,000 Americans demonstrating for civil rights take part in the "March on Washington."

President John F. Kennedy visits the Federal Republic of Germany in June. In front of the Schöneberg City Hall in West Berlin, he declares: "Ich bin ein Berliner."



Chancellor Adenauer resigns on October 16, handing over the reins to Ludwig Erhard, the "Father of the Economic Miracle."

On November 22, John F. Kennedy is assassinated in Dallas. Vice President Lyndon B. Johnson succeeds him as the 36th U.S. president.

Double-contact process helps to clean the air

Bayer scientists and technical staff worked ten years and the pilot plant was in operation three years before the world's first double-contact sulfuric acid unit could be opened for large-scale production in Leverkusen in 1964.

Today, the air in Leverkusen contains less SO₂ than many cities which do not have a local chemical industry. Sulfuric acid producers around the world have also adopted Bayer's double-contact process, which is now considered the international technical standard.

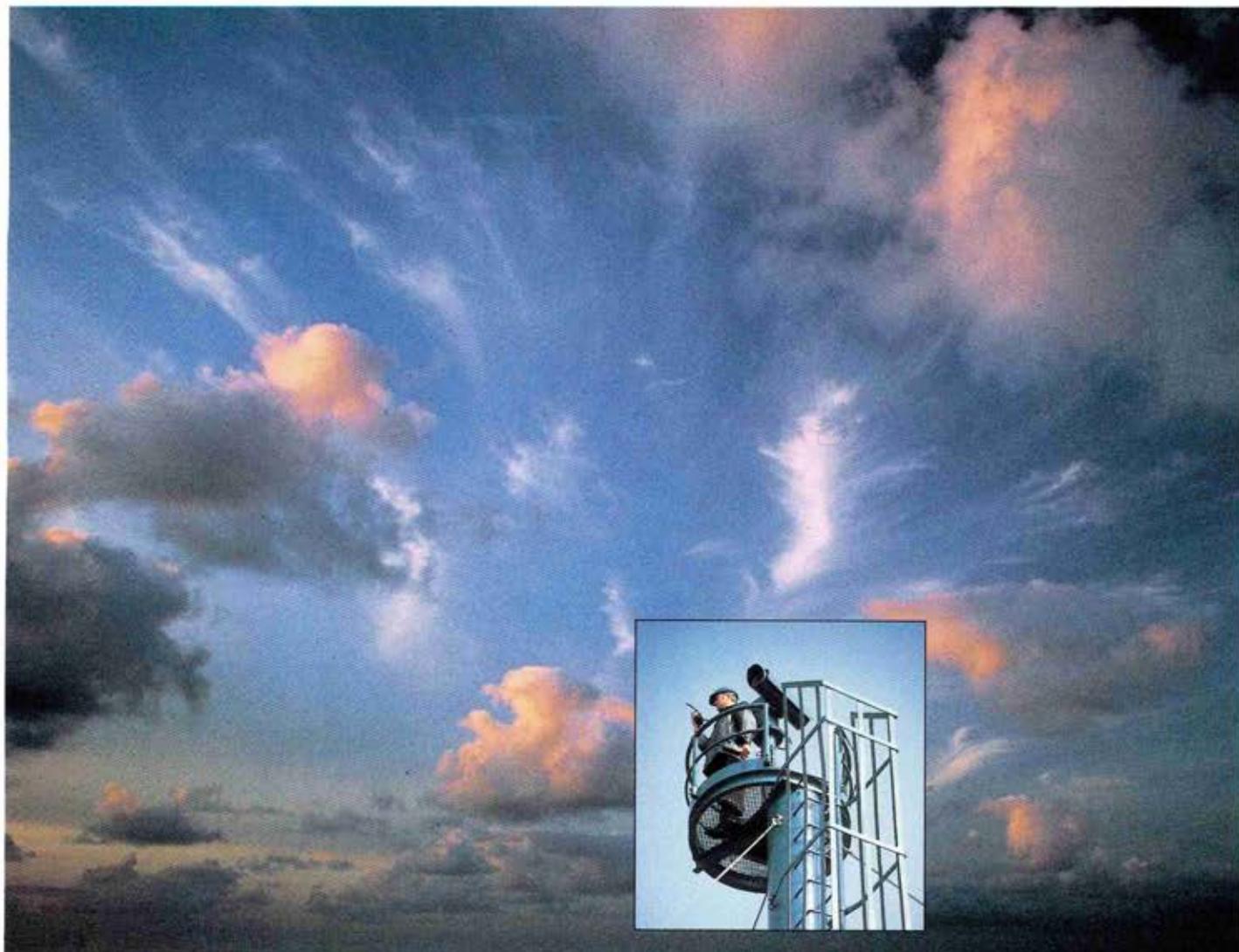
Sulfuric acid continues to be a key product in the chemical industry. World production currently runs at some 145 million metric tons. In the Federal Republic, 3.7 million metric tons were produced in 1986, almost one million tons of which came from Bayer alone. The Bayer Group has a total annual sulfuric acid output worldwide of some 1.8 million metric tons.

All production processes start off by making sulfur dioxide, which is then oxidized to yield sulfur trioxide. This is subsequently combined with water to give sulfuric acid. The oxidation of the sulfur dioxide takes place "in contact" with a catalyst, hence the name "contact." Depending on the construction of the plants, only about 97–98 percent of the sulfur dioxide reacts; the remaining two to three percent escapes with the waste gas into the atmosphere.

Scientists and technicians had been searching for a new method of production since the 1950s. The answer finally lay in Bayer's double-contact process, which was first put into operation ten years before the Federal German authorities introduced their comprehensive clean air legislation. This step was one of the earliest examples of the company's policy to combine environmental concerns with economic efficiency. In the patent registration of 1960, Bayer suggests this process as a means to achieve higher yields, but also as an answer to "the demand to keep air clean."

In the double-contact process, the sulfur dioxide is "in contact" with the catalyst twice. This was a costly step in technical terms because it involved putting the small remaining amount of SO₂ through





a secondary oxidation and extracting the newly formed SO_3 from the reaction gases as economically as possible. The success of the new process has meant that at least 99.6 percent of the sulfur dioxide can be converted, thus reducing its presence in waste gases to only one-tenth of the former level which resulted from single contact processes. Sulfuric acid production is now responsible for less than 0.3 percent of all of the SO_2 emissions in the Federal Republic of Germany.

Few major chemical plants are so closely linked to their home towns as Bayer is with Leverkusen. And it is no exaggeration to say that there is no other town with as stringent an air quality control as Leverkusen.

An air control center supervises seven measuring stations, whose "feelers" feed some half a million data a year into the computer. A television camera records the visible emissions, while a van that measures the contents of the air moves around the

area to obtain local readings. Since even the most sensitive apparatus cannot detect all smells, human "sniffers" ride around on bicycles, reporting back to the air control center by radio.

The results of all these efforts, which have also been confirmed by the TEMES emission-control network of the North Rhine-Westphalian pollution-control authority, show that on average, Leverkusen air contains only some 46 micrograms of sulfur dioxide per cubic meter.

TEMES has drawn up a table comparing emission rates for sulfur dioxide in various parts of the state. An average reading of 42 micrograms for Leverkusen in 1984 compared with 86 in Bottrop, 80 in Castrop-Rauxel, 76 in Moers, 74 in Gelsenkirchen and 72 in Lünen. Outside North Rhine-Westphalia, the average content is put at 58 (60 for Frankfurt and Hof). Among the German large cities, only Munich can claim to be better off with its reading of a modest 20 micrograms.

Double-contact technology in sulfuric acid production, carried out in units like the one shown on the left, may be complicated, but it is nonetheless worthwhile because it reduces the level of sulfur dioxide emissions to less than 0.3 percent. Sophisticated control systems, among them

the television camera in Leverkusen seen in the inset, not only monitor sulfur dioxide emissions, but also register any other foreign substances found in the air.

A Japanese shrine dedicated to E 605

Memorials are usually set up to honor a famous personage or a battle; very rarely are they meant to commemorate an insect or a chemical. There are two such monuments in the world, and they are inseparable with the history of agrochemicals at Bayer.

In the South of the United States, a statue of the notorious boll weevil stands in Alabama. Thousands of miles away in the Japanese province of Kagawa, a Shinto priest dedicated a memorial to E 605 in 1964. This revolutionary insecticide had saved the rice crop from the stemborer.

Rice is the staple food of the Japanese. From time immemorial, this crop has been threatened by the insect pests whose larvae hollow out its stems, which are then unable to bear the ripening panicles. Statistics show that about one-half of the entire harvest used to fall victim to the stemborer every other year.

In the early 1950s, tests with Bayer's new phosphoric acid ester insecticide E 605 showed a remarkable effect against these pests. When Japan seemed to be heading for a disastrous crop in 1953, the first "air-lift" in the history of agricultural chemicals was organized to rush in E 605 from Germany. From then on, the country's rice production yields started to show a steady increase. Once dependent on rice imports, Japan now produces top-quality crops and has become a rice exporting country. The E 605 monument in Zentsuji commemorates this turn in the fortune of the millenia-old rice cultivation in Japan.

The statue in Alabama goes back much further than the discovery of E 605, but there is an indirect connection. The history of this memorial goes back to the final decade of the 19th century, when the boll weevil migrated to the cotton fields of the South in the United States from Mexico. The catastrophic results are described in a publication of the Smithsonian Institute as follows:

"The damage done by the boll weevil on its uninterrupted trek through the Cotton Belt threatened to end cotton growing completely. To comprehend the chaos that the boll weevil caused, one must keep in mind that Southern agriculture and industry almost completely depended on cotton. And in the first years of infestation, between a third and a half of the entire crop was destroyed in infected areas. Farmers, merchants and bankers were ruined; whole villages

What do cotton plantations like the one pictured at the top of the next page have to do with rice fields? The answer is the Bayer insecticide Folidol M, a derivative of the famous E 605. This crop protection product was used successfully to counter both the boll weevil in the U.S. and the stemborer in Japan.

and farms were desolated. Sharecroppers despaired and moved on.

"The boll weevil left a wake of panic and fear in its path. It was made the subject of innumerable poems and folk songs; the 'Ballad of the Boll Weevil,' a popular Negro song of the 1890s, is considered to be an early example of the black blues. The name and reputation of the boll weevil were known to everyone, and no home was free from its influence."

The weevil was a serious threat to every farm where cotton was cultivated—until 1952. In that year, experiments with Folidol M, a methyl compound of E 605, proved so successful that the head of the field-test team sent a rather macabre sounding telegram to Leverkusen from Mexico saying, *"Folidol es la bomba atomica contro el picudo"* ("Folidol is the atomic bomb to counter the boll weevil"). The new product became the basis for Bayer's crop protection operations in the New World.

Both the monuments, located in two completely different parts of the world, have to do with insect pests which had once devastated whole regions of the earth. And in both cases, the problem was solved by an insecticide based on a new class of active agents: phosphoric acid esters.

At the beginning of the thirties, chemist Gerhard Schrader was given the job of finding insecticides based on new active ingredients. As a result of this work, a theory was formulated in 1937 in which phosphoric acid esters were singled out as a class which might lead to effective insecticides.

The first marketable product, a pyrophosphoric acid tetraethyl-ester, emerged from the company's research laboratories in 1942 and was sold under the trade name of Bladan.



This product was, however, not a very stable compound and proved highly toxic. In a slightly modified form, it was offered as the fumigant Bladafum for use in greenhouses and was

the first partial success for this class of products.

The real breakthrough did not come until 1944. That fall, the substances E 600 and E 605 were obtained by a systematic alteration of the basic molecule. These names are obviously in no way indicative of their chemical composition; they are simply index numbers recorded in the laboratory journal.

Under the trademark Mintacol, E 600 was only used for a short time in ophthalmology. The phosphoric acid ester E 605, however, was the basis for a whole group of chemical substances to be applied in the fight against insect pests and thus played a key role in the upswing of Bayer's agrochemical operations after World War II. The new development came at a time when, as a result of the war, food supplies and consequently crop protection were of prime importance.

Phosphoric acid esters unfortunately also played a role in the history of chemical warfare. During the German government's rearmament program in the 1930s, the military command in Berlin-Spandau that was responsible for procuring weapons set about the task of looking for new biological warfare agents. When the army chemists heard that new and highly toxic compounds had been discovered, they were extremely interested.

Two of these compounds, which Elberfeld scientists had found unsuitable for use as agrochemical products because of their high toxicity, were turned into chemical



Agrochemicals based on phosphoric acid esters

Phosphoric acid and its soluble alkali salts are non-toxic. Phosphates are used, for example, in detergent production. Phosphoric acid is vital to the organism and is present in ester bonds with complicated organic molecules. In the form of adenosine triphosphoric acid, it is instrumental for transferring energy within the muscle.

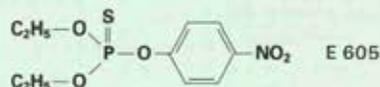
In complete contrast to these functions, certain low-molecular phosphoric acid esters are highly poisonous. The degree of toxicity depends on the nature of the organic substituents and varies from low to extremely high.

Developing an efficacious insecticide for agricultural

use from among the numerous possible compounds meant finding a substance that demonstrated the highest obtainable toxicity toward insect pests and the minimum toxicity toward warm-blooded animals.

Research efforts aimed at an insecticide with a broad range of applications led initially to Bladan (pyrophosphoric acid tetraethyl ester), which proved unsatisfactory in use.

The real breakthrough came in 1944 with the compound 0,0-diethyl-O-(4-nitrophenyl)-thionophosphate, later given the trade name of E 605 or Parathion:

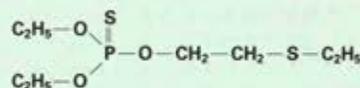


O,O-diethyl-O-(4-nitrophenyl)-thionophosphate

E 605

Systox, the first systemic insecticide, was introduced to the market by Bayer in 1951.

It has the following constitution:

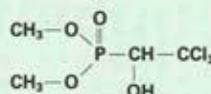


O,O-diethyl-O-(2-ethylthioethyl)-thionophosphate

Systox

In Metasystox, which is less toxic to warm-blooded animals, the two C₂H₅-O groups are replaced by methoxy

radicals (CH₃-O-). Dipterex, whose active agent was synthesized in 1952, has the constitution

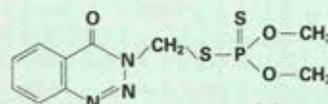


(2,2,2-trichloro-1-hydroxyethyl)-O,O-dimethylphosphonate

Dipterex

Bayer's product Gusathion, which was first tested in field trials in Mexico in 1954,

possesses a much more complicated structure:

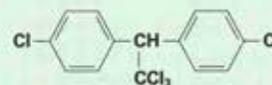


O,O-dimethyl-S-[(3,4-dihydro-4-oxo-1,2,3-benzotriazine-3-yl)methyl]-dithiophosphate

Gusathion

As esters of phosphoric or thiophosphoric acid, all of these substances can be saponified. They disintegrate relatively quickly after they have been applied. In contrast, DDT (dichlorodiphenyl

trichloroethane), which has been in use for many years with great success all over the world, has no such "weak link" in its formula that could be attacked by a hydrolytic process:



DDT

weapons by the Wehrmacht: Tabun and Sarin.

In the end, however, these products were not used in the war.

Almost simultaneously with the research work done in Elberfeld, the Swiss company Geigy based in Basel had determined the insecticidal properties of DDT. Like E 605, it has a wide range of applications and is a contact poison, which means it disturbs the coordination of an insect's nervous system. The major difference lies in the fact that DDT is very stable and thus degrades only very slowly in the environment, while under open land conditions, E 605 soon disintegrates into its chemical components and reenters the natural cycle in non-toxic form. At the same time, however, E 605 has a relatively high acute toxicity, which led to widespread misgivings about the risks involved in its application.

With its much lower level of acute toxicity, DDT seemed preferable at the time, whereby the possibility that DDT could accumulate in the tissue of living organisms and in the environment was not initially seen as particularly serious.

E 605 was, in fact, the first major product resulting from a new class of substances. The work of Schrader and his team aimed at modifying the basic molecule to find active agents that had better overall properties than E 605. The most important goal was the search for substances less toxic to warm-blooded animals.

There was another interesting aspect to their work. In comparison with other widely used insecticides of the day, E 605 had a more penetrating effect because it not only attacked insects on the outside of a given leaf, but it also worked against certain caterpillars underneath the surface of the leaf. This effect sparked off an important research project that called for a cooperation effort between chemical and biological researchers. The result surpassed all expectations.

In 1952, Systox came on the market as the first agrochemical that permitted a kind of internal therapy for the plant world. The active ingredient was absorbed by the plant and distributed by the

circulation of the plant's juices throughout the tissue; this was the first time that a pesticide had been introduced to the plant's own metabolic system. The new group of products consequently was given the name "systemic" insecticides because of its mode of effect.

This principle of crop protection offers numerous advantages. The automatic distribution of the active agents makes it possible to protect all of those parts of the plant that grow after application. In this way, multiple treatment can be avoided, which is obviously advantageous for both ecological and economic reasons.

Scientists also determined that it is possible to combat both pests living in the plant interior and those—such as plant lice—that suck plant juices from the outside. Since this insecticide works inside the plant and not on the surface, it is able to get at the really damaging pests.

Crop protection chemicals based on phosphoric acid esters are the heart of a wide range of agrochemicals that Bayer now offers to the agricultural industry. In the course of time, researchers have been able to reduce the toxicity of these products even further.

In 1954, the company introduced Metasystox as a new and versatile, but less toxic, insecticide. To an increasing extent, specialties in crop protection began to be developed for individual sectors of application. One example of a highly specialized product is Gusathion, which is effective against cotton pests and is used, in particular, as an insecticide in fruit crops. Since the 1950s, Bayer has marketed products for both field and garden applications.

Bayer's crop protection products, which had their beginnings in the 1920s with seed dressings, now had achieved a firm position in the agricultural industry.

Bayer used the above symbol in the 1950s in international advertising for its crop protection products.

Agfa-Gevaert makes more than just pretty pictures

On July 1, 1964, Europe's leading photographic companies — Germany's Agfa AG and Belgium's Gevaert Photo-Producten N.V.— agreed to join forces. This merger was far in advance of the political and economic steps taken by the various national governments to integrate Europe.

Life without photography would be hard to imagine today. Vacation snapshots and press photos are not the only forms of photography that pervade our daily lives. Before printing, texts are set by using photo-composition techniques, and pictures are reproduced photographically. The images are then projected onto a photosensitive surface from which plates for printing can be prepared.

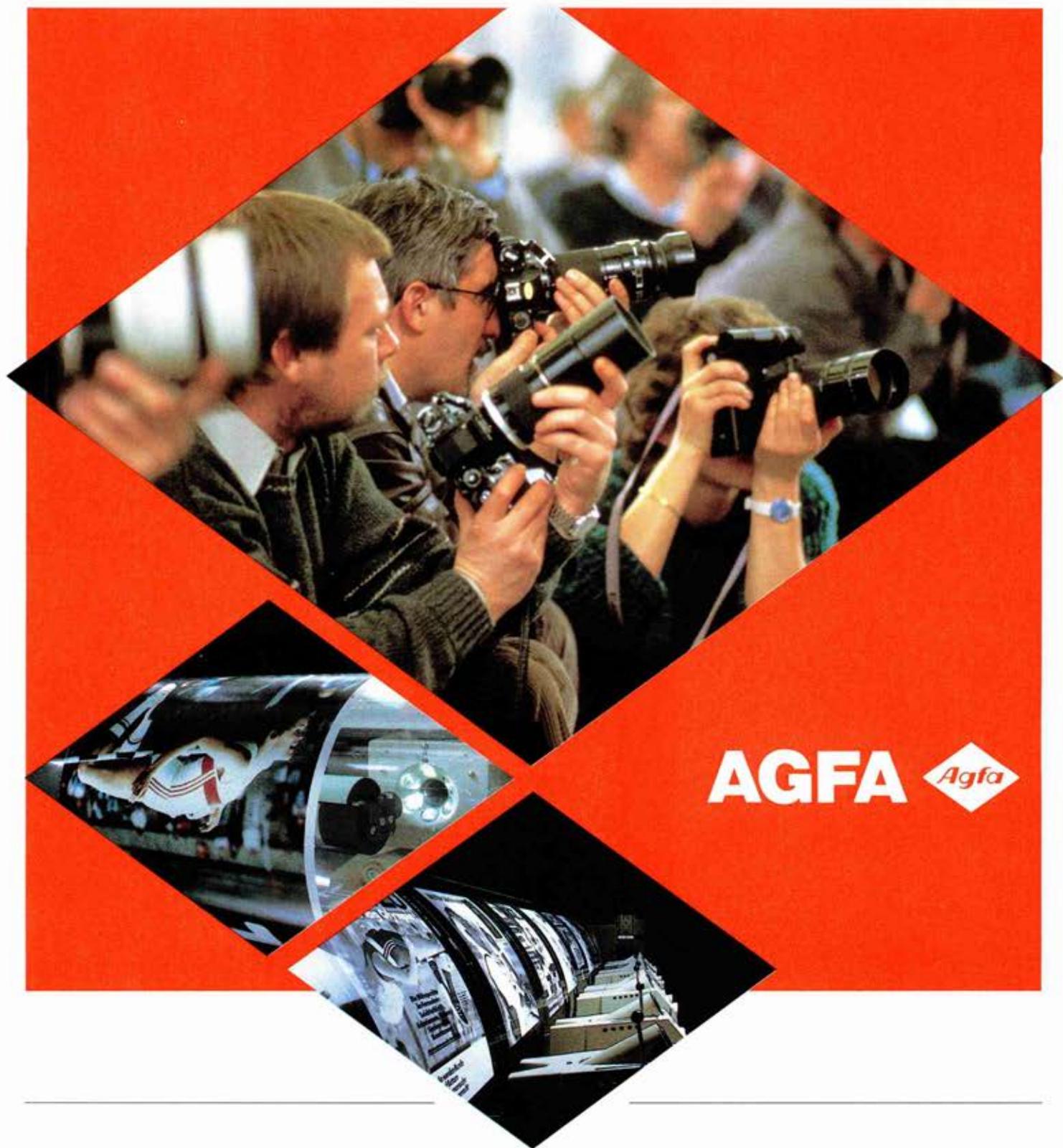
Medical diagnostics would not be complete without X-ray photography, and microelectronics has been made possible by microchips that are produced with the aid of photography. And modern business would be lost without its photocopiers. All of these examples illustrate why Agfa-Gevaert has the slogan, "We make more than pictures."

In 1888, when Agfa set up its photographic division in Berlin, no one could have imagined today's application possibilities. Back then, photographic companies had the job of producing materials for photographers and for the cinematographic industry. It was 1920 before the first X-ray film came on the market; rotogravure and process photography plates were introduced the following year. In 1925, films for the graphics industry were developed. But all of these products remained of more or less marginal interest.

In 1952, "Agfa Aktiengesellschaft für Photofabrikation" was set up in Leverkusen as one of the 12 successor companies of I.G. Farben. Like the Agfa Camerawerk AG in Munich, it became a fully owned subsidiary of Bayer. The two companies were merged into the newly formed Agfa Aktiengesellschaft, Leverkusen, in 1957.

Based in the Belgian city of Antwerp, Gevaert had developed along different lines. Its story began on June 28, 1894. Lieven Gevaert, a 26-year-old porcelain photographer, invented a machine that considerably simplified the manufacture of photographic papers. Instead of immersing the paper sheet by sheet, the machine made a continuous and regular production process possible. After receiving a flood of orders for his machine, Gevaert sought and found business backers. They set up the limited partnership

The name Agfa stands not only for quality photographic materials for amateurs and professional photographers around the world, but also for equipment and materials used for other applications in the photographic field, for example, in the printing industry.



AGFA *Agfa*

L. Gevaert & Cie. and the foundation stone for an international concern had been laid.

The little firm grew quickly. In the first year of its existence, Gevaert extended his business contacts over the border to France, where he proved to be just as successful. The original machine was improved again and again. Gevaert then decided to hire a chemist to look for better emulsions to coat the photographic paper. The resulting "Blue Star" paper became an international hit.

The labor force grew so much that the modest factory soon became too small. The company then bought a five-acre site in nearby Mortsel, where construction of a new plant for the 90 workers began in 1904.

On December 4, 1920, L. Gevaert & Cie. was reestablished as Gevaert Photo-Producten N.V. with capital stock of 15 million Belgian francs. By this time, it was not only manufacturing photographic paper, but also photographic plates and rolls of film, as well as the corresponding chemicals. Shortly after the company changed its name, studio, cinema and X-ray films were added to the sales program. These turned out to be promising ranges, which were then systematically expanded. The company developed into a major supplier of technical and professional products, which accounted for three-quarters of all sales by 1964.

The emphasis at Agfa was just the opposite; the German company had been concentrating on products for the amateur photographer. Since their activities complemented each other, the two European companies were a good match. At the same time, neither firm was big enough to stand up to international competition in the long run. Their biggest competitor, Kodak of the United States, had alone eight times the sales of the two companies combined. The rationale behind the decision to merge was, therefore, quite clear.

A consolidation of the German photographic market under Agfa's leadership preceded the merger. This strategy included Agfa's acquisition of such companies as Perutz Photowerke in Munich and Fotopapierfabrik Mimosa in Kiel.

Both partners, Gevaert Photo-Producten and Bayer as Agfa's parent company, defined the framework of the 1964 merger in the following way.

The amalgamation was to be carried out on the basis of equality and aimed at covering the entire range of entrepreneurial activities in the areas of science, technology, business administration and finance. The targeted coordination of scientific operations was intended to strengthen research potential. The merger would aid the task of streamlining production and marketing, and as a result, the competitive ability of the joint company will be improved.

It was not, in fact, possible to form a single merged organization because there were no common European company laws. But in the end, a solution was found in which the interests of both parties were fairly represented. Two new companies were formed, Gevaert-Agfa N.V. in Mortsel and Agfa-Gevaert AG in Leverkusen, and the two parents, Bayer and Gevaert Photo-Producten, each held 50 percent of the two companies.

The starting position of the new companies looked good. Agfa and Gevaert together had a total of some 28,000 employees and sales equivalent to DM 1.2 billion per year. But the actual organization had its problems from the start. Different legal systems in the Federal Republic and Belgium complicated matters, quite apart from conflicting national interests and a difference in mentality.

During the following years, the operations of the two companies were gradually transferred to a joint organization. André Leysen, who was on the Supervisory Board of the Gevaert Group as a representative of Gevaert Photo-Producten N.V., played a decisive role in this development. In 1979, Leysen was appointed chairman of the boards of management of both companies in the Group. To strengthen the corporate integration, the activities of the two firms were combined under four main business areas in 1980: amateur photography, professional photography, office systems and magnetic tapes.

Unfortunately, things did not develop as had been anticipated. The dramatic rise in silver prices in 1979

Agfa products are used in a wide range of printing and lithographic applications—from orthochromatic film and panchromatic color-extraction materials to automatic developing units and reproduction cameras.

and the early 1980s caused enormous problems for the Group. Silver was used in film emulsions and was therefore a staple for the photographic industry. Between six and ten grams of the metal were needed for one square meter of negative film or up to twenty grams for the same quantity of X-ray film. Agfa-Gevaert was using some 700 metric tons of silver a year at a total cost DM 250 million.

The silver price had initially remained relatively stable until August 1979. Then the price began to rise—first to DM 600 per kilogram, then on to DM 900 in November and in December 1979, it hit DM 1,100 per kilogram. In the first days of 1980, it had shot up to DM 2,750 and reached the DM 3,000 mark by mid January. This meant that the annual cost of silver had rocketed from DM 250 million to no less than DM 2 billion—this in comparison with total sales of DM 3.5 billion. The business year 1979 closed with a loss of DM 120 million.

The silver crisis resulted in an Agfa-Gevaert crisis. For a time the two companies registered losses of as much as DM 50 million per month. The situation became drastic; Agfa-Gevaert urgently needed a great deal of money if it was to keep its head above water. The only way out was to increase capital by some DM 400–500 million.

Of the two parent companies, only Bayer had access to funds of this magnitude. Consequently, the German partner acquired a majority stake in Agfa-Gevaert and in a last effort, the two companies

joined up in 1981 to become the fully owned Bayer subsidiary, Agfa-Gevaert AG. Gevaert Photo-Producten N.V., today known as Gevaert N.V., obtained Bayer stock in exchange for its share of the company.

Another serious problem arose in 1982. Agfa had been a trademark for cameras since 1925. The history of Agfa in this field goes back to 1896, when optician Anton Heinrich Rietzschel founded the "Optical Institute." His first camera, the "Clack 1900," was a big hit. The firm grew steadily, but its financial resources were not sufficient to keep up with expansion. Rietzschel found the ideal partner in Farbenfabriken Bayer, which first acquired an 80-percent holding on March 1, 1921, and the remainder in 1924. A year later, the camera works became part of the I.G. Farben organization. Such legendary cameras as the "Billy" and the "Box" thus bore the Agfa rhombus trademark. Cameras for amateur photographers were made at the Munich plant until the early 1980s. One product that is particularly worth noting was the Agfa "Optima," the world's first camera with fully automatic exposure.

Increasingly, however, Japanese manufacturers flooded the world market with huge numbers of mass produced, cheap, but perfectly good cameras. With its relatively small facilities, the Agfa works in Munich could





not keep up with this pace in the long run. As losses grew, the painful decision was made in 1982 to give up production of amateur cameras and as a result to cut the labor force.

Fortunately, new products and new business activities create new jobs. Since the camera production was ceased, the Munich works and other plants in Bavaria have been concentrating their operations on equipment for such promising fields of professional photography as microfilms, X-ray technology and the printing trade, as well as laboratory apparatus for more conventional photographic applications and film cartridge production.

Right from the beginning, photochemical products were the real basis of today's Agfa-Gevaert Sector. These products have been and continue to be improved and adjusted to meet the new demands of the market. This development is evident for both color film for prints, as well as for black-and-white film for technical uses. For example, many photographic materials in the technical field are now produced for exposure by laser beams.

The photocomposition systems of Agfa's U.S. subsidiary Compugraphic use lasers to "draw" the letters on corresponding films or paper. In the field of medical diagnostics, Agfa has developed systems in which images produced by CAT scanning are transposed onto film by means of electronic rays or laser beams. The Agfa-Gevaert Sector also supplies microfilm systems, graphics systems and equipment that prints electronically with the help of light-emitting diodes. Another important business is electrophotography, which is used in such equipment as photocopying units.

The Greek root for the word "photography" means "written with light." Agfa "writes" with sunlight, with lasers, electronically or electrophotographically. The fundamental strength of today's Agfa-Gevaert is its ability to offer a wide range of different systems that combine sophisticated photochemicals with high-precision, optical elements based on complex modern technology to meet the demands of the many areas of application for photography.

Agfa's successes have not only been in the classic photographic and reprographic sectors but have also extended into many other fields. The company has created and conquered new markets in such areas as medical diagnostics, office communications and—with the recent

takeover of the U.S. firm Compugraphic—photocomposition. The montage of pictures on the left includes a shot of an employee at work in Compugraphic's development labs.

Bayer chronicle 1964

Baygon, a broad-spectrum insecticide against household and hygiene pests, is developed. In the forthcoming years, it is to become one of Bayer's best-known and most successful pesticides.

Morestan comes on the market as a new agent against mildew and mites.

Agrochemicals testing center is opened at Kaha, near Cairo, Egypt.

New large-scale cis-butadiene plant goes on stream in Dormagen.

Sales agencies in Japan, Iran, Argentina, Venezuela and Peru add "Bayer" to their company names.

Plant for the production and packing of pharmaceuticals is opened in Karachi, Pakistan.

Bayer builds a pharmaceuticals plant in Thailand's capital, Bangkok.

World events 1964

Willy Brandt, mayor of West Berlin, is elected chairman of the German Social Democratic Party on February 15, a post he is to retain for 23 years.

The United States starts to play an active role in the Vietnam War.

Nikita Khrushchev is deposed on October 14. His successor as the head of the Soviet Communist Party is Leonid Brezhnev.

In the United Kingdom, Harold Wilson succeeds Sir Alec Douglas-Home as prime minister.

Lyndon B. Johnson is elected president of the United States on November 3. He receives the greatest number of votes ever recorded for a candidate.

The number of foreign workers in the Federal Republic of Germany exceeds the one-million mark.

The 22-year-old American boxer Cassius Clay beats his compatriot Sonny Liston on February 25 to become the new world heavyweight boxing champion.

Bayer Antwerp — a pioneer on the river Schelde

Handling some 90 million tons of goods per year, Antwerp is one of the world's largest ports. Its quays run along the river Schelde from the Dutch border to the northern suburbs of the city. An expanse of unused land stretched between the docks and the river.

At the end of the 1950s, Antwerp's city planners decided to locate a major European industrial center on this site. Immortalized by Peter Paul Rubens, the old city with its splendid squares and spacious houses would retain its character because the development area lay well outside its boundaries. Although the site was still quite rural, its industrial development would indeed help the city and the surrounding region to gain in significance.

A ten-year plan to expand the port and to provide the necessary infrastructure was worked out. The land was to be made available at a favorable price and to include tax breaks. Bayer was the first company of any size to take advantage of this offer; it bought a 445-acre lot with almost two miles of waterfront on the right bank in 1961. On March 16, 1965, the foundation stone was laid for the first production unit. Other firms followed Bayer's pioneering lead, and the city officials' dream of Antwerp's development was destined to come true.

Since space was getting scarce on the Lower Rhine, Bayer's management in Leverkusen had long ago begun looking for an appropriate site to build a new major Bayer plant. The offer from Antwerp could not have come at a better time.

As a matter of fact, it would have been hard to find a more suitable spot. Antwerp is relatively close to the company's main plants on the Rhine and its port was already an important Western European shipping center. No fewer than 100 million people, or almost one-third of the total population of the European Community, live in a radius of 220 miles. The same radius also encompasses major concentrations of Western European industry, including the Ruhr, Rhine, Main and Saar areas of Germany, northern France, Alsace-Lorraine and southern Holland. This vast inland trade region is served by the port of Antwerp.

The city is also one of the most important inland waterway centers in Europe. It lies just short of 200 miles by water route from Leverkusen. Although the land route is barely 125 miles, shipping via waterways is nevertheless much cheaper.



Some 60 percent of all shipments to and from the Bayer works in Antwerp are thus conducted by ocean- or river-going vessels, which is double the share for the company's German plants. The highway network also links up with the docks, and in the course of the road system's expansion, a highway connection was built that leads directly to the Bayer site.

A source of electricity was already available, and water did not pose any problems either; fresh water is supplied by the public utilities and cooling water from the harbor basin.

There was also enough skilled labor in and around the city of Antwerp to insure that the plant would have qualified staff at its disposal. The industrial parks and residential areas were designed and constructed well apart from one another, but the existence of extensive public transport systems prevented this from being a problem. The area also offered all the auxiliary workshop businesses needed to support the new plant's operations.

Bayer did not remain the only chemical company to find a home in the port of Antwerp. Today, there are no fewer than 15 production facilities and subsidiaries of such international firms as BASF, Monsanto and Solvay. Like Bayer, they have benefited from, among other things, the positive attitude toward industrial development of the local authorities, who also have the backing of the political parties. The efficient handling of requests

for operating concessions confirms this unprejudiced approach to industry.

In preparation of the construction of the plant, Bayer Antwerpen N.V. was established as a Belgian subsidiary in 1961. The strategy was to keep the Antwerp operation strictly a production facility; research and sales were to remain the responsibility of the parent company in Germany.

The motivating factors behind the organization of this plant were conceived at a time when Germany, in particular, was reckoning with a rapid development of economic and political unity within the European Economic Community of the 1960s. This optimism was no doubt premature. Whatever the case, Bayer Antwerpen N.V. considered itself to be the "fifth Bayer works," despite its actual status as a legally autonomous company.

Immediately after the foundation stone had been laid in 1965, work began on the construction of a caprolactam unit. Caprolactam is an important raw material for plastics and textile fibers. This unit went on stream in 1967.

A by-product of this production process was ammonium sulfate, which is used as a fertilizer. For its storage, a two-and-a-half-acre hall was soon built on the site.

Production of the key chemical substance sulfuric acid also began in 1967. Several other units were opened in the following years:

The picture above shows ammonium sulfate stacked on the quay of Bayer's Antwerp works on the Schelde. This is a synthetic fertilizer obtained as a by-product from the manufacture of caprolactam, itself an important raw material for plastics and textile fibers.

Bayer Antwerp—a pioneer
on the river Schelde



—The coarse Perlon fiber marketed under the name Dorix and used in carpets and other heavy textiles has been produced since 1968.

—Production of titanium dioxide white pigments began in 1970.

—Together with Shell, Bayer opened a unit in 1972 to make isocyanate components for polyurethane chemicals. The corresponding operating company had been set up under the name of Bayer-Shell-Isocyanates N.V. three years earlier.

Although their site on the right bank of the Schelde was far from full, Bayer prepared for possible future needs by buying an additional 495 acres on the left bank in 1972. The distance from one site to the other is still nearly 19 miles via the Schelde Tunnel at the southern end of the port, but an Autobahn tunnel will join the Bayer plants as of 1991.

In 1973, the first production unit was opened on the left bank site, where rubber chemicals are manufactured. Facilities for fiber glass production followed in 1976 and agrochemicals a year later. At the same time, the original plant was expanded.

Fourteen years after the foundation stone had been laid, the initial phase of development was completed in 1979. Today, Bayer in Antwerp has more than 2,200 employees and annual sales exceeding 20 billion Belgian francs, or about one billion marks.

And expansion will continue. DM 260 million are currently being spent on the construction of two new production units that will broaden Bayer's program of high-performance technical plastics. A polycarbonate plant is to go on stream in Antwerp in 1989, and the production of the starting material for plastics, polyphenylene sulfide, will begin the following year.

The banks of the Schelde today have little in common with the flat, peaceful landscapes in Flemish paintings of times past. But not everything has disappeared. To the north of the Bayer plant and surrounded by other industrial facilities is the little village of Lillo, whose carefully restored houses, ponds and dikes remind 20th-century visitors of 17th-century Flanders.

The BSI plant is on the premises of the Bayer plant in Antwerp. The abbreviation stands for Bayer-Shell-Isocyanates NV, a joint venture of Bayer and the Royal Dutch Shell group. The isocyanates produced here are used in the production of polyurethanes.

Bayer chronicle	1965	World events	1965
<p>A television camera is installed to control air pollution in the Leverkusen plant.</p> <p>Support groups are organized for foreign workers; a wide range of language courses are introduced for employees.</p> <p>A rapid-effect intravenous anaesthetic is introduced to the market under the name of Epontol.</p> <p>Production starts in Uerdingen of Desmodur 44 (MDI), which is used in the manufacture of high-performance polyurethane specialties.</p> <p>The new Novodur P2MC process is developed, which makes the galvanization of plastics with copper, nickel or chromium possible.</p>		<p>Soviet cosmonaut Alexei Leonov is the first man to leave a space capsule when, on March 18, he moves about in space for ten minutes.</p> <p>On June 3, American astronaut Edward White leaves Gemini 4 and spends 20 minutes in space.</p> <p>After an eight-month journey, U.S. space probe Mariner 4 reaches Mars on June 14 and sends back clear pictures of the planet's surface to Earth.</p> <p>Gemini 7 is launched on December 4 and will orbit the Earth for 145 days, covering 5.48 million miles; on December 15 it meets up with Gemini 6 for the first rendezvous in space between two manned capsules.</p> <p>Sir Winston Churchill, British statesman and Nobel laureate for literature, dies on January 24 at the age of 90.</p> <p>Famous missionary doctor, theologian and philosopher Albert Schweitzer dies at the age of 90 on September 4.</p> <p>A war over Kashmir breaks out on September 6 between India and Pakistan.</p> <p>Some 55,000 people go to see the Beatles at New York's Shea Stadium at the biggest rock concert ever.</p>	

Organic chemicals— at the core of chemical production

The classic organic chemicals have rightly been described as the very heart of chemical production. Bayer was quick to recognize their manifold importance—from starting materials and intermediates right up to finished products.



The Leverkusen-based Central Pilot Plant for Organic Chemicals—with the German acronym ZeTO—is a highly modern and highly versatile experimental unit run by the Organic Products Sector. Its facilities are also available to other Business Groups.

The Central Pilot Plant for Organic Chemicals (ZeTO) and the former Intermediates Department (ZW) that was dissolved during the major reorganization in 1970 are incorporated in today's Organic Chemicals Business Group. This Business Group produces a series of basic chemicals and intermediates, many of which belong to the category of classic industrial organic chemicals. The history of Bayer's activities in this field goes back to the last century.

In the early years after its founding, Bayer bought starting materials that were used to manufacture its dyestuffs from the coal tar industry. After building the Leverkusen works, the company set itself the goal of becoming independent in the inorganic chemicals field by erecting units for sulfuric, hydrochloric and nitric acid, as well as for chlorine and sodium hydroxide.

The blueprints of the new works also provided for the construction of facilities for organic intermediates as early as 1895. These units formed the basis of the subsequent Intermediates Department in Leverkusen, or as it was referred to in the company language, the ZW Department. The installation of the so-called A plant soon followed. This unit was named after aniline, which was a key product of the company at the time. In addition to aniline, several other products were also produced in the A plant. Crude benzene that stemmed from the production of tar was further processed into rectified benzene, toluene and xylene. These materials were subsequently chemically converted into nitro, amino and chloro compounds, which were then used by the Intermediates Department to manufacture the special products needed by the dyestuff facilities.

Originally, the units of the Intermediates Department and the A plant were only intended to meet the works' own requirements for organic chemicals. However, the substantial surpluses that had quickly accumulated could easily be sold to other companies. By 1920, this business had grown to such an extent that a special sales department for chemicals had to be set up. Over the years, this department was to become *Farbenfabriken Bayer's* biggest single marketing

operation. By the end of World War II, there had been a sharp rise in the exports of organic chemicals because numerous countries had themselves started to manufacture such end products as dyestuffs.

A large number of those products that account for such impressive sales figures today were first produced in considerable amounts in the former Intermediates Department or the A plant. The raw materials needed for polyurethane chemicals are a typical example. In the course of time, the polyurethane business became so important that it gained the status of a separate division during the restructuring of the company in 1970. The responsibility for the corresponding production units was subsequently assigned to the division. Similar developments occurred in the fields of plastics and synthetic rubber. The Organic Chemicals Business Group has hardly diminished in size as a result. Its production program extends from such basic chemicals as aniline and formaldehyde, through dyestuff intermediates like anthraquinone or naphthalene derivatives and so-called fine chemicals or photochemicals to specialties for the protection and preservation of materials.

The sales unit of this group has also assumed responsibility for sales and marketing of those petrochemicals from Bayer's joint venture *Erdölchemie* in Dormagen that are in excess of the company's own needs (see page 358). Its clientele ranges from other major chemical producers to the cosmetics and food industries. More than 70 percent of all the chemicals sold go to foreign markets.

With the various forms of such traditional basic processes as chlorination, sulfation, nitration or reduction, the A units and the intermediates facilities work within the bounds of classic organic chemical manufacturing, i.e. preparing chemicals for further production stages. This does not mean that their operations are monotonous or boring; the very multiplicity of the products results in constantly new demands. Just how complicated this is becomes clear when scientists face the challenge

of converting the procedure used to make a newly developed substance in a glass test tube into an industrial-scale manufacturing unit.

One or more upscaling stages are often needed on the way from laboratory synthesis to a technically feasible production process. In 1923, a department was created that was concerned with the technical and scientific aspects of up-scaling. It functioned as a bridge between lab and plant. Many well-known products were "raised" here.

By 1958, management realized that a major expansion was necessary. The company devoted DM 40 million to the initial building phase of the newly formed "Central Pilot Plant for Organic Chemicals," or as it is called in the German abbreviation, ZeTO.

Several years passed before this project was completed, but then Bayer had a state-of-the-art and highly versatile pilot plant at its disposal. Today, it serves not only the organic chemical operations but other groups within the company as well.

In taking the development of a product right up to full-scale manufacture, ZeTO's task goes much further than simply working out a set of detailed regulations for the plant. Operational safety, occupational health and environmental protection are among the most important individual criteria to be considered during the realization of a particular project. But the decisive factor that will determine whether or not a product will be developed on a full scale is the economic viability of its production.

In early 1969, the so-called ZeTO II factory started production. This unit was intended primarily for new products, small-volume runs and auxiliary substances, i.e. those products whose relatively modest output would not warrant a plant of their own. ZeTO also helps out when a factory is unable to meet peaks of demand or is temporarily closed for repairs.

The broad scope of ZeTO's responsibilities calls for a particularly close cooperation between chemists and engineers. Many "teething" troubles in the development of a product are problems for the chemical engineer; for example, dosing, mixing, pumping,

heating or cooling are all operations that can be performed in a variety of different ways. The operating engineer and the responsible chemist jointly discuss and then decide on the choice of methods and even the kind of equipment that should be used and whether it should be made out of a specific material for a specific task.

The cooperation between chemical engineers and chemists is not limited to ZeTO, but extends to all facets of production. Within the Business Groups, chemical engineers run their own special engineering technology units. They also form a link to the Central Engineering Service Division, which is responsible for inter-departmental tasks.

In the long historical development of the Intermediates Department and the A plant to today's Organic Chemicals Business Group, the transition from a group of production units that supplied the dyestuffs sector into an operation with worldwide sales demonstrates the constant change in even the traditional activities of the company. In fact, since World War II, two products groups have emerged that have made the Organic Chemicals Business Group into a supplier not only of starting materials and intermediates, but also of finished specialties: the ion exchanger resins in the Lewatit range and the Preventol material protection products.

Ion exchangers are used in modern dishwashers, where they convert the lime that precipitates as a white incrustation during the heating process into soluble sodium salts. Since the exchanger becomes saturated with calcium ions after a certain period of time, it must be regenerated regularly by treatment with common salt.

Ion exchangers on the basis of synthetic resins go back to a British invention of 1934 for which I.G. Farben obtained a license. They were produced in Wolfen, which ended up in the Soviet zone after the war. Bayer thus started their production in the West.

Ion exchangers are used in all kinds of processes where water is needed. Large quantities are necessary to remove salt and lime from water that is required for technical purposes. No power station

The original task of the ZeTO unit—whose production facility is shown at the top of the opposite page—was to upscale new products for subsequent commercial-scale manufacture. As the link between the laboratory and the plant, ZeTO has many more responsibilities, however.

One of its additional duties, for example, is to help out with actual production when demand peaks or a plant is closed for repairs. The picture to the right shows samples being taken from a production run.

could do without it because boilers and pipes would be ruined by scale in no time. In fact, those customers using large quantities of ion exchangers for industrial purposes have basically the same problems as the homeowner who needs them for the washing machine or dishwasher. Our drinking water is clean, but its taste depends in part on the small quantities of natural salts dissolved in it. These salts, however, are a handicap in the production of many foodstuffs and drinks. Ion exchangers are needed where water has to be extra "pure," e.g. in breweries, softdrink production, meat-packing plants and canned-goods factories. The sugar industry uses ion exchangers for desalting and decoloring sugar. They are also necessary in the cosmetics, electronics, photographic and pharmaceutical industries, which have equally high purity standards.

Over the years, Bayer research has supplemented the original Lewatit range with a series of special products including catalysts and substrates for enzymes which, due to their solid form, can easily be removed from reaction mixtures. Hydroculture plant boxes, now so common in offices and homes, also depend on exchanger resins to satisfy the nutritive requirements of the plants over long periods of time.

The creation of the comprehensive Preventol program for material protection was made possible by the wide range of applications of Bayer's organic intermediates. In respect to their chemical composition, the various Preventol types belong to different substance groups. The resulting



versatility in properties helps to fulfill the most varied application needs required by processors.

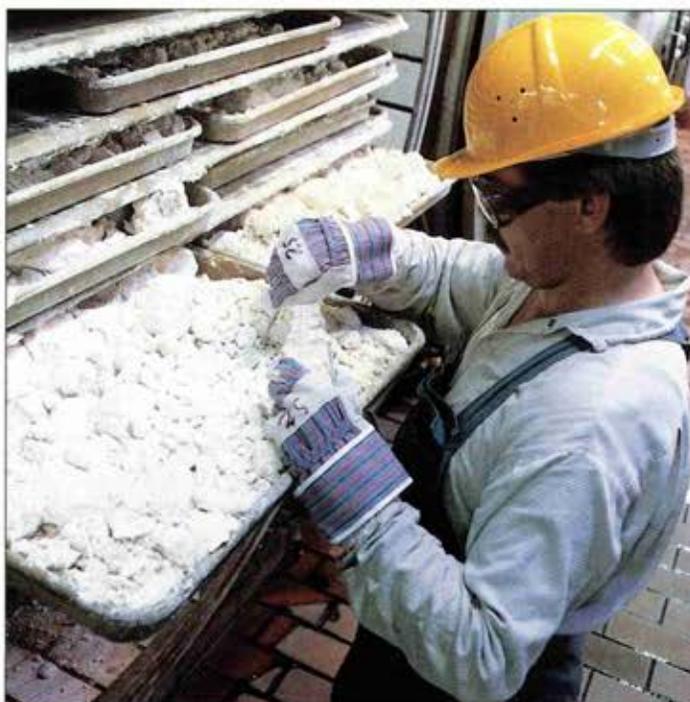
Bacteria, algae, fungi and yeasts are omnipresent in our world. Mankind has used these microorganisms to its benefit since ancient times; for example in

brewing and fermentation techniques. On the other hand, microorganisms destroy goods worth the equivalent of about DM 300 billion worldwide every year. There is hardly a product in everyday life that is not threatened by them or an industry that can dispense with protective or preservation measures because of them.

Paper mills, for example, would soon grind to a halt if one of the Preventol series did not prevent slime from forming in the process water. Microbiocides have to be added to cooling lubricants for cars. Without preserving agents, it would be impossible to export fruit or hides from Third World countries. Preventol is also needed for paints, fillers, adhesives, textiles, leather, plastics, disinfectants, food preservatives, toothpaste and bath salts; in fact, it is used just about everywhere.

Nevertheless, the broad field of organic chemicals can still be described as the most classic within the various sectors of the traditional chemical industry. The enormous variety of individual products and

the large number of new specialties appearing year after year demonstrate that organic chemicals remain at the core of modern chemical production. They will continue to retain a considerable economic significance as well as an unbroken dynamism.



Environmental protection has a long tradition at Bayer

Regional authorities, the town of Leverkusen and Bayer AG joined forces to regulate the large-scale disposal of liquid wastes in an area with a population of some 400,000. In 1966, construction of a jointly operated waste water treatment plant began in the BÜrrig district of Leverkusen.

This site, which is actually bigger than Bayer's Leverkusen works, is not only designated for the treatment of effluents, but also incorporates an incinerator for combustible waste and a controlled dump for Bayer's own use.

Bayer is justifiably proud of the fact that steps were taken to protect the environment at an early stage of the company's history: a first "Waste Water Commission" was set up in Leverkusen in 1901. The air has been monitored since 1910, and a "Committee for Clean Factory Air" was established three years later. In 1933, the company submitted a patent application for a process to clean gaseous wastes. Beginning in 1936, the plant had its own special "clean air delegate." Measurements of hydrogen sulfide in the air began in 1939. And the list goes on.

All of these albeit admirable efforts nonetheless did not add up to a systematic environmental protection program. A problem can be solved only when it has been recognized as a problem.

In retrospect from the year 1988, it cannot be overlooked that "environmental protection" was far from being a widely understood concept only 20 years ago. Indeed, the modern German word for the environment in its ecological sense, "Umwelt," was not even known until biologist Baron Jakob von Uexküll coined it early in this century. The idea of protecting the environment, in fact, really only emerged when it was high time.

For example, the city officials of Hamburg did not decide to install a sewage system until 8,605 people had died of a cholera epidemic in 1892; garbage and human waste had simply been thrown into the water or spread over farming land.

Industry handled its waste problem in much the same way. Fortunately, the remarkable regenerative ability of the waterways was generally capable of managing this burden, and people could still find room for garbage dumps.

Between the two World Wars, initial steps were taken to introduce a technical solution for the treatment of chemical wastes. Chemische Werke Hüls opened its own purification plant in 1936, for example.

This test with zebra fish is part of statutory requirements to monitor acute health hazards resulting from chemicals.



Waste treatment at Bayer

Liquid waste

The biological purification plant is an important way of treating liquid waste at Bayer. This method makes use of the ability of microorganisms to feed on the organic components of the effluent.

The treatment plant functions according to the same principle as a river in its self-purification process, but the various stages of "cleaning" work more concentratedly and more rapidly.

Like humans, microorganisms need oxygen in their environment in order to obtain vital energy from the oxidation of the nutrients. In both living organisms, the end product of this nutrition process is carbon dioxide.

The microorganism utilizes part of the available nutrients for its own reproduction. It converts them into substances contained in its own cells and then divides.

The procedural system of a purification plant works as follows:

In a preparatory phase, the liquid waste is freed from coarse pollutants and neutralized because the microorganisms can only function in the waste water treatment plant when the liquid environment is close to the neutral point.

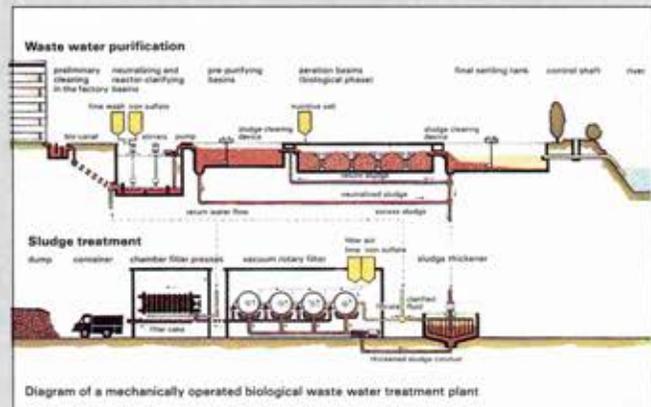
In the course of neutralization, some components, including organic substances and dissolved metal salts, are precipitated and can be removed together with the neutralized sludge.

After this first process, which itself represents a considerable step toward purification, the liquid waste is fed into aeration basins in which a mixture of sewage and activated sludge, i.e. microorganisms, is already present. In the form originally introduced, these basins are big, flat and open reservoirs with large stirrers that are positioned to introduce a constant flow of oxygen by continuously agitating the contents.

Organic components of the sewage are decomposed in these basins, and at the same time the masses of bacteria are continuously reproducing. To keep the system in balance, additional liquid wastes are fed in one side in the same proportion as clarified sewage and surplus activated sludge are withdrawn from the other side.

The purified waste is passed on into the main drainage channel, whereby the masses of bacteria are subsequently separated off, dehydrated and finally burnt or dumped.

The following diagram shows the individual phases in the clarification of liquid industrial waste:



Bayer played an important role in the general introduction of biological sewage treatment into the chemical industry. Of particular significance was Bayer's development of the so-called "Tower Biology" principle, which involves a special form of air injection into a tower-like aeration chamber. For more details see the 1980 chapter on Tower Biology.

An essential part of any waste treatment process is a reliable control system. This system should not only cover chemical analyses, which are in part performed automatically, but also biological testing methods.

Two data are particularly important for the evaluation of how efficiently a purification unit is working. One of these determines the chemical oxygen demand (C.O.D.) of the sewage. Standardized methods are used to attain as complete an oxidation of the organic contents to CO_2 as possible. The oxygen con-

sumption rate provides information on the quantity of organic components in the sewage.

The second indicator is the biochemical oxygen demand of the components, which is obtained by observing the biological degradation of the contents of the liquid waste under specific laboratory conditions.

This method works with the help of microorganisms and therefore supplies the values pertaining to the biochemical oxygen demand of the contents, or the B.O.D. Since this biological test needs much more time than a chemical analysis and its results depend on the length of the experiment, a fixed duration must be set for the determination of this rate. In most cases, the value is determined after five days, giving the so-called B.O.D.-5.

(continued on page 426)





All of these efforts came to a temporary halt with the outbreak of World War II. In the immediate postwar period, the stress was on production; the universal priority was for industry to turn out as much as possible as quickly as possible to make up for the privations of wartime.

It will take us a long time to counteract the repercussions of this neglect. From the early period of the Industrial Revolution up into the 1950s, far too much waste was allowed to sink into the earth, subsoil and the beds of rivers and lakes. This kind of pollution cannot be eliminated overnight.

Soon after its reincorporation, Farbenfabriken Bayer began to build up its own environmental protection organization capable of expansion to meet immediate and future demands. For example, the "AWALU" laboratories were set up in 1954. This acronym stands for the three main areas of concern: solid waste, water and air. The AWALU laboratories provided the ideal framework to study scientific and technological aspects of waste disposal.

Before these laboratories were incorporated into an autonomous department in 1964, the results of their work had provided the groundwork for the establishment of far-reaching policy decisions: all waste air problems were to be handled by and solved in the plants where they had originated. The consequence of this decision was that in the course of only a few years, all of the trails of steam and smoke over the various production units gradually disappeared. Where necessary, washing and filter installations were put into operation to guarantee unobjectionable air quality. In the case of solid waste, it was decided to lay out controlled dumps and build incinerators; wherever possible, waste disposal by incineration was given priority over dumping.

For the central disposal of liquid waste, the decision was made to build biological purification units. The jointly operated water treatment plant in Bürriq was not the first of these installations. In 1958, just after the establishment of Erdölchemie GmbH, Bayer started building a central treatment facility for liquid waste.

Bayer has been instrumental in the chemical industry's introduction of biological clarification processes for liquid waste. Its corresponding treatment facilities—the Leverkusen unit on the left and that at Dormagen above—make use

of the ability of microorganisms to degrade organic substances in waste water.

A comparison of the chemical and biochemical test values permits an estimate of the amount of sewage components that are not easily broken down by the microorganisms.

Sewage with a high content of components that are difficult to decompose needs preparatory treatment before it reaches the purification unit. Wet oxidation or other processes can be employed in such cases. However, when, for example, the salt content is too high, totally different

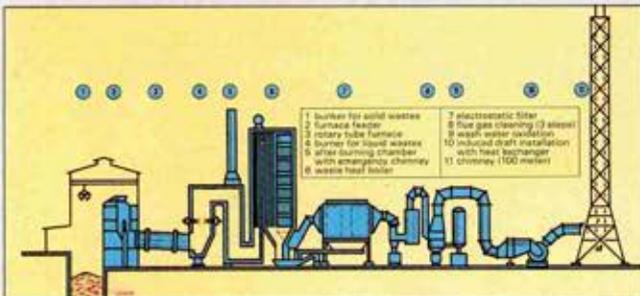
forms of disposal become necessary, such as burning the liquid waste.

The most effective step toward finding a solution to waste management problems is the development of production processes that result in only small quantities of liquid waste containing components that are easily degradable. This is where Bayer's chemical engineers are instrumental in helping the company's environmental protection efforts.

Solid waste incineration

Environmentally acceptable burning of chemical waste is possible only in those special facilities which guarantee virtually total combustion and whose ash and waste gases contain no significant quantities of harmful substances.

The following diagram shows that the furnace itself is only a minor part of the complete incineration unit:



This plant, whose functions are described in the main text of this chapter, can also be used for the safe destruction of substances containing sulfur, phosphorus and halogen.

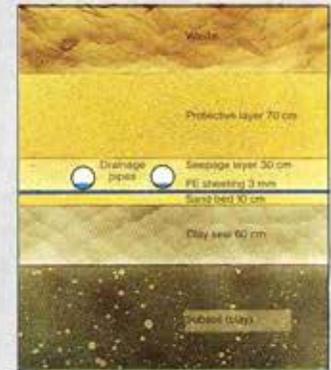
It is also approved for the disposal of such highly chlorinated products as polychlorinated biphenyl (PCB) waste.

Controlled dumps

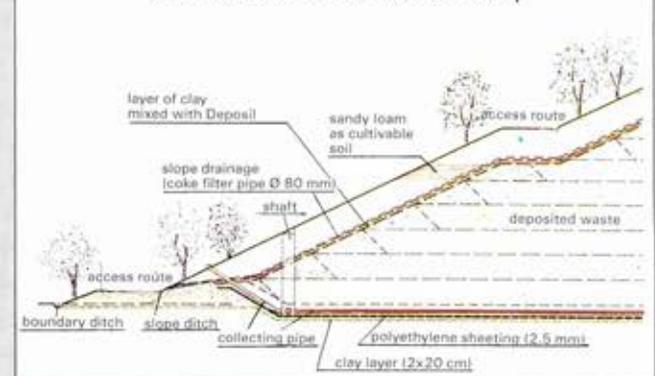
In connection with the description of controlled dumps in the main text, the two sectional drawings shown here illustrate the complicated nature of these facilities.

An important feature of long-term control of such dumps is that waste is deposited according to a determined grid and subjected to an exhaustive recording system. Apart from the safeguards incorporated in the doubled base-sealings, additional control pools are installed

in order to be able to detect any possible leaks quickly.



Structure of a Controlled Dump



The situation was more complicated in Leverkusen because there was a lack of available space. Initially, a purification unit was built in the Flittard suburb of Cologne to handle effluent from the southern part of the works. This unit went into operation in 1966. However, the city of Leverkusen and its immediate surroundings still had no adequate sewage disposal system, so all interested parties decided to get together and set up a joint treatment plant. The dump for solid waste and the incinerator were to be purely Bayer facilities, while the purification plant—in contrast to the practice in other Bayer works—was to treat both domestic sewage and industrial effluents.

Before this plant could be realized, however, a great deal of "landscaping" was necessary. Thus, the courses of the Wupper and Dhünn rivers had to be changed and the surrounding meadowland widened; this job alone required the shifting of over 21 million cubic feet of soil.

The Wupper River Authority laid conduits from Solingen to Leverkusen to bring in the sewage from four towns. The Bayer plant in Leverkusen itself built a new drainage system for the collection and transport of chemically contaminated water.

The first phase of the joint project was completed in 1971. In keeping with the technology of the day, its installations consist of a system of open basins in which bacteria feed on the pollutants of the liquid waste after initial neutralization and mechanical cleansing. Huge stirrers constantly agitate the surface of the liquid to make sure that the "hungry" microorganisms get sufficient oxygen.

The biological treatment proved its worth, but it was not without its drawbacks. The problems lay less in the process itself than in the noise made by the motors and in the fine mist produced by the stirrers that, in the case of unfavorable winds, was blown into the neighboring residential areas. Together with difficulties having to do with space, these factors were the impetus for Bayer to develop a second phase: the so-called Tower Biology. Its story will be told in a later chapter.

Today, some 25 million cubic feet of water flow through the Leverkusen works daily. Of this amount, more than 80 percent consists of coolant water taken from the Rhine that never comes in contact with chemicals and is then fed back into the river after use. Only 10 to 15 percent of all liquid wastes are polluted with organic chemical substances and thus need cleaning in the purification plant. This clarified water is subjected to continuous control both by Bayer and by the responsible authorities.

The other Bayer plants have also been active in waste treatment. The Elberfeld plant was first linked up with the Buchenhofen sewage works of the Wupper River Authority over a mile away in 1970. Almost one-half of the conduit to the works runs through a hill. In 1976 Bayer opened its own, closed biological unit on the other bank of the river, in the Rutenbeck district of Wuppertal. This unit, just like the subsequent Tower Biology development in Leverkusen, proved that treatment plants for chemical wastes have to be adapted to fit local requirements and the respective conditions of the production plants. These considerations, and the fact that the Wupper Valley is very narrow, necessitated the feeding of pure oxygen to the bacteria in a closed system, instead of having the basins just being exposed to the open air. In this way, problems with exhaust air could be much more easily handled.

The central waste treatment plant in Dormagen was expanded to reach a capacity of over 3.5 million cubic feet per day in 1973, and in Uerdingen a biological purification plant went on stream two years later.

While these various treatment facilities for liquid wastes were being constructed, Bayer was also building or expanding its controlled dumps and incinerators for solid combustible waste. In 1966, the same year that the ground was broken for the joint waste water treatment works, the new dump in Leverkusen was ready for use. The first incinerator came into operation in 1967 and the second in 1975.

Monitoring equipment incorporating the most recent technology is used to keep a continuous watch on air quality at Bayer plants. Nevertheless, an important role is still played by the human sense of smell. As sensitive as they are, stationary analysis units cannot identify

all smells, so human "air sniffers" move from place to place using highly sophisticated portable devices to analyze the contents of the air.

As the saying goes, waste is raw material in the wrong place. In this simplified form, such a claim is without a doubt exaggerated. After all, it is characteristic of chemical reactions that they lead not only to the desired end product but also to more or less considerable quantities of other substances. If only for economic reasons, it makes sense to use as many of these by-products as possible.

Fortunately, in many cases the highly diversified production facilities of today's chemical industry are indeed able to recycle the by-products. But nevertheless, there is always something left over that would fall into the category of "waste." Even though this amount may be relatively modest in terms of percentage, it adds up to substantial absolute quantities.

Bayer alone has something like a million metric tons of solid waste per year. This includes non-chemical wastes such as building debris and excavated material. The environmental protection departments analyze some 1,200 different kinds of waste in special laboratories and then decide how they are to be disposed of in the best way.

Incineration is, ecologically speaking, undoubtedly the safest and "cleanest" method of disposal. Naturally, this statement presupposes the condition that no unacceptable amounts of harmful substances are contained in waste gases or filter waters.

Otherwise, getting rid of solid wastes would simply create a new problem of air or water pollution.

The incinerators are designed to obviate this concern. The waste is fed into rotary furnaces that maintain a temperature of some 1000–1200° C. The flue gas from these furnaces is itself subjected to secondary combustion in after-burning chambers, then cooled down in waste heat boilers before being freed from dust electrostatically. It is subsequently cleaned in a washing unit and finally expelled, virtually free of pollutants, through a 330-foot chimney. The heat created during combustion is used in the form of steam as energy for production. Only dust and slag remain after incineration. Like other non-combustible chemical waste, they are brought to a controlled Bayer dump.

Controlled dumps like the ones the company operates in Leverkusen, Dormagen and Uerdingen are not old-time dumping grounds, but highly sophisticated pieces of construction. A foundation made of compressed layers of clay and fine sand on the existing subsoil is covered with a waterproof, wear-resistant and chemical-resistant polyethylene mat, whose seams are tested for impermeability by ultrasonic equipment. Above the plastic cover,



a system of drains in a siliceous filter layer guarantees that rainwater which has soaked in this far is recovered and subsequently led off to the sewage works. A further protective layer is extended over all this, and only then is the waste dumped. Observation pools are placed around the dump so that the ground water can be controlled on a regular basis.

Earth embankments are formed to enclose the entire area; they are then covered with clay and soil on the outer sides and planted with bushes and trees. These embankments surround the dump like the sides of a basin, allowing the controlled domestic and chemical waste to be stacked there in proper order and without any danger to the environment. The contents of trucks are carefully checked at their entry into the site; the tires of the vehicles are cleaned before they leave the area.

When the waste reaches the height of the sides of the embankments, new ones are built with smaller dimensions. This means that in the course of time the dump grows in a pyramid-like fashion into a "mountain." The dimensions of such sites can get to be quite remarkable. The size of the one at Bürrig is over 160 acres, or the equivalent of 60 soccer fields.

The Bürrig site can accommodate 500,000 metric tons of waste per year, which means a total capacity of more than 700 million cubic feet. The small quantity of chemical waste that cannot be stored in this carefully controlled dump is deposited at a depth of 2,300 to 2,600 feet in a former salt mine. When the Bürrig plant is full after about 50 more years of use, it will be covered over with clay and soil. At a height of nearly 200 feet, it will then be the highest elevation of the ground in the Lower Rhine region.

In the swampy area at the former mouth of the Wupper, a sanctuary has been set up not only for birds of the region, but also for rare and jeopardized species. According to a publication of the German Association for the Protection of the Environment and Nature, Leverkusen is the home of one of the ten tree frog colonies discovered since 1970. And even pheasants, partridges, ducks, buzzards and falcons are thriving in the dump area today.

Residue from waste incineration and incombustible chemical waste are sent to the company's own controlled dumps. These sites are far from being old-time refuse heaps. The accumulation of waste is carefully planned, and nothing may be deposited

until the ground has been specially prepared by laying out heat-sealed polyethylene mats.

Bayer chronicle 1966

Bayer purchases a 25-percent holding in Chemische Werke Hüls AG from Hibernia, which makes the two companies joint owners.

A new Levapren facility goes on stream in Dormagen and an additional plant for of yellow iron oxide pigments starts production in Uerdingen.

Tiguvon is introduced to the market as a pesticide used against warble flies.

Dorvivan curtains made from a new quality yarn are marketed for the first time.

A new adhesives system for rubber fabrics and rubber-metal bonds is developed and is subsequently sold under the trade name Cohedur.

Plant for the production of laminated rigid-foam sheets is developed.

Evening school for chemical technicians is set up.

Moltopren plant is opened in Rauma, Finland. Bayer delivers two complete Moltopren units to Romania.

An agrochemicals formulation facility is opened in Gebze near Istanbul, Turkey, and a pharmaceuticals plant begins production in the French town of Sens.

World events 1966

On January 21, Indira Gandhi (photo) becomes prime minister of India.



The Aswan Dam is inaugurated in Egypt on January 15.

The Cultural Revolution begins in China in May.

On July 1, President Charles de Gaulle announces France's withdrawal from the military activities of NATO.

The world's first tidal power station is opened at St. Malo in Brittany, France, on November 26.

After the resignation of the Free Democratic Party from the German coalition government led by Ludwig Erhard, Christian Democrat Kurt Georg Kiesinger forms a coalition with the Social Democrats on December 1.

At the Brookhaven Laboratory in the United States, P.G. Katsoyannis and his research team synthesize human insulin.

Plastics capture the automobile market

A very special car was on display at the K'67, the International Plastics Fair in Düsseldorf in 1967. It was almost completely made of plastics; the only metal components were the engine, the transmission and the wheels.

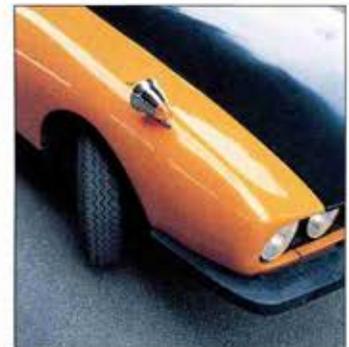
This first sports car with a plastic body carried the license plate number LEV-K 67. At a cost of DM 1.5 million, it was hardly destined for mass production. But over the years since its introduction, the prototype of a plastic car has passed numerous tests on the famous Nürburgring race track and has withstood trials by almost all car manufacturers.

In 1978, a cutaway model of the vehicle was given to the German Museum in Munich as a tangible demonstration of just what can be done with plastics in automotive construction. It can still be seen in the museum's vehicles section today.

At the K'86 in Düsseldorf, 19 years after the presentation of "LEV-K 67," several firms showed plastic cars in series production. In one demonstration, a Porsche was backed into a wall over and over again without its bumper suffering the slightest dent.

"LEV-K 67" had been the result of years of cooperation between various companies. The former Gugelot Design GmbH, of Neu-Ulm, Waggon- und Maschinenbau AG in Donauwörth and the BMW manufacturer Bayerische Motorenwerke AG had been looking into the possibility of building an integral plastic chassis for a BMW sports car since 1963. A solution was finally found when Bayer technicians suggested the use of a polyurethane sandwich system for the underbody. This base unit of the car was presented at the Hanover Industrial Fair in the spring of 1967. By the time the K'67 was held in the fall of that year, scientists had been able to make the roof, hood, fenders, bumpers and other components from plastics, too. Applications experts also came up with suitable plastics for interior fittings. Much of which was put on display in 1967 has since become standard equipment in cars.

One tends to forget just how cars were equipped only 20 years ago. For example, no Volkswagen driver would have ventured out on a long journey without an ersatz V-belt in the trunk. Made of rubber and reinforced with fabric, the belt would often stretch and finally tear. Thanks to today's virtually indestructible plastics, car mechanics these days hardly ever have to change a V-belt.





And many more problems in the automotive sector have been solved since the advent of plastics. For example, the metal bumpers that protruded from the body had the bad habit of hooking on to obstacles during maneuvering. They also dented at the slightest collision and were quick to rust.

A driver needed to wear gloves when trying to hold the hard rubber steering wheel in hot weather; it was the only way to keep his or her hands from slipping. And those who left their car parked overnight under a lime tree had a hard time getting the shine back into the finish.

The springs in the car seats of yesterday were prone to make themselves felt. And the upholstery often needed slipcovers because it was neither abrasion-proof nor light-proof.

Since fabrics and flooring were not made of sound-absorbent materials, the whole car seemed to drone like a double bass. And under the "right" conditions—when extra strong head winds forced it through the windshield seals—rain occasionally managed to get into a closed car.

For all that, up to ten kilograms of plastic materials were used in cars even before 1967. Today, the content is more like 70 to 100 kilograms, not counting the synthetic rubber in tires, the adhesives, the textile fibers and the coatings. In the United States, the industry is already approaching the 200-kilogram mark.

Only the deluxe-model of cars are considered status symbols today. For the vast majority of people, a car is strictly a utilitarian article. In the Federal Republic, some 455 out of every 1,000 inhabitants owned a car in 1987. This huge market potential places special demands on the automobile industry.

Cars should, for instance, last as long as possible. In its fight to survive, corrosion is the car's "Number One Enemy." Plastics do not rust.

Cars should be both comfortable and safe. Molded foam seats, hard or soft depending on their use, offer comfort; and in fact, plastics in a car's interior provide both comfort and safety because they are able to guard against injury.

Photographic impressions of a prototype: the first-ever plastic car, developed by Bayer in cooperation with a number of other companies, was presented at the 1967 International Plastics Fair. In this vehicle, only the engine, gears and wheels were metal. Back

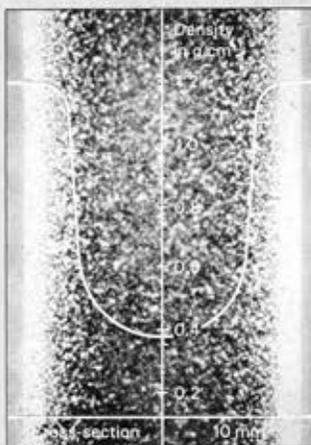
then, the idea was quite unconventional, but today the use of plastics in the automotive industry is the normal practice. In fact, it is difficult to imagine cars being made without these versatile materials.

Integral-skin foams and other interesting developments in the plastics field

The manufacturing processes that have been mentioned thus far produce polyurethane foams with a closely knit, thin skin. Immediately under this skin is a foam mass whose density is virtually the same throughout.

In the 1960s, methods of production were eventually discovered that permitted the formation of materials with clearly thicker outer layers without pores. From the outer layer moving in the direction of the core, the number of pores increases as the skin blends into the actual foam.

The density pattern shown in a model cross section is illustrated by the following diagram:



Two fundamental conditions are prerequisites for the formation of a structure of this kind:

One involves a method whereby more reaction mixture is introduced into the mold than would be necessary to

fill the mold with foam. The other requirement is that the tool temperature must be at least 60° C below the maximum reaction temperature at the core of the foam being produced. This normally means that it would be necessary to keep the inner surface of the tools at around 50° C to 70° C.

The process can be used for either soft or rigid foams and permits a wide range of variations. The resultant surface layer can, for example, be mechanically reinforced by applying a meshwork made out of glass fiber to the inside of the mold before introducing the reaction mixture.

The PUR mass permeates this glass fiber material and unites with it as it solidifies.

Other fillers can also be added to the reaction mixture, either to make the product cheaper or to give it specific properties. This series of processes is, in technical terms, referred to as Reaction Injection Molding, RIM for short.

The molded element can also be strengthened by the addition to the reaction mixture of small pieces of glass fiber; this is known as Reinforced Reaction Injection Molding, or RRIM.

The use of the prefix "Bay" in those trade names frequently mentioned in the main chapter such as Bayflex, Baydur or Bayfit indicates

that these polyurethane materials were developed especially for the auto industry and other technical applications.

Baydur:	rigid integral-skin foams
Bayfill:	semi-flexible foams
Bayfit:	flexible cold-curing molded foams
Bayflex:	semi-flexible integral-skin foams
Baymer:	rigid foams
Baynat:	thermoformable rigid foams

Developments in plastics technology aimed at expanding the range of possible applications by adding fillers or reinforcing substances or by introducing new processes are also typical for the thermoplastics and duroplasts sectors. In some cases, the trend actually started in these fields, as with unsaturated polyester resins, whose reinforcement with glass fiber fabric, meshwork or fleece has been practiced for decades. Improvements in technology have led to the replacement of glass fiber by metal, boron, carbon and graphite fibers, which has paved the way for high-performance composite materials such as those used in aeronautics and astronautics.

Thermoplastics for injection-molding purposes can also be reinforced with fibers that have been cut small or ground. The short fibers arrange themselves parallel to the direction of flow during injection, thus forming an effective reinforcement system on the inner side of the molding shape.

This system also substantially increases shape and dimensional stability of the product. Camera housings and other articles that require a high degree of precision in their measurements can be mass-produced cheaply in this way.

As early as the 1950s, it was discovered how to use the already known monomers as a base for thermoplastics with improved properties. By using catalysts specially developed by Ziegler and Natta, polymer chains could be constructed with a specific steric alignment. In the so-called graft polymerization process, a carrier polymer (monomer A) is used as a base for the grafting of "branches" from a second monomer (B). The combination of hard and soft segments in the polymer chain also results in plastics with special technical characteristics and increased efficiency:

The first successful plastic-bodied car was introduced in an admittedly limited series of small autos with a double-shell body made of Leguval. It was not only lightweight but also offered very high tensile strength and excellent resistance to weathering.

the choice of the chemical components, a special method of production could be achieved for these PUR foams; a firm and durable skin could thus be formed on the surface of the solid or flexible molded element.

The flexible integral-skin foam Bayflex was first used for armrests in the Volkswagen beetle. And the Volkswagen car manufacturer also started to fill up hollow spaces in the chassis with rigid polyurethane foam to counter noise and corrosion.

But the real pioneer in the use of plastics was Porsche. As early as 1969, this sports car producer ordered bumper guards made out of Bayflex. The then British Leyland automobile concern—now Rover—was also ahead of its time; it began to test chassis made of the rigid integral foam Baydur in its Mini-Cooper model in 1969.

The use, or partial use, of polyurethane foams for prefabricated roof linings and steering wheels was new in 1971, but today it is the standard material.

The next important step was the introduction of reaction injection molding (RIM) in 1971. General Motors had pioneered this invention in the United States. In Germany, Krauss-Maffei of Munich developed the necessary plant, and Bayer the material. Use of the RIM process enabled the single-phase manufacture of simple or even highly complex molded parts. The following year saw the development of a process using Bayfit for the foam backing of textiles, while in 1973, Volvo started production of all-plastic seats that needed no springs.

In 1975, Ford began using Baytherm to fill the hollow spaces of the chassis, and General Motors introduced the serial use of RIM.

This successful RIM system was further developed to the reinforced reaction injection molding (RRIM) technology. Glass-fiber-reinforced chassis components that could be coated resulted from this development. The Porsche 924 Carrera GT was equipped with frontal skirting and fenders which were made out of this material.

In 1980, Baydur interior paneling that is reinforced with glass mat came on the market. Seat cushions



made in one molding step with reinforced edges were introduced in 1981; these seats premiered in the Audi 100 model. Prefabricated Baynat roof linings soon went into mass production at Audi, Volkswagen, Renault, Peugeot and other car manufacturers.

The rapid spread of applications for engineering plastics in the automobile industry was indeed impressive. The sensation of the K'83 was General Motors' all-plastic car, the Pontiac Fiero, with its RIM exterior components. At the K'86, a number of plastic cars that were in serial production were exhibited; among them the Renault Alpine whose chassis was entirely assembled out of Leguval and Bayflex parts and lacquered with DD coatings. The mixed adhesives held parts together better than any screws and rivets.

Bayer's products have made a major contribution to the Ford Scorpio. The company's engineering plastics are used for the radiator grill, fenders, blinkers, taillight housings, console, window sheathing, door handles and components, tank lid, mirror holders, hubcaps, access strips, dashboard, windshield wiper holders and many other parts. Names such as Leguval, Novodur, Pocan, Bayblend, Makrolon and Durethan show how many different products of Bayer's range of engineering plastics have a place in auto construction.

The example of the Mercedes 190 model demonstrates just how much effort goes into developing new applications for synthetic materials in the automobile industry. For ten long years, Daimler-Benz, two coating manufacturers and Bayer all looked for a dual-component high-solid lacquer that would surpass all of the qualities available until now and would need fewer solvent additives to ease the burden on the environment. Bayer's DD coating was exposed to hardness tests for 19 months before it was finally accepted for the new model.

The development of other products, processes and applications subsequently led to the exact bonding of window glass to sealing material. In addition, the lasting protection of such semiconductor elements as diodes, transistors and integrated circuits could



The proportion of Bayer plastics in the Ford Scorpio is particularly high. Various types are used to make the radiator grill, fenders, direction indicators, taillight housings, dashboard, door elements, hubcaps, access strips and many other components.

be obtained by embedding them in polyphenylene sulfide (PPS).

When looking through the alphabet from Alfa Romeo to Volkswagen, there is hardly a European car manufacturer to be found that is not a Bayer customer today. And although there is progress in Europe, the trend toward a plastic car is moving at an even faster rate in the United States.

National legislation had its hand in this rapid development. A U.S. safety code of 1973 requires that vehicles must be able to withstand impact at 5 m.p.h. without damage. This demand presupposed a new kind of bumper. A test with 150 New York taxicabs showed that polyurethane would do the trick.

General Motors in Detroit is the world's biggest automobile producer, with 750,000 employees and annual sales equivalent to DM 270 billion. In 1974, it started to equip its Chevrolet Monza, Buick Skyhawk and Oldsmobile Starfire with front and rear elements made by the RIM process. Other models followed. By 1985, 75 percent of all cars built in the United States were equipped with RIM front and rear bumper parts.

In 1983, GM marketed the Pontiac Fiero as the first mass-produced car in the world with a plastic chassis. In the first year, 100,000 units rolled off the production line.

The Fiero has a steel "space frame" to which the non-structural panels or "hang-ons" are attached. These hang-ons are made from glass fiber reinforced plastics and RIM polyurethanes.

This construction method can be used for several different models without having to adapt the steel "backbone." It also makes "face-lifting" more economical, and designers can come up with chassis styling which would be too expensive if steel were used. But this meant that completely new plant and machinery had to be installed. Rebuilding the existing units was unfortunately not possible. New production lines had to be constructed.

Bayer's Pittsburgh-based subsidiary Mobay supplied the raw materials for the flexible body-parts: Bayflex 110 was specially developed for this purpose.

Why was this business cooperation of such importance to Mobay? What General Motors does in the United States tends to be a signal for the rest of the industry. This is, of course, unlike the situation in Europe, where one manufacturer may introduce a new process without its competitors necessarily feeling inclined to follow suit.

Mobay also has the advantage of its close ties to the parent company in Germany. This synergy enables a unique coordination of a variety of activities—from the research and development of the raw material, to the experience with Hennecke machinery on up to advice on applications and products such as coating systems or glass fiber. Mobay experts regularly visit the Federal Republic, just as Bayer staff is often in the United States. At the moment, Mobay and Bayer are cooperating on the development of Bayflex 150, a material for chassis components that promises even higher temperature resistance and better general stability than the existing Bayflex types.

If reducing the weight of cars allows fuel to be saved, think of how important the weight of an airplane is in saving energy. Under the influence of the gravity of the earth, a jumbo would never get off the ground if a third of its components were not made of lightweight synthetic engineering materials. A reduction of its weight by only one percent is enough to achieve savings in fuel costs equivalent to hundreds of thousands of marks.

The skin of the fuselage of planes is treated with DD coatings. Aluminum parts that cannot be welded are held together with adhesives that are sturdier than rivets. Interior fittings are made of engineering materials of various kinds, while highly sophisticated specialties are used in cockpit electronics.

Research has the clear goal of developing a new range of high-performance construction materials. Bayer spent DM 363 million for research in this field in 1985. Innovation today lies less in the plastics themselves than in their adaptation to special needs, their bonding ability, variations in their starting materials and new methods for their manufacture.



A market with potential — Bayer in Italy

Italy is a country with an ancient culture, thousands of miles of coastline and scenery right out of a fairy tale. Cities like Venice, Rome, Pisa and Florence attract visitors from all over the world. But Italy is also a leading industrial power, where textile, ceramic and glass manufacturing has a long tradition. Bayer Italia S.p.A. has been serving this market since 1967.

For Bayer, Italy is the biggest single foreign market in Europe and is surpassed only by the United States in overall sales volume. Business links to Italy go back many years.

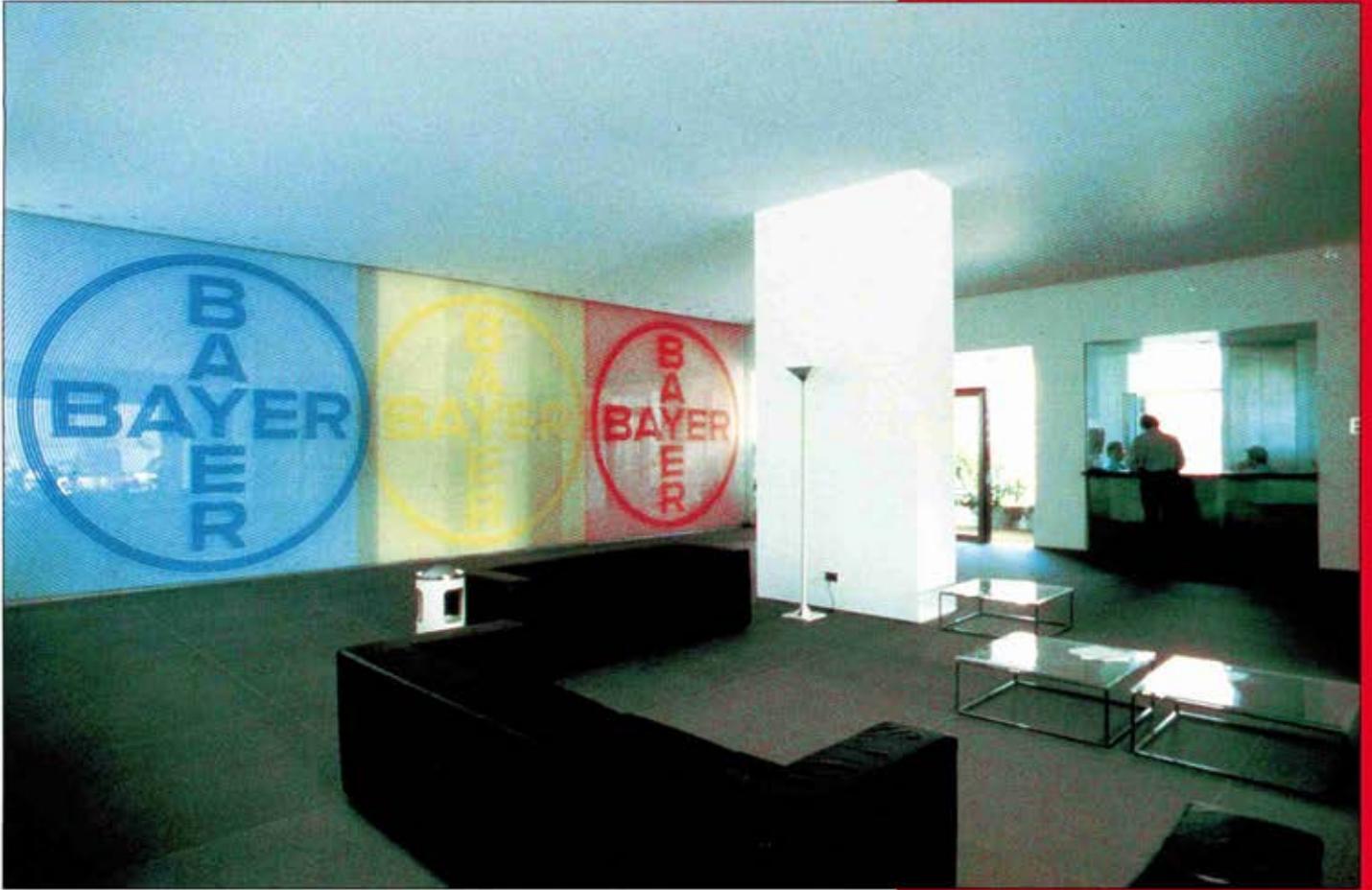
In 1899, the Elberfeld dyeworks set up their first Italian subsidiary, Fedo. Bayer & Cia., in Milan. Until this subsidiary had been founded, the local firm Lepetit, Dollfus & Gansser had represented Bayer's interests in Italy. Agencies were eventually set up in Turin, Genoa, Prato, Tuscany and elsewhere. In 1906, an agency was opened in Naples.

Textile producers in northern Italy were Bayer's major customers. In the publication commemorating the first 50 years of the history and development of *Farbenfabriken vorm. Friedr. Bayer & Co. Elberfeld* from 1863 to 1913, the chronicler wrote enthusiastically: *"It is with feelings of delight that we draw near Alessandria, for this town is the home of the leading customer of the Farbenfabriken in the hat industry: the house of Borsalino. Renowned throughout the world, Borsalino covers, if not its entire demand, at least the greatest part of its dyestuff requirements with the products of the Farbenfabriken."*

The entry of Italy into the First World War in 1915 put a temporary end to Bayer's flourishing business there. Fedo. Bayer was confiscated and subsequently dissolved, which meant that the company had to start from scratch again after the war. But this effort did not prove too difficult.

Soon after the war was over, a representative of Leverkusen set off for Italy in the fall of 1919. He met up with a thoroughly friendly response and quickly made fresh contacts. The following year, the company of Dr. Petro Mistó was made Bayer's sole agent for Italy and its colonies.

The pharmaceutical business in the Italian market was gaining particular importance as the Bayer cross became a well-known trademark throughout the country. The companies of I.G. Farben began a cooperation in this market with Compagnia Farmaceutica S.A. (Co-Fa) in 1925, which was subsequently made into a joint-stock corporation on February 1, 1927. The Second World War brought



The Elberfeld dyeworks set up a subsidiary in Milan as long ago as 1899. Today, Italy is Bayer's single biggest foreign market in Europe and the second biggest market in the world after the United States. The above picture shows the reception hall at Bayer Italia S.p.A., Milan.

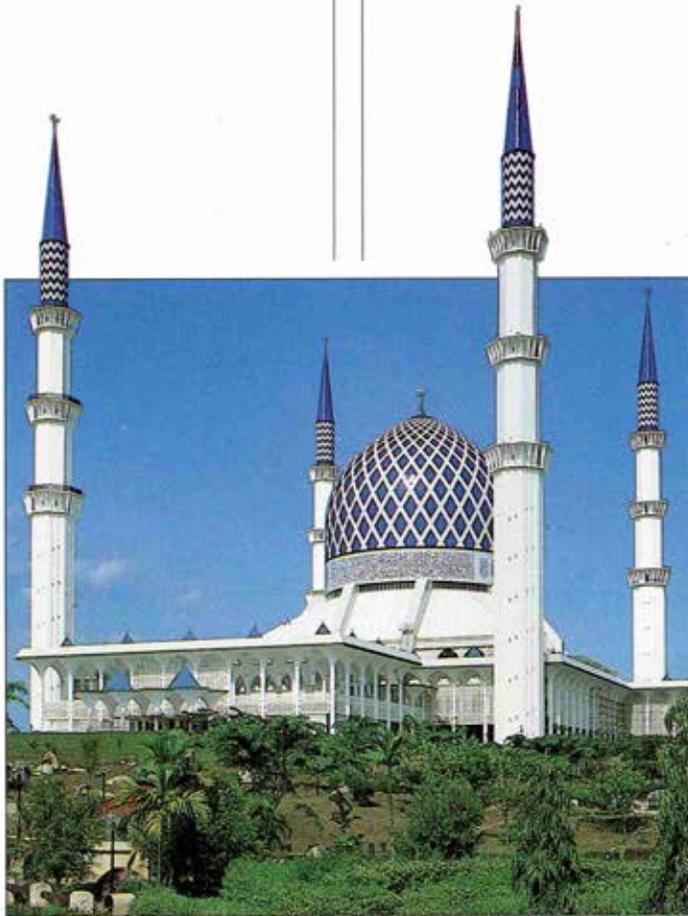
Enamel puts a shine on metal

When Bayer acquired the enamel frit plant in Brugge, Belgium, from SCM Glidden Corporation, an important step was taken in the expansion of Bayer's already important position in this sector.

Bayer has been manufacturing enamel products since the end of World War II. Enamel itself is, of course, a great deal older; in ancient times, it was admired for its ornamental character in both interior decorations and jewelry. Since then, it has become an important form of material protection for metal in such everyday articles as pots and pans, bathtubs, shower stalls, sinks and a host of other household items. The advantage is that enamel has not lost its purely aesthetic qualities in the process.

Enamel has also gained an excellent reputation in such high-technology applications as corrosion protection in the heat exchanger units of power stations or microelectronic components.

Enamels are glasslike substances that are produced by smelting such raw materials as quartz, feldspar, borax, titanium dioxide, soda and other components. In order to apply the substance to a surface—generally steel or cast iron—the enamel mass is either turned into a spreadable paste by a wet process or ground into a powder by a dry one. Enamel can also be applied as an electrostatically spreadable powder. At temperatures of 800° to 900° C, the powder melts to form a composite with the metal.



The dome of the Great Mosque of Shah Alam in Malaysia is fitted out with some 194,000 square feet of enamels from Bayer.

During the war, scientists in Leverkusen had looked for ways to replace the then-scarce borax by a different fluxing agent. In the process of their search, they stumbled onto sodium titanium silicate. Further research yielded the first-ever titanium white enamels for industrial use in 1942.

These various successes paved the way for Bayer's initial production of enamels after the war. The company subsequently went on to make further developments in the fields of process engineering, enamel processing and smelting technology.

As early as 1954, the first foreign production unit for enamels was opened at Garbagnate, Italy. It was soon expanded into a modern vitrifying operation.

The next steps were the acquisition of the plant in Brugge from SCM Glidden and the integration of the Mobay-Pemco works in Baltimore, Maryland, that had been acquired—also from SCM Glidden—in 1979. But the list of production units does not end here. There are now factories in Vitoria, Spain, Stoke-on-Trent in the United Kingdom and Saltillo, Mexico.

Bayer enamels enjoy a worldwide reputation. The dome of the Great Mosque of Shah Alam in the Malaysian city of Kuala Lumpur is covered with some 194,000 square feet of Bayer enamel. It is thus the biggest single enameled surface in the world.

an end to the development of this venture; Co-Fa was confiscated in 1945 and sold to the American Commercial Company.

Once again, though, it was soon possible to reforge connections with business partners in Italy. After the sequestration order was lifted, Bayer signed a ten-year representation and production agreement with Co-Fa at the end of 1950. Four years before this agreement was reached, the Italian company had already started to build a plant in Garbagnate, less than nine miles from Milan.

Also in 1946, Bayer was able to buy back its trademark and other rights in Italy, an important asset in the reestablishment of its position there. The Bayer cross has remained an extremely well-known and popular symbol in Italy and is invaluable for the company's comprehensive activities in the Italian market.

In the meantime, Co-Fa was not only acting as the Bayer agent in the pharmaceutical sector, it also took over the entire range of products from dyestuffs through chemicals to crop protection. In 1964, Bayer's financial holding company Bayforin acquired more than 95 percent of Co-Fa's capital, which turned out to be another historic step in the development of Bayer's business in Italy. Indeed, three years later the company was renamed Bayer Italia S.p.A. Its headquarters were established in Milan.

In 1962, Emails S.p.A., another subsidiary of Bayforin, had begun production of enamel frits in Filago. With an annual production volume of 12,000 metric tons, this unit was the biggest plant of its kind in Italy. In cooperation with Germany's Degussa, Emails S.p.A. also produced pigments and glazes for the large ceramics industry in Italy.

Whether for household use or for the construction industry, ceramics have long been an Italian specialty. Modena in the Emilia-Romagna region is the home of the world's largest concentration of tile producers.

To be as close as possible to this interesting market and to be able to react to the needs of its customers quickly, Bayer Italia set up a development laboratory

for ceramic materials at Spezzano, near Modena, in 1987. In this "Centro Sviluppo Ceramica," innovative products for the ceramics industry are being developed for the world market. Bayer Italia also manufactures ceramic frits and pigments at the Cannara works in Umbria. The pigments production that first began in Garbagnate has since been relocated to Filago.

The enamel and ceramics plants that Bayer has acquired were only the start in Filago. In order to meet growing demand, Bayer Italia broke the ground for a plant of its own in Filago in 1971. The first facilities were for the compounding of thermoplastics; an applications laboratory for synthetic rubber, plastics, coatings and polyurethanes followed in 1972, and a plant for the production of polyethylene foam went on stream in 1973. The production of resin mats and Perbunan began in 1976. A year later, aerosols joined the production program.

Today, Filago is Bayer's biggest Italian plant. The second biggest, which is located in Garbagnate, may be more than 40 years old, but it has been substantially modernized over the years and is an important center for pharmaceutical production today. "Aspirina," as the famous drug is called in Italian, anti-allergic drugs and diagnostic products are manufactured at this site. And Garbagnate also houses a plant for the production of raw materials for coatings. In addition to these two major works and the Cannara unit, Bayer Italia operates two more small pharmaceutical factories since the acquisition of Sighurta in 1981.

With the expansion of Bayer AG's international activities over the years, Bayer has become more in Italy than just Bayer Italia. Local subsidiaries of Miles, Agfa-Gevaert and Haarmann & Reimer now also belong to the group of Bayer companies. Bayer has no doubt established a good position in this fascinating country, which has a national market with enormous potential.

1967

Mobay becomes a full-fledged Bayer company

A suit by the antitrust authorities of the U.S. Department of Justice forced Monsanto and Bayer to part company. In 1967, the joint venture Mobay Chemical Company became a 100-percent Bayer subsidiary.

Ulrich Haberland and the Bayer Board of Management were convinced from the start that the company would not be able to resume operations in the United States where it had left off before the war. The patents had been lost, and Bayer, unlike BASF and Hoechst, had not even been able to retain the use of its name in the United States after the war. It was obviously going to be necessary to blaze a new trail. In 1952, Kurt Hansen was sent to the United States to probe the various possibilities left open to the company.

Polyurethane chemistry with its fast-expanding fields of application was a business where Bayer had a headstart. The Monsanto Chemical Company based in St. Louis, Missouri, had long been experimenting with isocyanates, but unfortunately in vain. So when Hansen appeared at their door, the company was immediately ready to buy a license from the German visitor. However, this was not what Bayer had had in mind.

In the end, the Americans met with Bayer in Leverkusen and an agreement was reached on a joint venture for the production of polyurethane raw materials for foams and coatings. Mobay Chemical Company, whose name was taken from the first letters of the names of its parent companies, was set up at its present home in Pittsburgh, Pennsylvania, in 1954.

The first plant was constructed in New Martinsville, West Virginia, and it subsequently went on stream at the end of 1955. Both companies benefited from the deal: Monsanto had gained entry to the promising engineering plastics market and Bayer had found a partner who could provide the capital it did not yet have at its disposal in the United States. The market expanded at an enormous pace. All went well—until 1964.

In that year, the U.S. Department of Justice brought action against Mobay on the grounds that if two companies join up to produce something that either one of them had the potential to produce on its own, it constituted a violation of free competition, and thus contravened the American Antitrust Law.

The original and the modernized trademarks of Mobay Corporation are shown on the right. The Mobay Chemical Company was set up as a joint venture of Bayer and Monsanto in 1954 for the production of polyurethane raw materials. Its name was formed from the first letters of

the two parent companies. The partnership had to be dissolved, however, due to an antitrust suit. Since 1967, Mobay has been a 100-percent Bayer subsidiary.

Monsanto was all set to fight this suit. The American company protested against the term "potential," claiming that Bayer was the only one with the potential.

In a publication marking its 75th anniversary, Monsanto asked ironically: "Can it also be said that a one-year-old boy has the 'potential' to be a father?" The company's lawyers contested the antitrust case for several years.

It was rather awkward for Bayer to be involved in legal proceedings of this kind at a time when the German company wanted to build up its American presence. Bayer therefore offered to buy up Monsanto's 50-percent holding in Mobay. Monsanto accepted Bayer's proposal, and in its 1967 annual report, an extraordinary profit during the first quarter of almost \$6.4 million was recorded from the sale of its Mobay shares. Mobay, which retained its name, was henceforth a full-fledged member of the Bayer family.



The further development of the U.S. company was to go beyond its original activities as a polyurethane manufacturer. In 1974, Bayer decided to amalgamate all of its six affiliated companies in the United States under the name Mobay. But this story will be told in a separate chapter.

Bayer



Bayer chronicle 1967

A large-scale system for electronic data-processing is installed at the Leverkusen plant's computing center.

Bayer acquires a majority holding in Maschinenfabrik Hennecke, with which it develops polyurethane foaming equipment.

A Dralon fibers plant is built in Lima, Peru, and an animal health research station is opened in Australia. Bayer Hispania starts production of alkyd and polyester resins in new facilities near Barcelona; in India the Group begins producing rubber chemicals.

Management and employee representatives reach an internal agreement that introduces monthly cashless wage payments to blue-collar workers.

Bayer and the Berlin company Schering sponsor a DM 10,000 prize for the German Diabetes Association.

World events 1967

East German Parliament orders the introduction of a separate nationality for citizens of the German Democratic Republic.

On March 1, the British House of Commons decides to convert the British currency to the decimal system beginning in 1971.

Led by Martin Luther King, some 350,000 Americans demonstrate in favor of civil rights on April 15.

The Biafran War begins on May 30 after the province of Biafra declares its independence from the Nigerian federal government.

On June 5, Israel launches a preventive strike against Egypt. In the "Six Days' War" the Israelis capture the Old City of Jerusalem, West Jordan, the Golan Heights, the Gaza Strip and the Sinai Peninsula.

South African surgeon Christiaan Barnard performs the first successful heart transplant on December 3. The patient lives with his new heart for 18 days.

The World Health Organization (WHO) initiates a program to eradicate smallpox, which had still claimed some 60,000 lives in 1966.

Behringwerke of Marburg introduces the first multiple vaccine against polio, measles, diphtheria, tetanus and whooping cough.

The fight against the “scourge of Allah”

Bilharzia, also known as schistosomiasis, is second only to malaria as the most common tropical disease. More than 200 million people are suffering from this disease in Africa, South America and the Far East.

Toward the end of the last century, Egyptologist Heinrich Brugsch deciphered a 3,000-year-old papyrus that described the sickness “âââ” as “*an incurable, fatal disease sent by the god of death that tortures men and women with severe stomachaches, palpitations of the heart, and pains in the heart and sides.*”

In 1910, Sir Marc A. Ruffer, a bacteriologist and a pioneer of paleopathology, reported the discovery of two calcified schistosome eggs in the kidney tubules of two mummies from the period of the 20th dynasty (1200–1090 B.C.). This evidence proves that the Egyptians already suffered from bilharzia under the Pharaohs of ancient Egypt.

In the following three millenia, bilharzia endured as the fate of mankind. It came to be known as the “scourge of Allah” because there was no other understandable explanation for its cause.

The disease was studied in the 19th century by German physician Maximilian Theodor Bilharz. He went to Cairo in 1850 as the assistant to Tübingen professor Wilhelm Griesinger, who had accepted a chair at the university in Cairo.

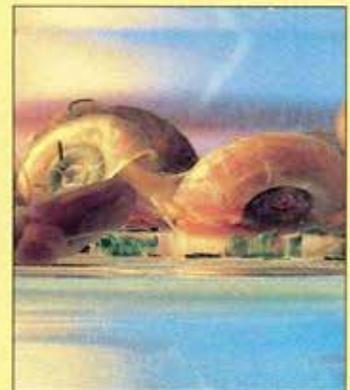
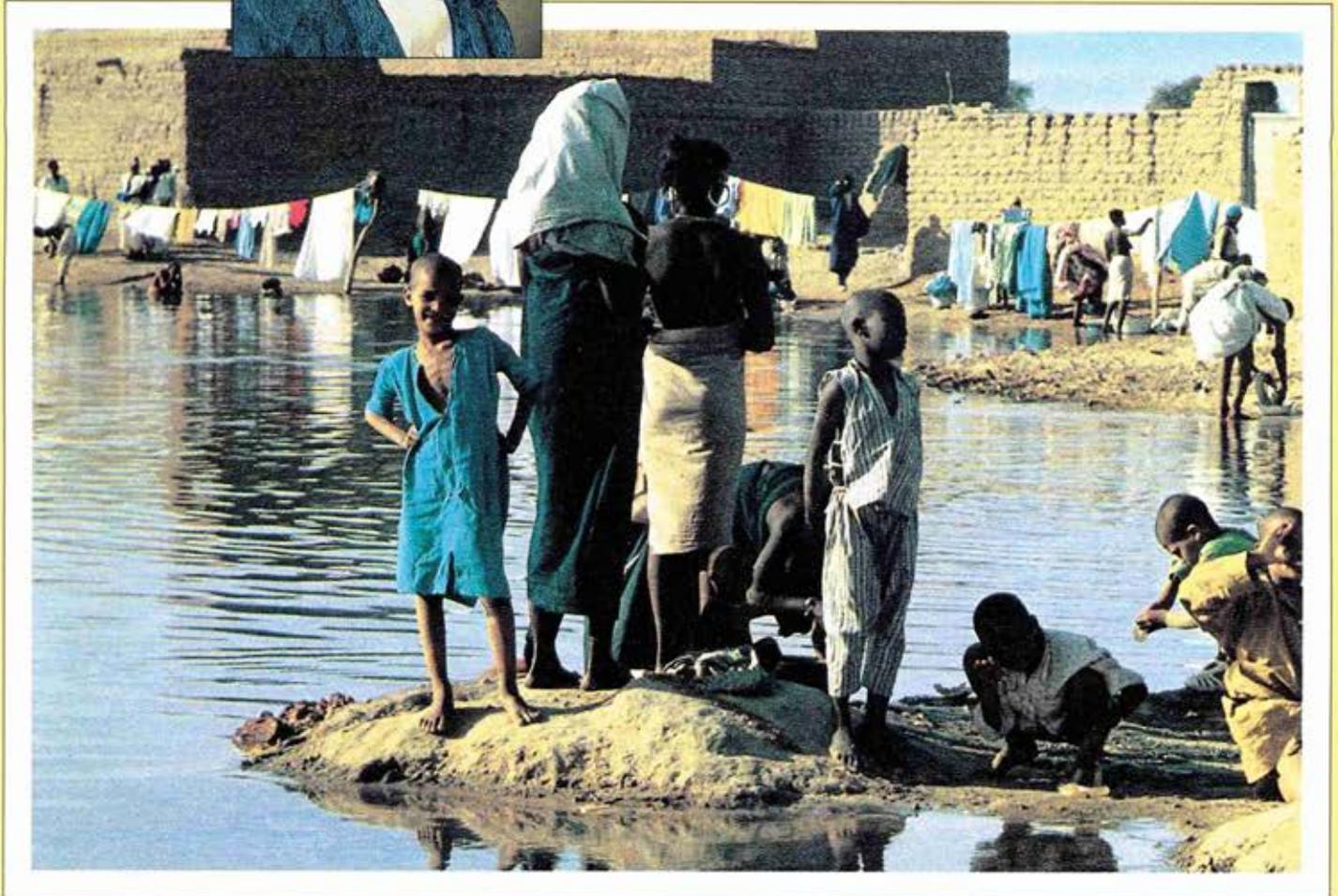
Bilharz was 25 years old and full of curiosity. He was given the task of performing autopsies on the bodies of Egyptian soldiers at the university hospital. After some 400 such post-mortems over a 17-month period, he wrote to his former teacher, the famous Freiburg zoologist Carl Theodor von Siebold, “*I have already found four new human-intestinal worms.*”

Bilharz suggested the name *Distomum haematobium* for the worm that was to be decisive for the future research work on the disease. A friend of Theodor Bilharz began using the term “bilharzia” in publications from about 1856 onwards, while a British scientist wrote of *Schistosoma haematobium*. This is how the disease came to be referred to by the two names of bilharzia and schistosomiasis.

Bilharz died of typhus after having been in Egypt for 12 years. He had only lived long enough to express his suspicion that the pathogenic agent “came from the water.” It was not until 1914 that Japanese



Maximilian Theodor Bilharz
1825–1862



Of the tropical diseases, bilharzia has been—and still is—one of the scourges of humanity. Working in the mid 19th century, South German physician Theodor Bilharz traced the disease to the *Schistosoma haematobium* leech, which attacks

humans in tropical waterways. This parasite uses snails as an intermediate host for its larvae.

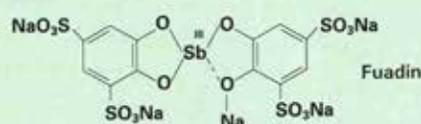
The fight against bilharzia

As is the case with malaria, bilharzia can only be effectively controlled when measures are taken simultaneously against both the disease and the corresponding cycle of infection. Bayer has developed successful active agents to be used in both directions.

Drugs against bilharzia

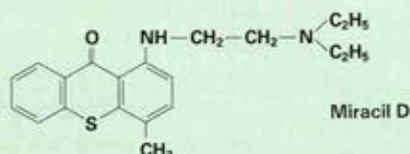
Successful experiments to counter bilharzia and other tropical diseases with such antimony substances as tartar

emetic had been carried out earlier. Bayer itself was active in this field in the 1920s, and development work continued at the Elberfeld plant during the I.G. Farben era. A problem lay in the poor tolerance of these products. A substance was not found that would be suitable for more general use until the development of Fuadin, the sodium salt of an antimony(III) complex:



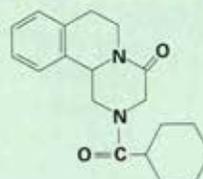
Researchers subsequently turned away from a therapy with antimony-based substances and made use of lessons learned in the battle against malaria: the first

orally administered bilharzia drug, Miracil D, was introduced in 1952. Its formula shows its chemical affinity to Atebrin:



The real breakthrough in the pharmaceutical treatment of bilharzia came with the development of Praziquantel, whose active agent was synthesized by the Darmstadt firm E. Merck. Bayer scientists

subsequently recognized the significance of this active agent in the therapy of the disease. The two companies cooperated in the development of this substance to a finished drug.

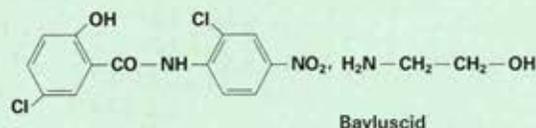


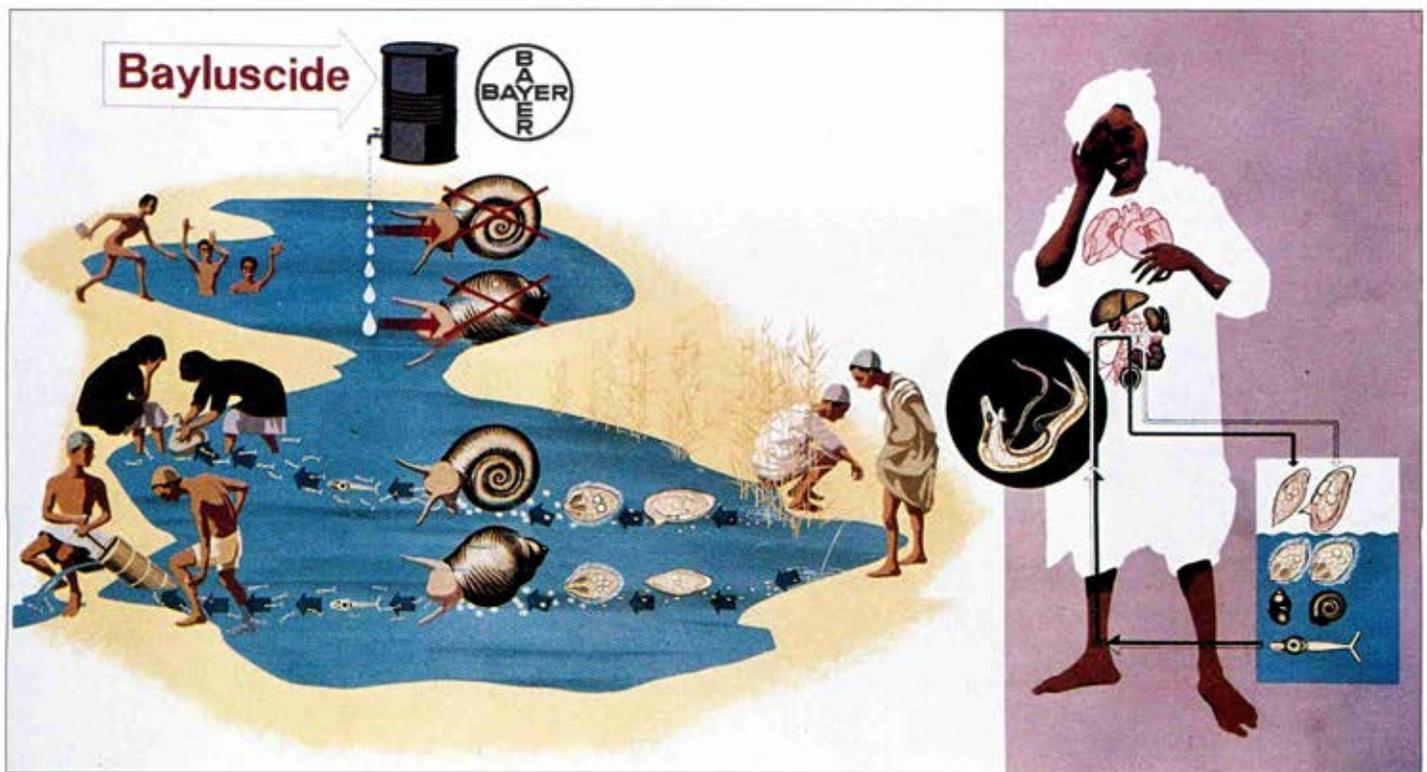
Agent to combat the carrier snail

After the decisive role of certain freshwater snails in the spreading of the schistosoma had been identified, effective substances and methods of attack were sought for their destruction. In the 1950s, several different researchers carried out a number of successful experiments with copper sulfate, pentachloro-

phenol and dinitro-o-cyclohexyl phenol. For various reasons, not least for ecological considerations, these substances were not suitable for widespread application.

In the end, systematic studies with substituted salicylanilides performed by Bayer led to the development of Bayluscid:





researchers Keinosuke Miyairi and Minoru Suzuki proved that an intermediate host was necessary to spread the disease.

Schistosomiasis of the bladder occurs primarily in Egypt, the Sudan, Madagascar and East, West and South Africa. This form of the disease is similar to schistosomiasis of the intestines, which leads to an enlarged liver and spleen and occurs in those areas as well as in South America, Surinam, Puerto Rico and parts of the West Indies. In central and southern China, Japan, Taiwan, the Philippines and the Celebes, *Schistosoma japonicum* attacks the digestive system, in particular the liver and spleen. Animals also suffer from this disease.

Explained in simplified terms, the vicious circle of the disease takes the following course: Parasitic worms penetrate the skin of people bathing in or wading barefoot through infected water. The female lays between 300 and 3,000 eggs daily in the bloodstream, most of which penetrate the walls of the large intestines or of the urogenital tract. The coupling leeches can live in the body for 20 or more years.

The eggs enter the water again via excrement. Ciliate larvae hatch out of the eggs and seek a specific freshwater snail as an intermediate host. In the snail they change into sporocysts as a secondary larval form, which subsequently transforms into so-called cercaria, the next stage in the life of the fluke. A snail can produce several hundred thousands of cercaria in a few months time.

The tiny (0.5 mm) cercaria leave the snail and again penetrate the skin of humans or animals. They reenter the bloodstream, thus causing the disease. The vicious circle continues.

In 1928, between eight and nine million people in Egypt alone were suffering from bilharzia. Three years earlier, Bayer had introduced Antimosan for use against animal parasites. The Egyptian government decided to try out a form of this product against the disease. In makeshift hospitals made from tents, some 150 patients were successfully treated with the substance which had been modified for human use. In honor of King Fuad I, the product was later named Fuadin. The experiment was in fact only a partial success because Fuadin had to be injected and was thus unsuitable for widespread application.

Some 15 years later, work in another field in Elberfeld led to an alternative solution. Substances obtained by structural modifications of the anti-malarial drug Atebrin proved to be effective against schistosomiasis. Chemotherapeutical testing took place during the Second World War, but there was no opportunity for field tests.

After the war, trials were carried out in Egypt, the Congo, southern Rhodesia and South America. As a result, Miracil D was introduced.

In 1962, the snail-killer Bayluscid opened up a new way to counter the disease. By destroying the intermediate host, the parasite's life cycle could be broken, thus preventing the spread of the disease.

The illustration above is used for instructional purposes in areas suffering from bilharzia. Easily comprehensible by illiterates, it shows how the pathogenic agent enters the body and what harm it causes.

A concentration of 0.3 grams of Bayluscid per 1,000 liters of water was enough to kill the snails and their larvae. After field tests in eight African countries, WHO determined that Bayluscid was the most effective, most economical and environmentally most acceptable product to combat the intermediate host of bilharzia.

In 1967, the Federal Republic and Egypt decided to carry out a field trial project on a scale without precedent up to that time.

The El Fayoum oasis, some 60 miles southwest of Cairo, was inhabited by 1.2 million people, 85 percent of whom were infected with bilharzia. The oasis is criss-crossed by some 24,600 miles of waterways, mainly irrigation ditches, carrying some 495 million cubic feet of water. This entire area was to be completely freed from the conditions that led to bilharzia.

The Federal Republic supplied 33 trucks, 12 vehicle-mounted sprayers, 180 portable spray units, three laboratories and 600 metric tons of Bayluscid, as well as a number of experts. Work began in the fall of 1968 and lasted for three years; the water was treated with Bayluscid twice a year. By 1971, only 17 percent instead of 85 percent of the population of the oasis was infected. Of the children who had contracted the disease before 1968, only 2.6 percent were infected. All children born after 1968 were healthy.

This was a major success in the fight against bilharzia. However, it was an isolated success since the conditions in the El Fayoum area were not necessarily identical to those elsewhere.

For example, these results would not have been possible in a region where the snails are carried away by the current before they can be effectively destroyed. Nor could the success be reproduced in areas where rivers cross national borders.

The oasis conditions do not apply to the Nile either, where the Aswan Dam has proved to be a huge breeding ground for snails. It was thus necessary to find a universally applicable drug against the pathogenic agent itself. A decade of joint research efforts by Bayer and the Darmstadt company E. Merck, in cooperation with the WHO, led to the breakthrough: in 1980, Praziquantel—sold by Bayer under the name of

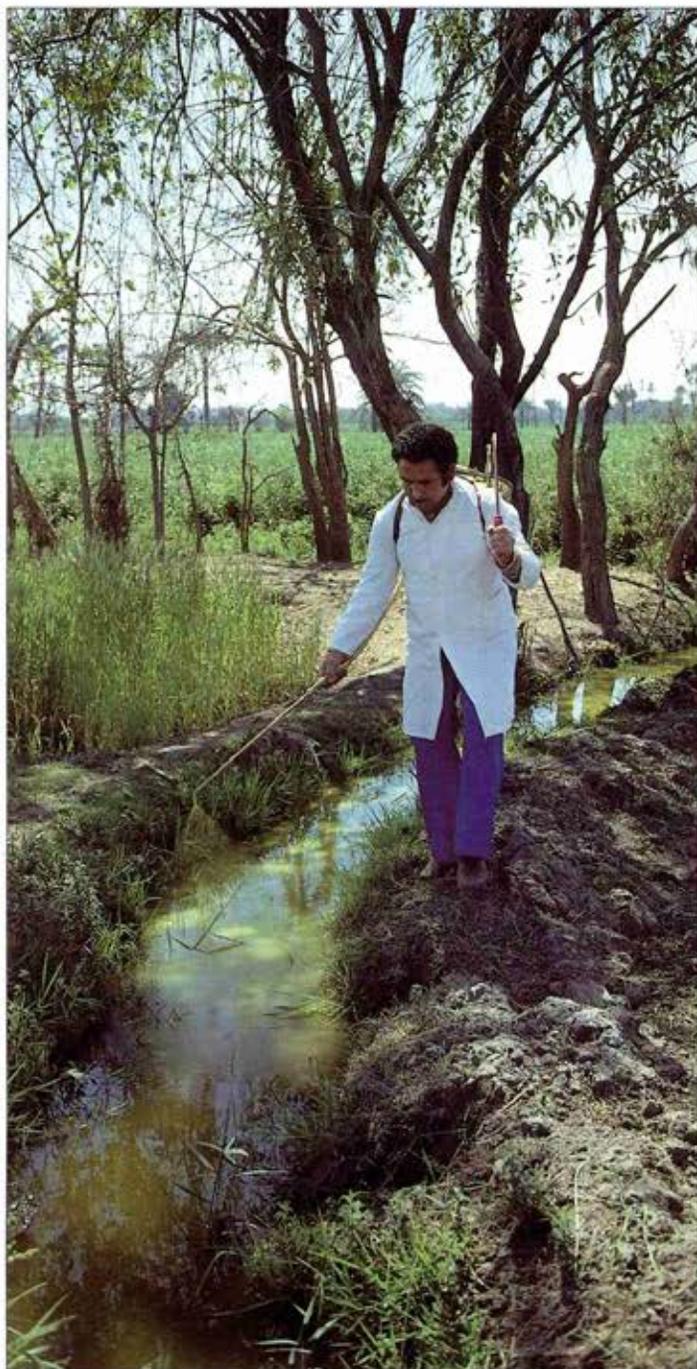
Biltricide—came on the market. Praziquantel is effective against all kinds of schistosoma, whereby a single oral dose is enough to kill all the flukes in the organism in 90 percent of the cases.

The two companies won the German Galenus Prize for the new drug and, in 1987, the French Prix Galien, which is awarded annually for an outstanding pharmaceutical product and for a particular scientific achievement. Bayer had already received this French prize in 1980 for its Adalat, a drug used against heart disorders, and is thus the only pharmaceutical company to date to have been awarded the Galien prize twice.



The official, bilingual emblem of the Egyptian-German Joint Project for Bilharzia Control is shown above. This so-called El Fayoum Project stresses the importance of eliminating the snails as the intermediate hosts for the parasite in the fight against schistosomiasis.

Their destruction means that the disease can no longer be passed on to humans.



The joint Egyptian-German program was started in the El Fayoum oasis in 1968, when 600 metric tons of Bayluscid were sprayed into waterways extending over a total of some 24,200 miles. Spraying was done by airplane, by motorized devices and even by hand in

the smaller ditches in fields. The campaign was a great success. When it was initiated, 85 percent of the local population was infected; in 1971, only four years later, this figure had dropped to 17 percent.

Bayer chronicle 1968

Ethylene replaces acetylene as the raw material in the process used for the production of the intermediate vinyl acetate. Hoechst participates in the development initiated by Bayer. A total of 17 licenses in various parts of the world adopt the process for their own use.

The world's first fully automatic rubber testing center is opened by Bayer.

Bayer's three Brazilian subsidiaries are consolidated to form Bayer do Brasil. An 18-acre site on which a headquarters operation is to be built is purchased in São Paulo.

Bayer UK is founded in Richmond. It functions as a holding company for Bayer's British affiliates.

The Bayer subsidiary Verona Dyestuffs in the United States starts the construction of a dyestuffs plant at Bushy Park, South Carolina.

On March 5, the marketing company Bayropharm GmbH is incorporated in Cologne-Mülheim.

World events 1968

Attempted assassination of German Socialist student leader Rudi Dutschke in Berlin on April 11 results in demonstrations throughout the country, some involving violent confrontations between students and the police.

Student demonstrations, in which trade unionists also take part, lead to unrest in France that brings the country close to civil war conditions.

The U.S. presidential candidate Robert Kennedy is assassinated in Los Angeles on June 6.

Warsaw Pact troops march into Czechoslovakia on August 20 and put an end to the so-called "Prague Spring."

On October 10, a new outbreak of violence starts between Catholics and Protestants in Northern Ireland.

The German patents law is amended to allow patent protection not only of chemical processes but also of the substances themselves.

From adult education to top-notch cultural events

In the fall of 1969, the city of Leverkusen opened the "Forum," a spacious cultural center. At first Bayer had nothing to do with the center—at least to the extent that there can be anything in Leverkusen that Bayer has nothing to do with. But this new center soon proved to have initiated a new era in the company's own cultural activities.

As big as Bayer's "Erholungshaus" recreation center may be with its almost 1,000 seats, it lacks the technical installations to be able to stage such major events as operas, ballets or large-scale theatrical performances. These are, however, possible in the Forum.

The company decided to work out an agreement with the city's department for the arts. Contracts were drawn up with the aim of cooperating to improve Leverkusen's cultural program. Bayer was thus allowed to use the Forum for its own purposes, too. And when the stage of Bayer's "Erholungshaus" center burned down in January of 1975, the city's Forum proved to be much more than just a convenient alternative stage for one and a half years.

Cultural activities at Bayer have altered considerably over the years. The company's first amateur dramatics society was founded at the beginning of this century, and the precursor of today's Cultural Department, the "Central Office for Educational Programs," was set up in 1908. This department built up an interesting and varied program until everything was "brought into line" by the Nazis and finally, just before the end of the war, all theaters in the Third Reich were closed.

With the support of Ulrich Haberland, cultural activities soon started to flourish amid the postwar rubble, and Leverkusen once again was able to establish itself as a cultural center in its own right between the two cities of Cologne and Düsseldorf.

The opening of a new chapter in 1969 was not solely connected with the inauguration of the Forum. Several factors played a role in changing the cultural program at Bayer.

Accustomed to the technical perfection of radio and television, audiences demanded more sophisticated live performances. At the same time, the very word "culture" had become suspicious to a younger German generation that had not yet recovered from the social unrest of the previous year. From the point of view of many young people, culture had come to characterize the escapism of their elders from the brutalities of war and the superficialities of a materialistic society.

Whether one agreed with this simplified analysis of the world was not the question. But Bayer realized that the younger generation was truly looking for new substance, new statements and new forms of art. The company accepted the implied challenge and expanded its cultural program to include more critical and contemporary artists and works.

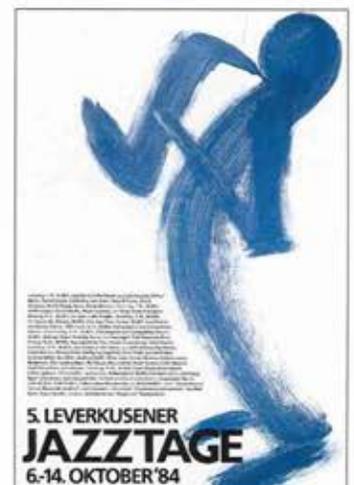
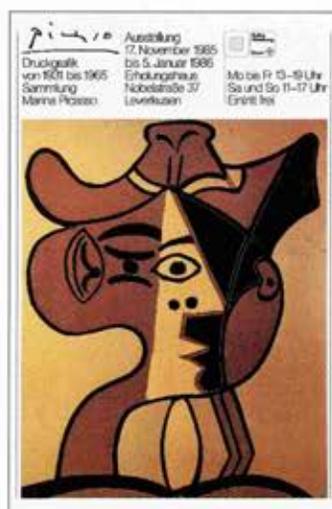
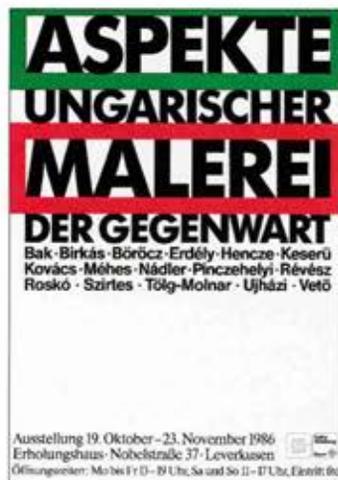
Unfortunately, the kind of art that arouses the enthusiasm of young people often evokes the opposite reactions in the older generations. A way had to be found to give both groups their fair share. The tactic was "conserve the old and try out the new," which may sound simple, but it was not easy to put into practice. If the existing program were changed to please the tastes of both generations, every event would have played to only half an audience. To avoid this problem, Bayer expanded the overall scope of activities in order to keep everyone satisfied. The Cultural Department thus developed into a full-scale cultural "agency."

Today, the department's program covers about a hundred public events per year. And it is not an exaggeration to say that a list of the famous actors and actresses, soloists, orchestras and choirs who have made guest appearances in Leverkusen would easily read like a who's who in contemporary performing arts.

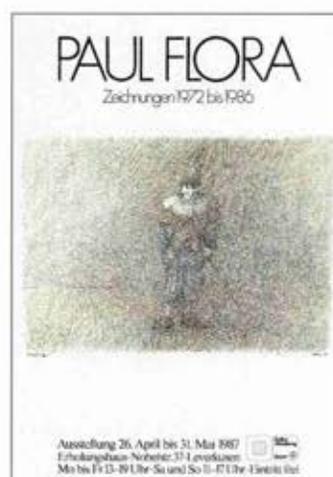
But not all artists have to be brought in from the outside. What started as an amusing occupation in the leisure hours of employees has, in many cases, long developed into top-class cultural performances.

The cultural societies of the works have grown in size and significance to an extent that nobody could have predicted back when they were founded early this century. Their talent is in fact admired far beyond both Leverkusen and Germany. For example, the Bayer Philharmonic, one of the country's best-known corporate orchestras, had a triumphal reception in Britain and Switzerland in 1986, and the Bayer Men's Choir of Leverkusen was acclaimed with great enthusiasm in Japan and Korea that same year.

Visual arts are not overlooked in Bayer's cultural program either. An example of Bayer's commitment in this field is the "GaLerie am Werk," an art gallery that was opened in 1980 at the edge of the plant site.



This center provides a meeting place for Leverkusen's own artists and an opportunity for these artists to "communicate" with their environment.



This collection of posters commissioned by Bayer's Cultural Department shows only a small sample of the range of performances and exhibitions offered to the public.

Having the right education to qualify for success

After six years of construction, the education and training center in the Flittarder Field section of the Leverkusen works was opened in 1969. The various lecture rooms, training laboratories, pilot plants and apprentice workshops as well as the plant's two vocational schools were now concentrated on a single site.

When Bayer opened a training workshop and school for apprentice toolmakers in 1901, it was one of the first companies to have such facilities at its disposal. The combination of schooling and practical training was way ahead of its time. Much later the concept of "dual" education was to become law, and it is now the general rule.

Today's younger generation would be quite amused to glance through the code of conduct for the trainees at the turn of the century. One regulation reads as follows: *"Pupils are obliged to engage in well-mannered behavior both within the school and elsewhere. They have to obey the instructions of their teachers and superiors willingly and comply with paternal discipline."*

The first training laboratory was established in 1913, but it had to be closed again during the First World War. With room for 40 trainees, the second was opened in 1928, for the first time under the supervision of a full-time principal. However, this facility ended up a victim of the cost-cutting measures introduced three years later. The third training laboratory, which could accommodate up to 48 trainees, was set up in 1937 and was later expanded to handle 100 pupils.

After World War II, there was a major influx of adults without suitable professional training into the chemical industry. Bayer instituted evening courses for these people. Attended by hundreds of employees, this vocational schooling was recognized with a Chamber of Commerce diploma.

Advanced-training courses for toolmakers led over the course of time to the establishment of a works vocational school for technical trades. After this first step was taken, a vocational school for chemical trades was opened in 1951 and an evening school for chemical technicians in 1966. In 1971, these three schools were merged. Training centers were subsequently set up in Dormagen, Uerdingen and Elberfeld, too.

In 1965, there were 47 trainee occupations within Bayer, and not only for scientific and technical professions. Young people could also be educated to

Generations of technicians have been trained in Bayer plants. Back in former times, it would have seemed quite unimaginable, but today, women are every bit as successful in technical professions as their male colleagues.

The picture (bottom right) shows the diploma of the first toolmaker apprentice, who became a journeyman on June 1, 1904.



Lehrzeugnis.

Dem *Yngve Eriksson* ist durch *Yngve Eriksson* bezeugt, daß er am *1. Januar 1908* als *Lehrling* in unser *mechanische Hauptwerkstatt* in *Essen* eingetretten ist und am *1. Januar 1908* sein *Lehrjahr* ordnungsgemäß beendet hat.

Seine *Arbeitszeit* und *Verhalten* hat *sehr gut* für *Lehrlinge* war *sehr gut*.

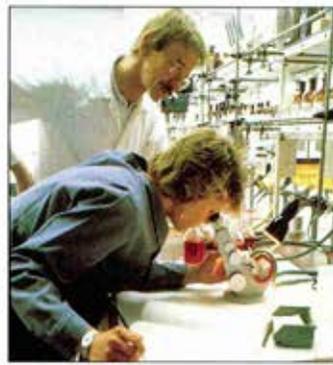
Die *Lehrzeit* - *Verhaltenszeit* hat er mit *guter* - *Erfolg* beend.

Die *Direktion* der *Barkenscheitler*

Friedr. Beser & Co.

Essen, den *1. Januar 1908*

Yngve Eriksson



become commercial clerks, and there was professional training for cooks and gardeners. A total of 2,452 young people were employed as trainees, and they were supervised by a training staff of over 200 full-time and about 1,500 part-time teachers.

These figures have since grown from year to year. In 1986, the number of trainees had reached 4,700, including 1,645 pupils in their first year of training. Today, Bayer is accredited to train young people in 60 different occupations. The success rate is still high—over 95 percent of all apprentices and trainees passing the final diploma examinations.

Today's apprentices and works trainees tend to have different backgrounds than those of yesterday. Every fourth Bayer trainee has the German equivalent of a high school diploma. The enrollment of trainees in the various courses has shifted considerably as a result of the new qualifications demanded within the company. In 1986, some 46 percent of all trainees were in the scientific field, 29 percent in technical trades and 25 percent in the business and clerical sector. The ten leading occupations for male and female trainees are:

1. Chemical technician
2. Laboratory technician
3. Works toolmaker
4. Laboratory assistant
5. Office clerk
6. Clerical assistant/foreign language secretary
7. Commercial clerk/business assistant
8. Measurement and control operator
9. Industrial electrician/electronics technician for power stations
10. Biological laboratory technician

Bayer's training programs have always been a draw to prospective employees. At the peak of the baby boom years, up to eight young people were applying for every trainee position offered; in the case of the so-called "business assistants," sometimes more than 20 applications were received per available trainee spot.

In a modern company, formal education is not enough; there has to be a system of further educa-

tion to back this up. This concept, too, has a long tradition with Bayer.

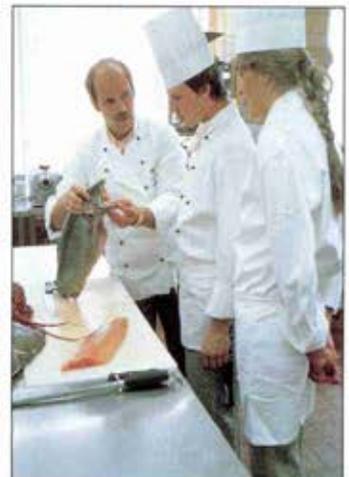
Back in 1907, it was decided that "a librarian with a university education and living in Leverkusen will be hired with the additional duty of giving lectures to workers and staff on general scientific subjects."

These efforts have since been highly diversified and expanded. The wide range of courses appeals to the most varied groups of employees. There are both daytime and evening classes, as well as correspondence courses. In 1986, every third employee attended one of the company's 1,400 courses for further education.

The enormous speed of technological advances naturally spurred the necessity of further education. Today's working world with its process control systems, electronic data processing, computer-aided machine tools and new materials calls for constant updating of occupational skills. Due to the requirements of the production facilities, employees must also be kept up to date with developments in the important fields of occupational safety and environmental control.

A vital task of further education is to supplement existing training and disseminate new information in keeping with changes in the workplace. Salespeople are informed about the product line and then kept abreast of any new developments. Employees who are to be transferred to a position abroad or who correspond regularly with foreign countries are given the necessary language instruction.

Another important fact is that Bayer employs a large number of highly specialized experts who have to be able to work easily with people from other fields. This staff benefits from seminars in communication and cooperation techniques. For example, they practice in these courses how to make themselves understood by non-experts, how to listen attentively, how to ask questions properly and



Apprenticeships are offered in some sixty different occupations at Bayer today. Many of the training programs are for jobs that are not at all typical of the chemical industry, such as gardening and cooking (right).

how to let everyone have his say in discussions and conferences. Communication training is also of great importance for those who have a lot of contact with the public.

Generally speaking, the ability to cooperate calls for a mutual understanding of the basic subjects being discussed. This means that chemists and engineers, for example, should learn some elementary law and economics, while sales staff are advised to gain some scientific background. Anyone who is to take over major responsibility at Bayer has to keep learning all the time and prove his or her worth in various jobs; this includes foreign experience, too.

Some of those entrusted with instruction in the secondary training programs are full-time members of the various training departments. But also a large number of professionals from different corporate operations volunteer to pass on their know-how in addition to performing their regular duties.

Experts from universities and other places of learning are also invited to give courses at the company. Part-time teachers are themselves free to take part in "train the trainer" seminars to learn teaching methods and improve the efficacy of their instruction. And all the courses make use of modern teaching methods and equipment. Numerous training films on specific topics are even produced in-house.

The worldwide presence of the Bayer Group necessitates a close cooperation in educational fields between the parent company and subsidiaries. Training programs are offered on an international basis, experience is swapped and experts are sent abroad. The purpose is to make sure that existing know-how is spread as far as possible throughout the Group.

In Bayer AG's personnel and training programs, there is also room for the disadvantaged. For example, special support programs cater to unemployed youngsters, and "learning by doing" courses are offered to school dropouts and young foreigners.

Bayer chronicle 1969

With the further development of Eulan-Asept, textiles can already be made antimicrobial and mothproof during production.

The ground is broken for the Dralon fibers plant in Lima; this unit is to become Peru's biggest chemical facility.

Bayer Pharma Indonesia is established.

Bayer Hispania buys a site in Tarragona for the construction of a new plant to manufacture isocyanates.

Bayer acquires the pharmaceutical manufacturing



company, Troponwerke Dinklage & Co., in Cologne.

Bayer helps to establish the international chemical documentation center in Frankfurt.

With Sumitomo Chemicals, Bayer sets up the joint venture Sumitomo Bayer Urethane in Japan.

World events 1969

Headline of the year: at 3:56 a.m. Central European Time on July 21, Neil Armstrong becomes the first man to set foot on the moon.

On March 2, the Anglo-French Concorde becomes the first commercial airline to fly at supersonic speed.

Republican Richard Milhous Nixon is sworn in as the 37th president of the United States on January 20.

Denton A. Cooley implants the first plastic heart in Houston, Texas, on April 4.

After a referendum, General Charles de Gaulle resigns as president of the French Republic on April 28. At the end of an interim period, he is succeeded by Georges Pompidou.

Army Chief of Staff Muammar Gaddafi deposes Libya's King Idris I.

In the Federal Republic of Germany, the Social Democrats form a coalition government with the Free Democrats on October 21. Willy Brandt is elected chancellor and Walter Scheel becomes vice-chancellor and secretary of state.

The U.S. space observatory OAO 2, in orbit since December 7, 1968, transmits four million data to Earth in its first year of operation. This is 20 times the information that has been collected by all astronomers in the preceding 15 years.

Adjusting to local cultures : case study Thailand

The Bayer Group is represented in almost every country of the world. Each of these countries has its own specific customs and problems, which Bayer has to adapt to. As self-evident as this statement may sound, it is a simple, but hard fact of the international business world.

In 1970, the administrative headquarters of Bayer Thai Co., Ltd. was inaugurated in Bangkok. This modern building, the work of a Swiss architect, lies on North Sathorn Road, one of the main traffic arteries of the Thai capital with its population of six million.

Some years after the opening, a fatal car accident occurred in front of the office. The Buddhist staff felt they knew why. It was once again time, they said, to invite the high priest and his assistants to honor Chaotee, the house spirit who had a little temple to the left of the office entrance. The sacred rite took place in the presence of the entire staff. After the ceremony, everyone was relieved that the spirit had been appeased.

Every morning Chaotee is honored with such gifts as fresh flowers, rice, vegetables, soup and drinking water. In return for this reverence, he protects the house and all who work there. And he also protects their jobs. Bayer has a total of 750 employees in Thailand, and only six of them are "farangs," as the Thais call foreigners, or in this case Europeans.

Twice the size of the Federal Republic, Thailand has a total of 53 million inhabitants and is the world's biggest rice exporter. It has, however, lost such important customers as the Philippines and Indonesia,





which have intensified their rice culture to such an extent that they have now managed to become self-sufficient. On the other hand, Thailand has retained its traditional markets in Malaysia, Singapore, Hong Kong and, to some degree, China. New customers have also been gained in the Middle East and West Africa, Europe and South America; thus the Asian country has succeeded in replacing the United States as the top exporter of rice. But Thai farmers still fear competition from the, in their opinion, "subsidized" American rice growers.

Some 80 percent of the total population lives from agriculture. Thailand not only produces rice, but also cotton, rubber, tapioca, corn, soybeans, tobacco, palm oil, vegetables and tropical fruit. The forests of northern Thailand are the source of teak and other rare tropical woods.

A Bayer subsidiary was first set up in Thailand in 1962. Before its founding, the interests of the successor companies of I.G. Farben had been represented by a joint agency. Bayer Thai markets everything that the Bayer Group produces—from the Coryfinchen vitamin lozenges manufactured by Drugofa to the flavors of Haarmann & Reimer.

The first Thai factory was opened at Phrapradaeng in 1963, and a second was built at Bangpoo in 1982.

With the inauguration of these facilities, Bayer became a local manufacturer of pharmaceuticals, animal health products, agrochemicals and household insecticides. As a logical consequence of the market conditions, crop protection products and household insecticides have become the most important businesses for Bayer. They account for a total of 35 percent of country sales and have gained a market share of 13 percent, despite a lack of patent protection in Thailand and competition from domestic and foreign producers as well as imitators. Here, as in other countries, Bayer owes its success to its comprehensive customer services.

The problems facing Thailand's rice growers, and thus Bayer, are related to the world commodity market prices. In 1981, growers received 4,200 baht per metric ton of top-quality rice. This price plummeted to 3,600 baht the following year, 3,100 baht in 1983 and then on downward to 2,600 and 2,200 baht in 1984 and 1985. By 1986, a metric ton of rice brought no more than 1,800 baht on the world market.

The Thai government has intervened by supporting the falling rice prices during this persistent slump. Bayer Thai hopes to make a contribution of its own to ease the farmer's plight by helping to raise Thailand's agricultural yields.

Bayer first established operations in Bangkok in 1962. The house spirit Chaotee has his own little temple (left) to the left of the entrance of the Bayer building. Thailand is the world's leading rice exporter, a fact which makes agrochemicals a parti-

cularly important part of Bayer's sales program there. The photograph above was taken in 1985 on location for the company's agrochemicals documentary film entitled "The Voracious Enemy."

To be or not to be “Indian”

The Republic of India has continental dimensions: it is 13 times as big as the Federal Republic of Germany and has a population of almost 800 million. Bayer's first “passage to India” took place in the 1890s. Since 1970, the company has operated a major plant at Thane, near Bombay.



If you fly over the Thane plant in a helicopter, you can read on the roofs of the various factory buildings what is being made there: pharmaceuticals, rubber chemicals, pesticides. On the perimeter of the main works is the Tower Biology waste water treatment plant, Bayer's first unit of this kind outside Germany. A modern waste incineration plant was added in 1987. Some 1,300 people work at Thane. Jobs there are much sought after since the chemical industry is known to pay top wages, and Bayer has a good name as an employer. Loyalty to the plant is rewarded by Long Service Awards, and many a son has followed his father into the works.



A residential area with accommodations for the families of 12 Bayer managers stretches out under shade trees near the plant. In this way, the responsible person is conveniently within the immediate vicinity of his operational unit so that he is available to help out at all times. The technical manager is the only German working in the plant.

The production of pesticides may take place in the smallest building, but it is the single most important operation at Thane. Since the import of starting products is frowned upon, Bayer processes its own starting materials for the formulation of its crop protection products. Half of all base materials made in Thane are sold to other Indian pesticide producers.

There has never been any question about the importance of crop protection in India. Much of the population would have to starve if agricultural produce were not protected from weeds and pests.

Largely unobserved by the outside world, India launched the "Green Revolution" in 1970—the very year that the Thane works went on stream. India wanted to become self-sufficient instead of having to rely on imports of agricultural products. This policy soon made it possible for India to produce surplus quantities of wheat, rice and cotton that could be exported. If there is still hunger in India, the reason lies in the fact that many people cannot afford the available food, not for want of food itself.



An example from the Punjab, a state in northwest India between the upper Indus and Jumna rivers, illustrates how Bayer was able to contribute to the "Green Revolution." In 1976–1977 a new Mexican wheat variety was introduced to this region, which was expected to give higher yields than local varieties. What had not been expected was that the Mexican wheat would soon be in danger of being choked to death by weeds. Bayer saved the crop with its Tribunil.

The year 1984 brought with it the shock of Bhopal. In the worst industrial disaster of all time, 3,000 people were killed and many of the survivors lost their eyesight. Toxic gas had escaped from a pesticides plant of a foreign company. This appalling catastrophe prompted other producers—even those that were not involved with this incident—to ask questions about the safety of their own plants.

Bayer runs its operations according to the principle that Germany's stringent safety standards must be observed all over the world. Through the strict control of plants and conscientious training of its employees, Bayer tries to guarantee that accidents do not occur. The same care is given to the safety of the products themselves. Bayer complies with the demands of the Indian government that every pesticide has to be tested in India, even if comparable test results are available from other countries.

Bayer operates an experimental station that conducts studies on some 25 different kinds of plants at Kandlakoya near Hyderabad in the state of Andhra Pradesh. Its scientists are in constant touch with the research center in Monheim.

Bayer has 10 regional agencies and 20 distribution centers in India representing the interests of its crop protection products. Some 400 experts are in the field. When advising farmers, they use a series of instructional films, slides, posters and literature. Seventy of them are agronomists who not only speak Hindi and English but also have command of at least one of the 13 other official Indian languages.

The distribution centers supply 150 wholesale operators, who, in turn, sell the active agents to 12,000 formulating units and retailers. The actual

Bayer has longstanding links to the Indian market—initial contacts were made in the 1890s. Shortly afterwards, a branch was set up in Bombay. Today, the group operates a major production facility at Thane, near Bombay, which specializes in pharmaceuticals,

agrochemicals and rubber chemicals. The little seal shown at the top of the page pictures the Hindu god Vishnu. To the left is an old label once used on a dyestuff package destined for India.

consumers are millions of farmers in India's more than 600,000 villages. It has been estimated that Bayer advisers have visited some three million farmers to date.

Rubber plays an important role as a raw material in the Indian economy. The country is the world's fourth biggest producer of natural rubber, and its rubber industry as a whole has been growing at an annual rate of six percent over the past 25 years.

About one-third of the rubber is used in the production of truck tires; trucks are in fact the sole link between the many isolated villages and the outside world. The climate is hot, the roads are bad and 10-ton trucks regularly carry a 15-ton load, and so there is an understandably enormous demand for tires. Car tires are of much less importance since private cars are very expensive. Some 12 percent of the rubber is used in bicycle tires, and 15 percent goes to the shoe industry.

Natural rubber is cultivated in large plantations in India. What the country's rubber industry needs are rubber chemicals that can help to upgrade the natural product into a higher quality material. Bayer has thus been supplying rubber chemicals to the Indian market for many years and finally began local production of these chemicals in 1967. Today, the company is the market leader in India. Only 68 percent of the quota for the production capacity of rubber chemicals allowed by the government has been utilized by Bayer up to now. But business is guaranteed for the next 20 years if truck trans-

portation is going to continue to be used for the development of the Indian hinterland.

As with pesticides, Bayer's success in this field is largely due to the emphasis the company places on application technology. Its Technical Service Laboratories organize courses for the technicians from the whole area of Southeast Asia.

The Bayer Group owns 51 percent of Bayer India Ltd., the successor of the original company Bayer Agrochem that was founded in 1958. The remaining shares are divided up between more than 8,800 other shareholders, many of them employees. But the legal form of Bayer India Ltd. also has its disadvantages.

According to the Foreign Exchange Regulations Act of 1973, companies can only be considered "Indian" if foreign participation amounts to less than 40 percent of the capital. Particularly in the health care sector, "foreign" firms are often subject to unfulfillable restrictions in importing, testing or registration. For this reason, many international pharmaceutical companies changed the corporate structure of their Indian operations after 1973. In the whole chemical industry only seven "foreigners" remain: one of them is Bayer. (Miles' subsidiary is regarded as "Indian.")

To illustrate the situation, it took 12 years before Bayer's antimycotic Canesten, a great success in 107 countries, was finally registered in India. Although Bayer's pharmaceutical business is quite substantial in most other countries, it contributes only 12 percent of total sales in India and ranks third among the company's operations.



One of India's greatest scourges is malaria. In 1947, 75 million of the then 347 million inhabitants were infected by this disease; and malaria claimed approximately 800,000 victims per year. The government started a major campaign against the disease in 1960, which resulted in a decline in the number of infected persons to only 100,000 and practically no fatalities. Considering the 100-million increase in the population, this was quite a success. But then a turnaround came in 1976; 6.5 million of the 613 million inhabitants were infected. The disease retreated again in 1984 when 1.5 million sufferers were counted out of a population of 700 million.

What had happened? The initial success had set the country's mind at ease—too much so. The urgency to fight malaria began to wane and projects were cancelled for financial or ecological reasons. Emphasis was put on prophylactic and therapeutic medicine.

Bayer was able to offer an antimalarial remedy that had been developed back in the 1930s: Resochin. Production of this product in India started in 1968. Initial output of two metric tons per year burgeoned to 22 by 1972. Today, Bayer India produces more than 30 metric tons of Resochin per year. The resistance of the pathogenic agent to Resochin's active agent chloroquine observed in some countries has to date not proved to be a problem in India. The authorities thus place a great deal of importance on its production and its distribution.

Bayer India Ltd. and the Thane works are not the Group's only bases in India. Two Indian companies, Chika Ltd. and Jagat Chemicals, distribute Bayer products that are not manufactured at the Thane works. Bayer also has a holding in Colour Chemicals Ltd., a Bombay sales company for dyestuffs, pigments and auxiliary chemicals. If all this is taken together, Bayer truly has a wide range of activities. Its business is managed and coordinated from the Indian headquarters in a high-rise office building near Bombay's famous coastal Marine Drive.

Trucks are often the only form of transportation between India's isolated villages and the outside world. The roads are poor and vehicles are frequently overloaded. Wear and tear is a major reason for the importance of rubber as a raw material for India's tire industry.

Bayer chronicle 1970

An agreement is signed with the government of the German state of Schleswig-Holstein on the construction of a Bayer plant at a site in Brunsbüttel on the Lower Elbe river.

After years of painstaking negotiations, Bayer and the American company Sterling Drug Inc., New York, reach an agreement which acknowledges Bayer's right to the unlimited use once again of its own name and its Bayer cross in all countries outside the United States except for its pharmaceutical products in the Canadian market.

Mobay buys a site for a new plant in Baytown, Texas.

At the "Constructa 1970" Trade Fair in Hanover, Bayer presents a new composite material, 80 percent of which is composed of glass.

Lampit is developed as a remedy for Chagas' disease.

As the first German company in Iran, Bayer begins the production of synthetic fibers together with a local partner.

Production of titanium dioxide begins in Antwerp and a formaldehyde plant goes on stream in Uerdingen.

The Kurt Hansen Foundation is established to promote the education of science teachers.

The company launches a corporate restructuring program.

World events 1970

The inauguration of Boeing 747 flights over the North Atlantic on January 22 heralds a new era in civil aviation. The jumbo jet has room for 490 passengers.

President Richard Nixon presents a five-year program of environmental protection measures to Congress.

On April 16 the SALT discussions between the Soviet Union and the United States on the limitation of strategic weapons begin in Vienna.

Chancellor Willy Brandt meets Prime Minister of the German Democratic Republic Willi Stoph in Erfurth and Kassel. On August 12, a German-Soviet agreement is signed in Moscow and on December 7, an accord is reached between the Federal Republic and Poland in Warsaw.

Salvador Allende, of Chile, becomes South America's first democratically elected Socialist president on June 18. His government subsequently nationalizes key industries.

Civil war erupts in Jordan. King Hussein breaks the power of the Palestinians.

Polish Party boss Wladyslaw Gomulka is forced to resign because of a dockers' strike.

Wernher von Braun becomes NASA's deputy associate administrator for planning.

Restructuring the corporate organization

On January 1, 1971, the company introduced a new corporate structure. The reorganization had long been planned; an outline of its main features was presented in March of 1970. But it still took a number of years for everything to be realized.

The company's "function-based" management system dated back to the reincorporation of Farbenfabriken Bayer AG in the 1950s. The organization was based on a series of "columns," each of which represented a specific function, as, for example, production, sales, research, application technology or personnel. At the head of each column was a member of the Board of Management, and the complete Board of Management ranked above everything.

With the rapid growth of the company, this organization soon proved to be unwieldy. In 1965, the Board of Management decided to establish committees to coordinate activities of the major product groups. Individual experts on these committees represented the various functions, from research to sales. But new products, new markets and new foreign activities constantly appeared on the scene, so that in time this system also became too inflexible.

In 1971, the whole structure was revised. The columns now represented product groups that had been put together according to marketing considerations and as a result of allied technologies.

Nine divisions were formed: Inorganic Chemicals (AC), Organic Chemicals (OC), Rubber (KA), Plastics and Coatings (KL), Polyurethanes (PU), Dyestuffs (FB), Fibers (FS), Pharmaceuticals (PH), and Agricultural Chemicals (PF). Each of these divisions operated worldwide as a separate profit center.

At the head of each division were two co-managers: one commercial director and one technical director who both reported to the Board of Management but were not members of the Board. In the company, this organization became known as the "double kingdom" system or, more facetiously, as the "two-headed division" system.

Each division had a "staff department" that functioned as a central management team, as well as departments responsible for production, sales, research and application technology.

In addition to these nine product divisions, nine service divisions were also set up. They were responsible for such central corporate services as Personnel (PS), Engineering (IN), Finance and

The simplified diagram to the right demonstrates the principle of functional management, a structure introduced with the reestablishment of Farbenfabriken Bayer AG in the fifties.



Dyestuffs Production

Other Operating Divisions

Sales

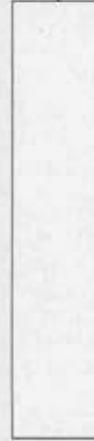
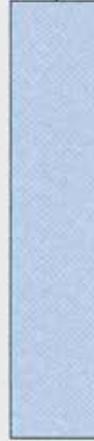
Research

Application Technology

Personnel

Finance and Accounting

Other Corporate Divisions



Special committees represent middle management

In every larger corporation today, there are management tasks which top executives have to delegate. This means that, in comparison to the total number of employees, a relatively small group of managers is created who do not belong to top management but do assume managerial responsibilities. In Germany, these managers are called "Leitende Angestellte."

Although this group of employees is represented in practically all service and industrial companies, there is no uniform definition of what exactly constitutes this middle management category. In practice, the number of designated employees varies widely according to the size and structure of the company and the industry to which it belongs. German law has therefore left it up to the individual employers to lay down their own guidelines on how to define its "leitende" employees. Unlike the situation of other employees covered by the wage agreements of the trade unions, conditions of employment for members of middle management in the Federal Republic are specified in individual contracts.

In 1971, Spokesmen's Committees were formed on a voluntary basis at Bayer to represent the interests of this group. Committee members are elected by their peers. The committees also nominate a representative from their ranks to act on their behalf as a member of the Supervisory Board. The initial task of the

Spokesmen's Committees was to present middle management as a separate category of Bayer staff. Of particular concern was the committees' advisory role in the advertising and evaluation of jobs as well as the creation of a special personnel statute ("Personalordnung für Leitende Mitarbeiter").

At first, discussions with company management were dominated by questions concerning salaries and fringe benefits, e.g. pension plans, capital-forming schemes and vacations.

Apart from that, the committees determined the basic task of middle management and the opportunities for advancement. Other topics included the extension of the customary staff evaluations to management consultation procedures and questions of personal liability for factory managers.

From the very start, these committees felt their duties extended beyond the general representation of the interests of middle management. It soon became clear that part of their work involved making the experience of middle management available to the company when it came to defining corporate policy, especially in questions relating to the role of the company as a whole in the economy and in society. The committees thus helped to formulate ideas and opinions on such focal subjects as the environment, occupational and plant safety, personnel advancement and quality standards.

Accounting (FR), Purchasing (BE), Advertising and Market Research (WM), Corporate Law and Taxes (RS), Central Research and Development (ZF), Patents, Trademarks and Licenses (PL) and Central Applications Technology (ZA). Each major works was given a plant management for the various administrative duties—from works security to cultural programs.

The fundamental principle of the new organization lay in the transfer of responsibility to a level of management below the Board. The Board itself was thus relieved of day-to-day tasks, which allowed its

Management

Production

Sales

Research

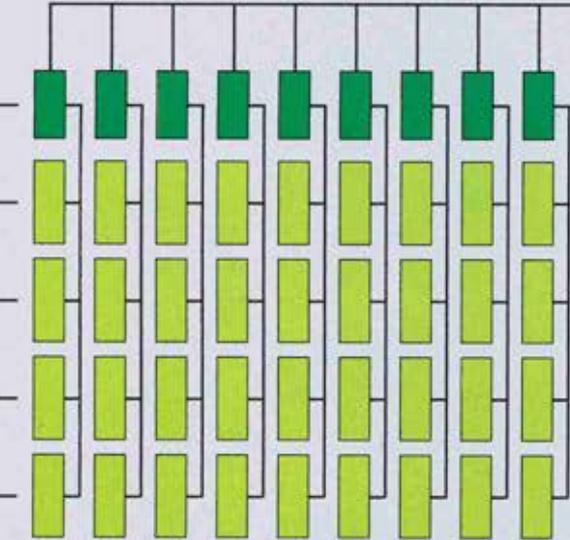
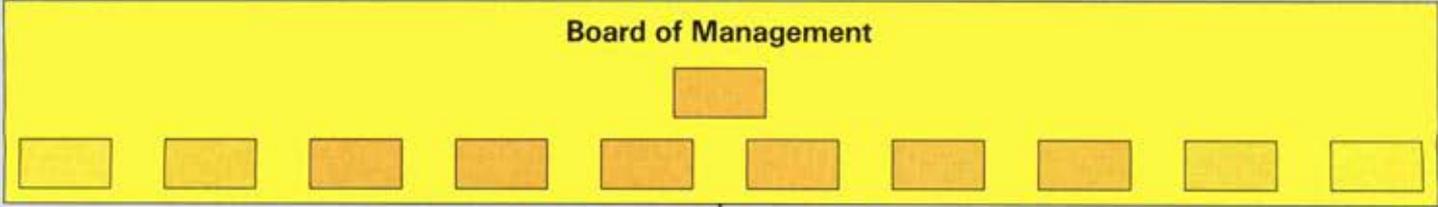
Application Technology

members to concentrate their efforts on management strategy. The departments of the Corporate Staff were set up to provide the necessary assistance.

This corporate structure was instituted to meet the needs of a major industrial company that had a wide range of international activities. But there can be no last word when it comes to corporate organization. What was an ideal structure in 1971 was no longer adequate 12 years later and had itself to be replaced by an organization more in tune with the times. This step is explained in detail in the chapter beginning on page 560.

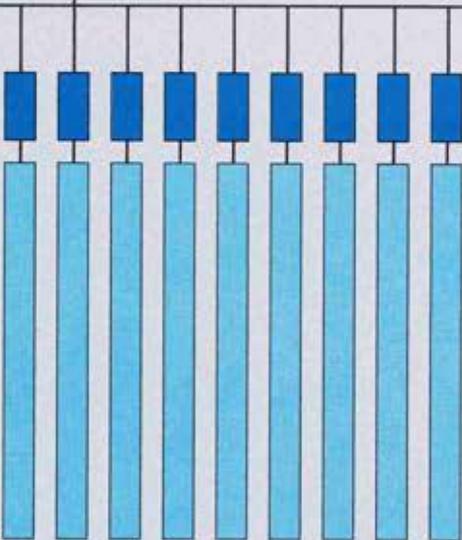
The expansion of the company necessitated a new form of corporate organization. The main changes were based on the principle that each new product division should operate as an autonomous profit center. This took the pressure off the Board of Management, which could

then devote its time to more strategic decisions. The organization plan to the right shows the management structure as of 1971.



Divisions

- Inorganic Chemicals
- Organic Chemicals
- Rubber
- Plastics and Coatings
- Polyurethanes
- Dyestuffs
- Fibers
- Pharmaceuticals
- Agricultural Chemicals



Corporate Divisions

- Personnel
- Engineering
- Finance and Accounting
- Purchasing
- Advertising and Market Research
- Corporate Law and Taxes
- Central Research and Development
- Patents, Trademarks and Licenses
- Central Application Technology



Plant Managements

- Leverkusen
- Dormagen
- Uerdingen
- Elberfeld

Half of Spanish sales stem from local production

In 1992, a World Fair is to be held in Seville to mark the 500th anniversary of Christopher Columbus' discovery of America on October 12. The exhibition is intended to symbolize the great tradition of Spain and at the same time demonstrate the new era heralded by the country's entry to the European Community.

The main geographical emphasis of Bayer's activities in Spain has always been concentrated in Barcelona. The company started supplying dye-stuffs to the Catalonian textile industry in 1884 and established its first Spanish subsidiary, Fedco. Bayer & Cia., on the Rambla de Cataluna in Barcelona on October 5, 1899. Not far from this original location is today's headquarters of Bayer Hispania, which is responsible for coordinating the business of a number of subsidiaries in Spain. These include Química Farmacéutica Bayer S.A.—one of the few foreign companies in the Bayer Group with an uninterrupted history. This subsidiary developed out of La Química Comercial y Farmacéutica S.A., which was the successor of Unión Química Comercial S.A. Until 1924, Unión Química was actually known by the original name of Fedco. Bayer & Cia.

As in other countries, Bayer started doing business in Spain in the dyestuffs sector; it supplied its products from Elberfeld and Leverkusen to dyeworks all over the country. Apart from offices in Barcelona, Bayer had agencies in Tolosa, Valencia, Seville, Málaga and Santa Cruz de Tenerife. As mentioned above, the Spanish subsidiary operated under the name of Bayer until 1924, when the name was changed to Unión Química Comercial. One year later, I.G. Farben was formed and the pharmaceutical sector was separated from the main subsidiary and incorporated as La Química Comercial y Farmacéutica S.A. I.G. Farben not only sold German-made products in Spain but also acquired holdings in local manufacturing companies.

The civil war from 1936 to 1939 and World War II, during which Spain remained neutral, blocked economic development. But beginning in the 1960s and particularly in recent years, the Spanish economy has shown dynamic growth. The population has also increased at a remarkable rate; since 1960 the number of inhabitants has grown by 8 million to a total figure of 38 million. Economists expect that in the years to come national income will increase much faster than the Western European average. Strong impulses for expansion



are the result of the opening up of the European Community's markets. Foreign companies will also continue to play an important role in the Spanish economy; they help to bring modern technology into the country, create wealth and pay taxes to the federal government.

Building on its traditional reputation as a pharmaceutical manufacturer, Bayer has expanded its activities in Spain and now produces both for the domestic and export markets. For example, part of the acetylsalicylic acid from the plant in La Felguera is produced for the manufacture of Aspirin abroad, and a large share is used in Barcelona by Química Farmacéutica Bayer S.A., which also makes other drugs and the artificial sweetener natrien. In Aranjuez, near Madrid, Agfa-Gevaert also operates a factory.

The biggest single works in Spain is located in the industrial zone of Tarragona. It was here that Bayer Hispania Industrial (BHI) inaugurated its second facility in 1971. Four years earlier, BHI had started producing raw materials for coatings in Barcelona's Zona Franca; the production of rubber chemicals

followed in 1969. The plant in Tarragona not only produces isocyanates for the domestic market but also forms part of Bayer's international operations in this business. One of the company's customers is the Spanish automobile industry, which is a significant growth industry. The same BHI plant also manufactures raw materials for coatings and plastics. Another affiliated company, Derivados del Fluor, produces hydrofluoric acid at a factory in Ontón located in a picturesque setting above the Bay of Biscay.

These are only some of the Group's business activities in Spain. In fact, half of all Bayer sales in this country stem from local production. This means that Bayer's own subsidiaries together with its affiliates, such as Miles, form one of the biggest chemical concerns in Spain. Its activities constitute an even balance between domestic production and the marketing of Bayer's products in the Spanish market.

Spain will most certainly play an important role in the future of the European economy, and it is one of the markets where Bayer plans to improve on its traditionally good position even further.

Traces of the past can be seen alongside the boundary of the Bayer Hispania Industrial S.A. site in Tarragona. This facility produces isocyanates for the polyurethane sector, raw materials for coatings and plastics for the domestic Spanish and export markets.

Sencor — the story of a superlative

Bayer introduced the selective herbicide Sencor to the market in 1971. With this product it was possible to destroy weeds and grasses without harming the crops. It is effective in weed control in the cultivation of potatoes, tomatoes, alfalfa, asparagus and particularly soybeans. Sencor became the Bayer product with the single biggest sales volume.

The United States is the world's biggest producer of farm products. Its share in the world production of major crops is 60 percent for soybeans, 45 percent for corn, 25 percent for tobacco, 20 percent for cotton and 15 percent each for wheat, barley and oats. The situation is similar in livestock production where the United States supplies 30 percent of the world's butter, 26 percent of its beef, 25 percent of its milk and 21 percent of its pork.

The enormous quantities behind these percentages are obtained by the some 2.5 percent of the U.S. population engaged in farming, thanks to the use of modern farming technology. It practically goes without saying that the country is also the world's leading manufacturer and consumer of agricultural chemicals and animal health products. The United States consumes one-third of total world output.

Kansas City is situated in the middle of the Midwest, where agriculture is big business. The nearest cities of any size are all relatively far away; Denver is some 620 miles away, Chicago and Dallas 500, Memphis 465 and St. Louis 250. The region around Kansas City is itself home to more than one-third of all American farms and 44 percent of all agricultural acreage. This area yields 56 percent of the country's pigs, 48 percent of its cattle, 59 percent of the corn crop, 56 percent of the soybean harvest and 46 percent of the wheat production.

No other crop has seen such dynamic growth both in acreage and yields as the soybean. Between 1925 and 1978, world acreage rose by 926 percent and yields increased by no less than 1,234 percent. In the United States alone, 71 million acres are planted with soybeans. The reason for the remarkable development of the soybean crop is the fact that no other plant has a comparable protein content.

Kansas City is the home of Bayer's agrochemicals activities in the United States. It all started out with Chemagro Corporation, which became a 100-percent subsidiary in 1967. This company was initially founded in New York in 1950 as a joint venture of Pittsburgh Coke and Chemical Company and Geary Chemical Company to market Bayer's crop protection



chemicals and also to produce agricultural chemicals of its own. Bayer acquired a third of Chemagro's shares in 1953.

With strong competition already in the market, Chemagro got off to a difficult start. Bayer's most important pesticide at that time, E 605, was no longer protected after the war and was already being sold in the United States under the Parathion trademark. Such Bayer products as Systox, Dipterex, Gusathion, Baytex, Metasystox, Baylucid and Baygon found a place in the market, but the quantities sold were small by American standards.

In 1957, Chemagro moved its headquarters from New York to Kansas City. The 300-acre Stanley Research Farm was opened outside Kansas City in 1962.

Five years later, Bayer became sole owner of Chemagro, which in 1971 was integrated into Baychem Corporation and in 1974 became the Agricultural Chemical Division of Mobay.

In Kansas City, the heart of North American agriculture, the company announced the introduction of Sencor, the ideal herbicide for soybean growers, in 1971. A production unit specifically for Sencor was opened there in 1976. Bayer had never invested such a large sum of money in the United States for a single product.

Unfortunately, patent problems soon developed. Du Pont claimed patent rights, contending that it had been working with metribuzin, the generic term for the substance, in the United States before Bayer.

Bayer operates a whole chain of research stations to gather experience in as many different climatic zones of the United States as possible. The main crops of the various areas are grown here to test the effect of agrochemicals on both the plants and the environment.

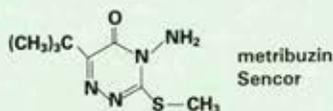
Sencor, a herbicide on the basis of triazinone

The triazinones, first described in the chapter on 1964, proved to be extremely effective herbicides in biological tests. A very large number of substituted triazinones were synthesized in Bayer's laboratories, and they were subsequently tested for their potential application in the agricultural market.

It turned out that with this specific category of active agents, it was possible to achieve good levels of efficacy

under highly selective conditions, even when used in small quantities.

A product given the test number Bay 94 337 proved to have an ideal combination of desirable properties and was introduced to the market under the trade name of Sencor. Its application to soybeans, but also potatoes, tomatoes and other crops, prevents the young plants from being overgrown with weeds.



The particular efficacy of the triazinones results from

their ability to inhibit photosynthesis in specific plants.

The two companies reached an agreement, whereby Bayer developed and produced the active agent and supplied 33 percent of its production to Du Pont, which did not have its own manufacturing unit. Both companies sold the product; Bayer kept the name Sencor, and Du Pont marketed its active agent under the trade name of Lexone. The herbicide proved so superior to competing products that both firms did well. Bayer's sales of Sencor rose from \$55 million in 1972 to \$350 million by 1985. Since Mobay was the company's sole producer, one-quarter of Kansas City output was exported. By 1978, Mobay had worked its way up to one of the top ten producers of crop protection products in the United States.

Mobay did not rest on its Sencor laurels but went on to introduce other internationally successful Bayer agrochemicals to the U.S. market, such as Nema-cur and Bolstar. The cooperation between the Agrochemicals Division in Kansas City and the Monheim research center in Germany (the subject of a later chapter) became particularly intensive.

The market for crop protection chemicals in the United States is now viewed as virtually saturated. The future lies in better and ecologically more acceptable products. A new generation of crop protection products is making its way onto the market: synthetic pyrethroids, plant growth regulators and insect growth inhibitors are just a few examples.

Today, Mobay operates research stations in all climatic zones of the United States. In addition to the Stanley Farm in Stilwell, Kansas, there is the Vero Beach unit in Florida, Nebraska's Springfield Farm, Tifton Farm in Georgia, Benoit Farm in the Mississippi Delta, Howe Farm in Indiana, Rio Grande Valley Farm in Texas and Urbana Farm in Illinois.

The United States and the Federal Republic have the world's strictest registration regulations for agricultural chemicals. The correspondence with the U.S. Environmental Protection Agency that was required before Sencor could be registered weighed a total of almost 600 pounds. But when a crop protection product has finally been registered by the U.S. authorities, a standard is set for the rest of the world.



Day-to-day operations at a research station are largely a question of careful book-keeping. Virtually every plant grown here is kept under close observation and its development registered accordingly.

Bayer chronicle 1971

Bayer's six subsidiaries in the United States—Chemagro, Mobay, Verona, Baytex, FBA Pharmaceuticals and Vero Beach Laboratories—merge to form Baychem Corporation, headquartered in New York.

Verona Corporation opens what is considered to be the most modern dyestuffs plant in the United States at Bushy Park, South Carolina.

With the increase of daily purification capacity to approximately 2.3 million cubic feet, the central waste water treatment plant of Bayer and Erdölchemie in Dormagen becomes Europe's biggest industrial sewage treatment unit.

A process for the automatic identification and analysis of gaseous air pollution is developed.

Bayer subsidiary Maschinenfabrik Hennecke delivers a large-capacity plant for the production of polyurethane foam moldings to the Soviet Union.

Bayer acquires all the shares of Rhein-Chemie Rheinau GmbH, Mannheim.

Aspirin plus Vitamin C is put on the market in the form of an effervescent tablet.

World events 1971

Switzerland introduces female suffrage in federal polls.

Bangladesh declares its independence from Pakistan.

The United States withdraws its commitment to exchange dollars for gold on May 15. This decision marks the end of the so-called Bretton Woods international monetary system, which had been instituted in 1944.

The four-power agreement on Berlin comes into effect. The status of the former Allies remains unchanged. Arrangements are made pertaining to the access routes between West Berlin and the Federal Republic.

For the first time in history, the Japanese emperor gives a press conference.

Willy Brandt is awarded the Nobel Peace Prize for his efforts as chancellor of the Federal Republic of Germany to bring about reconciliation with former foes.

Growing acceptance of the microprocessor in industry and other sectors of the economy heralds a new phase of technological development, which is tantamount to a second Industrial Revolution.

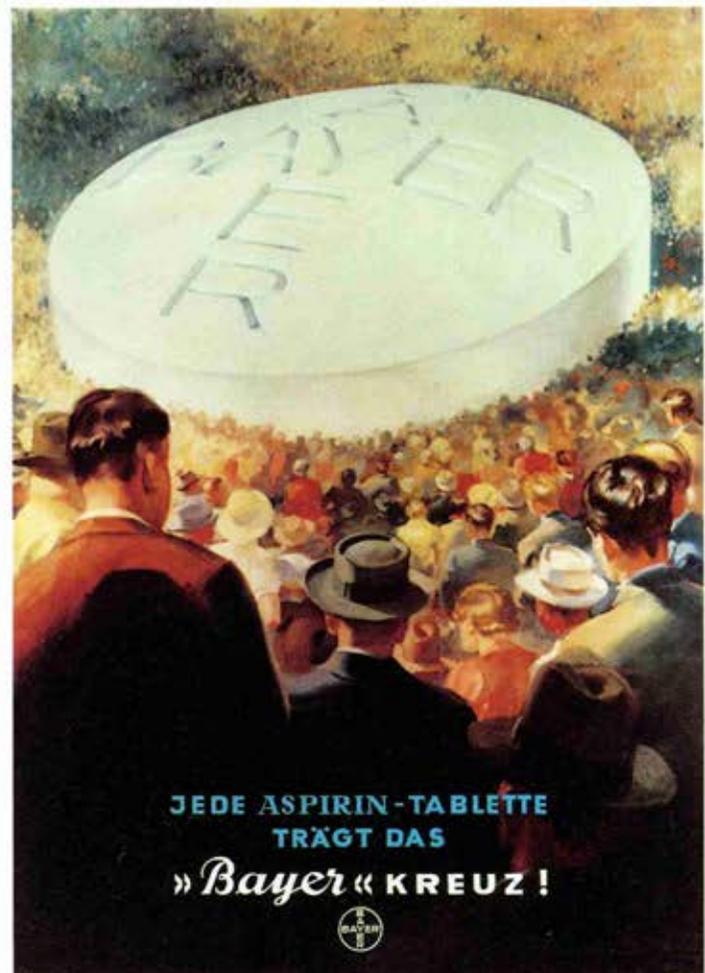
1972

A long tradition of worldwide advertising

The success of a company depends first and foremost on the quality of its products. The job of advertising staff is to promote these products. Over the years, Bayer's advertising departments have also informed the public about corporate philosophy. Since 1972, one of the most important commitments has been perpetuated by the slogan on a green lime leaf: "Bayer: research for a clean environment."

Just twelve hours before the opening of the world's biggest Plastics Trade Fair, which is held every four years in Düsseldorf, the tension is high as the curtain goes up on the final rehearsal of the show at Bayer's stand. The scene reminds the observer of an anthill with hundreds of people scurrying to and fro. Forklift trucks shift the last exhibits into place. Electricians give the complicated equipment of the multivideo show a last check. Monitors flicker. Brochures are unpacked. Headings and texts are cut to size and placed on their colored plastic foils. Stand constructors, designers, lighting staff, photographers, printers, interpreters, hostesses and, of course, advertising people are all standing by.

Advertising takes a wide variety of shapes and sizes at Bayer. It also has a long tradition. Already back in the days of *Farbenfabriken vorm. Friedr. Bayer & Co.*, creative approaches to advertising were developed and turned into effective publicity. A classic example is Aspirin—advertisements in the press, handbills, posters and imaginative packaging design all helped to make it so well-known. Both its effectiveness as a product and its advertising made



ACIDOL-PEPSIN
ANTIPYRIN
ASPIRIN
IMPLE
TUTO
CON
ATEBRIN
AVERTIN
HYPOPHYSIN
SUPRARENIN
PROTOSIL
CAFASPIN
ALBARGIN
HEXETON
FLADIN
FESTAL
ABASIN
EVIDAN
UNDEN
PROLAN
ERUGON
GRAVITOL
HELMITOL
MITIGAL
MELBERIN
ORAFIN
SOL
ABRO
TRYPAFLAVIN
CHOLEFLAVIN
TUMENOL-AMMON
AMPHOTROPIN
ELITYRAN
PADUTIN
NOVOCAIN
NOVALGIN
ANAESTHESIN
OPTARSON
MIGRANIN

ARZNEIMITTEL
MIT DEM



Bayer-Kreuz

DAS
ZEICHEN
DES
VERTRAUENS

PYRAMIDON
ENDOJODIN
BIGFERRIN
BAYRINOL
PER-ABRIGOL
LIQUIDRAST
PROTARGOL
CAMPOLON
DERMATOL
PELLIDOL
OREXIN
GARDAN
YATREN
CASBIS
CANTAN
LUTREN
SALYRIGAN
DEVEGAN
HYDROVAL
APALIN
INSULIN
SEMOBRAN
PANTOCAN
PLASMOLO
TOMORHOSHA
THEOMIVAL
SAJODIN
PRELOBAN
ELDORON
LACARNOL
KRESIVAL
PHENACETIN
PANFLAVIN

Aspirin virtually synonymous with painkilling remedies, and in many parts of the world, this famous product became a synonym for Bayer itself.

The best advertising is that which encourages the audience to put a product through a critical test. The consumer will soon discover if the manufacturer has exaggerated its claims. On the other hand, witty inspirations and creative ideas are also important ways to capture an audience's attention. And Bayer has never hesitated to seek new ways of drawing people's attention to the company and its products.

One campaign, for example, attracted a great deal of international acclaim in the 1930s. Although this was in the I.G. Farben era when there was no Bayer company as such, the Bayer cross was used by the trust all over the world as its pharmaceuticals trademark. I.G. Farben took to the air with this famous symbol: the inimitable Junkers "Ju 52" circled over London, Rio de Janeiro, Cincinnati, Hong Kong, Lisbon and other major cities bearing the Bayer cross for the crowds below to see.

Covering such a vast range of individual products and markets, there is nothing standardized about Bayer advertising. In addition to the information value, good advertising requires a great deal of creativity. The three examples on these pages show just how different the face of

Bayer publicity can be. In the advertisement to the left, the message is that each Aspirin tablet carries the Bayer cross. Above the company advertises its pharmaceuticals with the Bayer cross—the symbol to be trusted. Even airplanes were used for advertising purposes.

Word soon got around that the plane was carrying pharmaceuticals. In those days people referred to this as "aerial advertising," while today it is simply called consumer advertising.

With its comprehensive sales program, Bayer has a variety of different potential customers. One of the main requirements for successful advertising is that each of these respective target groups be addressed in its own technical language—correctly and intelligibly. This is why Bayer applies such different advertising strategies, and the consumer is not necessarily the most important target group.

Even when the Bayer cross sign hanging outside a pharmacy in Germany catches the consumer's eye, it is actually the physician who decides whether or not he is going to prescribe a Bayer product. But a doctor will only prescribe what he knows to be helpful and effective, and this is why he has to be given as much information as possible on any new drugs. Brochures and pamphlets produced by the advertising staff in cooperation with Bayer's Health Care Sector thus have the character of scientific publications.

Similar considerations apply for the many products that are hardly known to the general public because the consumer only sees them in a processed form. Dyestuffs, tanning chemicals, textile auxiliaries and many other products require exact instructions on the various applications. In the case of such Bayer products as plastics, synthetic rubber or textile fibers, which are all materials with very specific properties, detailed processing guidelines as well as technical data have to be compiled for the customer. Over the years, this technical advertising has given rise to whole libraries of reference material, brochures and instruction sheets that provide the processing industry with valuable assistance when using Bayer's products.

In such specialty sectors as the construction or automotive industries, where highly sophisticated engineering materials are put to use, comprehensive collections of technical information



including construction tips and examples of possible applications are made available to the experts. The detailed work that goes into such written material illustrates just how much more complex advertising is than simply putting together ads for the trade press and printing brochures. The quality of the content is what counts.

Advertising is also more than just a way to boost day-to-day business. It not only can be used to arouse the interests of a customer in a product, but also as a means to influence attitudes and opinions. Here, too, the clear and unambiguous message has the best chance.

The successful dissemination of information presupposes exact knowledge of the market and insight into the motives of the target groups. This rule applies particularly in coping with trends in public opinion, which are themselves often influenced by emotional factors and one-sided or incomplete information. Bayer has chosen a symbol to help convey its policy on one of these topical issues. The green lime leaf mentioned in the introduction to this chapter carries a statement of commitment: "Bayer: research for a clean environment" and has taken its place beside the Bayer cross as a meaningful company logo.

Bayer introduced the green leaf at a time when the word "environment" was taking on a totally new meaning for the German public. Technology, progress and the chemical industry had suddenly come to be regarded with ambivalence or even with suspicion. The benefits were ignored as more and more attention was focused on the negative effects. Concerned-citizen groups got together to call for new forms of action against what they—sometimes justifiably, sometimes misguidedly—saw as potential dangers.

The new Bayer symbol alone was naturally not enough to dispel suspicions. It did, however, clearly document the company's commitment to do more to protect the environment. Over the years following the introduction of the green leaf, Bayer was to invest several billion marks to this end.

Bayer publicized information on concrete measures it had taken to improve environmental protection procedures. But in 1983, for example, it also went so far as to take the "Good Old Days" to task. In this advertising campaign, reproductions of old paintings showed, for instance, farmers working in the fields and pointed out just how hard working and living conditions were in centuries past with 18-hour workdays, child labor, a minimum of health care and fear of famine or epidemics. Further double-page spreads followed. Schools in particular asked for additional information. The company answered 17,000 requests for its brochure containing a collection of the advertisements published in the campaign.

Besides the main written forms of advertising on a regular basis, i.e. brochures and advertisements, organized events also play an important role by providing a forum to present the company and its products. One example is the Plastics Fair mentioned earlier. After all the preparatory work is accomplished, and the gates of the trade fair grounds are opened for visitors, the real work begins at the Bayer stand. Commercial and technical experts join their colleagues from the advertising staff in order to inform and exchange information with the many visitors to the Bayer exhibits.

Stands like the one at the Plastics Fair in Düsseldorf have something to offer for the eye, too; there is more than just a touch of showbiz in the exhibition world. And everybody is delighted if a prominent guest appears at the Bayer stand; it offers the hundreds of international journalists and photographers attending such fairs a good story and picture featuring Bayer.

What really matters at these events though is the contact with the people from the trade and the general public. Customers, consumers, scientists, students and schoolchildren are all welcome. Fairs like these are the culmination of the many meetings Bayer has with its business partners. And Bayer's advertising is a successful catalyst to help cultivate such contacts.

A green lime leaf with the slogan "Bayer: research for a clean environment" has been the symbol for Bayer's commitment to environmental research since 1972. It also represents a promise to the public that Bayer will do its utmost to pursue this important task.

Bayer forscht
für den

Umwelt schutz



Lampit, the first remedy against Chagas' disease

In 1908, Brazilian physician Carlos Chagas discovered unicellular, flagellate protozoas that resembled the pathogenic agents of the African sleeping sickness. He also recognized the connection between this parasite and a disease that has affected ten million people, particularly in Latin America.

The most significant characteristic of the disease named after Carlos Chagas is that it strikes literally overnight. A predatory bug, which is about an inch long and only comes out of hiding at night, bites a sleeping person. Its spittle contains an anesthetizing substance so that its victim feels no immediate pain and the bug is thus not shaken off. It then releases a drop of excrement that it pulls across the bite. Should this drop contain the parasite *Trypanosoma cruzi*, the sleeper is infected.

The trypanosome reproduces in the blood and subsequently attacks the victim's liver, spleen and lymph glands. In a later stage of the illness, the esophagus, colon, central nervous system and the heart are affected.

In only rare cases, i.e. in about five percent of the afflicted, an ulcer, a so-called chagom, appears on mucous membranes a few days after infection. Otherwise the infection is not initially detected. After some time, the first symptoms begin to show up; they are often judged to be signs of an influenza and thus not taken so seriously. These symptoms also disappear in about three to four months, and the patient feels well again. It can take anything from 7 to 20 years for the organs to be so badly affected that a lingering illness or a sudden heart attack results.

Insecticides developed after World War II that were successful against mosquitoes causing malaria had little effect on the robust bug. With the development of Baygon by Bayer, an effective product was finally found to combat them. Baygon has insecticidal properties, and it also drives the bugs out of their hiding places. Since these bugs not only live in houses but also in the burrows, holes and nests of infected wild animals, it was unfortunately impossible to hunt them down everywhere.

For a long time, there was no way of actually battling the disease itself. All of the substances tested were either ineffective or intolerable. Hope finally came with the introduction of Lampit, a drug developed in Bayer's laboratories at Elberfeld.

The small, worm-like organisms in the bloodstream, pictured in the background of the diagrams on the right, are trypanosomes. They are the pathogenic agent of the dangerous Chagas' disease, which is transmitted by the bite of the *Triatoma infestans* bug, shown here in

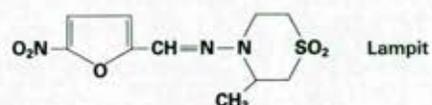
enlarged form. If the disease is not recognized in time, it can continue to develop until it finally results in death.



The fight against Chagas' disease

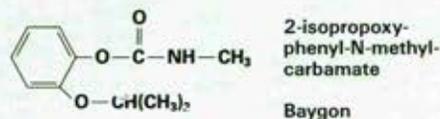
After numerous categories of substances had been tested without showing any signs of success, the nitrofuranes were the first to demonstrate interesting effects. Investigations started in 1961 proved less than satisfactory, however.

Initial prospects of a real breakthrough came during the study of nitrofurfurylidene compounds with special substituents. One of the active agents belonging to this group was Lampit, which has the following formula:



As is the case with other tropical diseases, the truly effective treatment also depends on a permanent interruption of the transmission cycle. Baygon, today as much of a household word in many tropical countries as aspirin,

proved to be the best insecticide against the often inaccessible predatory bug that acts as a carrier of the parasite. This product has as its active agent a carbamate with the following structure:



Bayer in Africa

Bayer's research efforts in the field of tropical medicine led to close ties with Africa at an early date. Pharmaceuticals for the fight against tropical diseases that occur extensively on the African continent had long been a focus of Bayer's endeavors.

In 1916, the company's research scientists had come up with a substance that was subsequently used against sleeping sickness. This drug later became famous under the trade name of Germanin. Other pharmaceutical breakthroughs followed, including products to treat malaria and schistosomiasis.

At the same time, Bayer was also developing agricultural chemicals to help save threatened crops. Modern crop protection systems will become even more important for Africa in the future because the rapid growth in population necessitates efficient agricultural production. In 1985, some 553 million people were living in Africa, whose land area of 11.7 million square miles is almost three times that of Europe.

Despite its considerable size, Africa is only a small market for Bayer. In 1987, it accounted for about two percent of the Group's sales. This apparent paradox can be explained by the particular economic conditions prevailing in this region.

Africa is largely used for agricultural purposes and its links with world markets are primarily through the export of agricultural produce and raw materials. Only South

Africa is really industrialized. Since most of Bayer's products are supplied to industrial clients, Africa is far from being a major customer.

In addition to this particular situation, prices for raw materials and agricultural produce have tended to decrease in the past years, while those for industrial products have remained stable. Thus, the purchasing power of African countries has declined, and they are now able to afford fewer



Cotton harvesting in Kenya

imports in exchange for the hard currency gained from their exports. This problem also exists for the more prosperous nations in Africa.

Bayer is represented in almost every African country. Focal points are Kenya in East Africa and the Ivory Coast in West Africa; both of these countries are centers of a wide range of activities. Over and above these operations, Bayer has sales representatives and, in some cases, production facilities in

Nigeria, Zimbabwe, Zambia, Mozambique, Angola, Zaire, Ethiopia, Tanzania, Ghana, Morocco, Egypt, Algeria and South Africa.

The company's policy has always been to maintain long-established business connections even in difficult periods. This is its philosophy in the case of South Africa, whose apartheid program has been the object of worldwide criticism. Many people have called for a complete withdrawal of all business activi-

work toward the integration and improved education of black employees.

The Bayer companies are run according to the principle of equal treatment for black and white staff and the premise that jobs and promotion opportunities should depend only on the skill and personal effort of the individual.

The potential wealth of the African continent is enormous. Many opportunities for development have been made possible by the joint efforts of African countries and the industrialized nations. However, Africa's economic situation is extremely diverse. The Arab countries on the Mediterranean are a totally different world from the countries to the south of the Sahara; and the industrialized society of South Africa has little in common with the agrarian regions in the central region of the continent.

Historical, cultural, social and ethnic differences have all meant that, just as in Europe, African unity is a political goal rather than an eventual reality. Bayer naturally has to adjust to all these various national markets and their different needs.

The future opportunities in African markets will also depend on how the continent can develop economically. This will itself depend to a large extent on the readiness of the industrialized countries to support African development and open their markets wider than at present for African products. Bayer's presence in Africa is an active contribution toward economic development.

Trypanosoma cruzi strains from all over Latin America were soon tested for their sensitivity to Lampit. But the real problems developed when Lampit was ready for clinical testing. How could the effect of the substance be proved if the symptoms of the disease disappeared of their own accord in three to four months and if the infection cannot be traced in the blood? The only possibility was to use xenodiagnosis.

Some 40 or more bugs, bred without the parasite, were applied to the patient. If only one of these insects picked up a trypanosome after having extracted blood, the parasite would breed in the bug's intestines and could then be detected.

Tens of thousands of a particularly suitable strain of bug were bred for this purpose, and over a period of almost two years, more than a thousand patients were tested and treated at two locations—working independently of one another.

These comprehensive tests resulted in success: the efficacy of Lampit was confirmed. The product was first introduced in Argentina in 1970 and shortly thereafter in other countries. At a symposium in Buenos Aires in November of 1972, scientists from eleven countries were able to discuss their experience with Lampit, the first pharmaceutical to work against Chagas' disease.

Bayer chronicle 1972

On June 30, the company changes its name from Farbenfabriken Bayer AG to Bayer AG. With 458,000 shareholders and a share capital listed at DM 1.835 billion, Bayer achieves the widest distribution of capital in its history.

The SO₂ and dust emissions of the Leverkusen plant are down by 80–90 percent compared to 1958 levels.

The "business assistant" profession is created for high school graduates. Participants are given further instruction in data processing and business organization after the training program for "industrial clerks."

At the Summer Olympics in Munich, Heide Rosendahl (photo) wins two gold medals



and one silver, while Rita Wilden is awarded a silver and a bronze medal. Both sports-women belong to the Bayer 04 Leverkusen club.

World events 1972

The United Kingdom, Ireland and Denmark join the European Community on January 22.

Richard Nixon becomes the first U.S. president to visit the People's Republic of China (February 21–28) and the Soviet Union (May 22–30).

The United States launches the space probe Pioneer 10 in the direction of Jupiter on March 2. The Soviet spacecraft Venus 8 makes a smooth landing on Venus on July 22 and radios back data to Earth.

After the failure of a vote of no confidence by the CDU/CSU opposition against the Brandt administration, the Parliament of the Federal Republic ratifies the Eastern bloc treaties on May 17. On December 22, the so-called treaty of principles is signed between the Federal Republic of Germany and the German Democratic Republic.

Arab terrorists make a raid on the Israeli team at the Summer Olympics in Munich and take nine hostages. In the process of an attempt to release them, all hostages are killed, as well as five Arabs and a Munich policeman.

Brunsbüttel: a new industrial complex is born

On October 4, 1973, Professor Hansen laid the foundation stone at the site in Brunsbüttel of Bayer's fifth German plant. The continuing growth of the chemical industry demanded a forwardlooking policy on expansion. Brunsbüttel offered many advantages, so Bayer chose it as a location for an important new "green-field plant."

The term "green-field plant," when used in connection with the chemical industry, should not be understood to mean that a new plant can be built on the next best meadow. Choosing the location of any such project is a highly complicated matter, taking into account a long list of considerations from transportation possibilities for raw materials and finished products to available energy and water supplies, and not to forget how attractive the site would be for future employees. The detailed work involved and how these criteria interact are exemplified by the preparations leading up to the development of Brunsbüttel as a future production center.

The question of products comes first. Where existing and expected demand exceeds available capacities, production facilities have to be expanded in order to be able to continue supplying the market. The manufacture of chemical products is complicated by the fact that it is generally a multistage process involving a whole range of raw materials, base chemicals and intermediates. At the same time, the process normally leads to the creation of—frequently numerous—by-products, which in part have to be fed back into the process or else recovered for use as base or intermediate substances for other products. This high degree of operational integration so typical of the chemical industry gives large plants a particular advantage. Experience shows that the unnecessary incineration or similar disposal of by-products as waste is clearly the least attractive method of solving the problem.

The planning of a new plant calls for a long-term integration program. For this reason, it is wise to calculate the space required generously. Brunsbüttel provided plenty of space; in fact, today's plant site covers 1,040 acres, or more ground than the Leverkusen works itself.

The presence of an existing infrastructure is of particular importance, and not only during expansion phases. No plant can start off as a world of its own; it has to rely on supplies from outside.





Brunsbüttel is situated at the mouth of the Kiel Canal, one of the world's busiest waterways, and the Lower Elbe river, so it is easily accessible by ship. However, this advantage alone would not have been enough for Bayer to locate there.

The government of the state of Schleswig-Holstein made every effort to promote the project in Brunsbüttel. This region of Germany and especially the West Coast area are largely agricultural. The authorities of Schleswig-Holstein do their utmost to develop the local economy and provide lasting jobs for the population. For this purpose, industry and trade have been encouraged to settle at appropriate locations in this state.

Substantial investments in infrastructure are necessary before industrialization can begin; a region of this kind is going to have to compete with other European locations when it comes to business investments. But in the end, investing public funds in such efforts is well worth it when companies make use of such facilities and bring jobs and money to the district.

The state government thus decided to buy land near Brunsbüttel that had good transportation connections. This area was subsequently developed for industrial use and offered to various corporations.

New railroad lines were set up, roads and docks were extended and a new waterworks was built. Power supplies were also secured. The necessary prerequisites had thus been created, and the individual companies could pursue their planning in light of the new situation. And still further steps were to be taken by the government to make this area even more competitive.

The location of a major chemical plant in a mainly rural area calls for more than just a few plans and a set of blueprints. Local inhabitants play a vital role; a company has to be attuned to their concerns if it wants to be successful. After all, they are not only neighbors but also the source of the company's future employees. Bayer was fully aware of their importance and from the very start set out to be a good neighbor.

To promote economic development in the northernmost state of the Federal Republic, Schleswig-Holstein made sites available for industry in an area around Brunsbüttel that has good transportation connections. Bayer bought a tract of land in 1970 and has since built its fifth German plant there.

Before production got under way, the company introduced itself to the local people by staging a special exhibition. While some remained skeptical, others welcomed the new plant as a way of bringing prosperity to the region and, more importantly, because it would offer work for the younger generation.

Unfortunately, all great projects take time to get off the ground, and plans often turn out to be more difficult to realize than anticipated. Originally, the production of Desmodur T, a key product in polyurethane chemistry, was due to go on stream in 1975. Bayer had bought the site in 1970 and the ground was first broken in October 1973. However, it took until January of 1975 for the actual construction work to begin; in order to support the buildings, the company had had to drive thousands of piles into the marshy soil that had already been filled with sand.

The importance Bayer places on the requirements of the environment is illustrated by the fact that the first unit to be completed on the site in June 1977 was a fully biological waste water treatment plant. Workshop and administration buildings had been set up earlier and the recreation and canteen block opened in June. Production of Desmodur T finally got started in December 1977.

Production consists of six integrated factory units linked in such a way that by-products can be fed back directly into the process cycle. Raw materials are partly supplied by other Bayer plants and partly obtained from the immediate neighborhood. The natural gas needed for the extraction of hydrogen and carbon monoxide is brought in by pipeline.

The opening of the Desmodur facility represented the initial phase of the Brunsbüttel project. The second phase provided for the production of rubber chemicals. Aging inhibitors for use primarily in the tire industry have been in production at this site since the mid 1980s. The third phase encompasses dyestuffs; Brunsbüttel has been operating one of the most modern azo dyestuff production facilities in the world since June 1981.

In 1973, Bayer and the Swiss chemical company Ciba-Geigy agreed to cooperate in the field of special dyestuff chemicals. For this purpose, the two firms set up the joint venture Schelde Chemie N.V., in Antwerp. As the name suggests, it was intended to be constructed on the banks of the river Schelde in Belgium. In 1977, however, the board of Schelde Chemie decided instead to locate the planned facility in Brunsbüttel. Some DM 1.3 billion were invested for the production of intermediates for dyestuffs and agrochemicals.

Unfortunately, the market took an unexpected turn. To make matters worse, technical problems developed and costs increased. The continuation of the joint venture was jeopardized so Bayer acquired the other 50 percent of Schelde Chemie in May 1985 and integrated it into the Brunsbüttel plant. Bayer also offered jobs to the Schelde Chemie personnel, and thus avoided having to lay them off.

In the new section of the plant, a few hundred yards from the main complex, Bayer Brunsbüttel added units for organic chemicals to those of its polyurethane, rubber and dyestuffs product groups.

A "green-field" plant undoubtedly has disadvantages in comparison with the long-established integration of the older plants. It does benefit, however, from the experience gained from the existing plants and can apply this know-how to create a framework for an overall works concept. Brunsbüttel's state-of-the-art waste treatment system illustrates this positive consequence particularly well. The unit includes a structured liquid-waste network with six independent mains that run primarily above ground and thus permit easy access and inspection. Effluents containing biodegradable residues are fed into the biological purification unit, while liquid waste that is difficult or impossible to decompose goes into an incineration plant. Brunsbüttel was the first Bayer works to receive an incineration plant of this kind for liquid waste substances. It went into operation in 1982.

But it is not enough to put up a plant equipped with the newest in technology and environmental



control facilities. The people working in the new plant must be able to develop a positive attitude toward their jobs and their employer. A safe job and adequate pay provide the basis, but a good working atmosphere demands more.

A company has to be able to adapt itself to the specific needs of its employees. This task takes on special significance in the case of a new plant. Many of the new employees from the West Coast of Schleswig-Holstein had never worked in a major chemical facility. On the other hand, people from Bayer's existing plants on the Lower Rhine who came to Brunsbüttel for the start-up of the works had to adapt to a completely new environment. Within a very short period of time, Brunsbüttel itself and other towns such as Burg, Marne and Itzehoe found themselves with a large number of new residents. Under such circumstances, everybody concerned, and particularly management, had to demonstrate their willingness to keep up an open dialogue. This constant readiness to communicate

with its neighbors has made the Bayer works in Brunsbüttel a good corporate citizen.

For Bayer, Brunsbüttel is a location with a future. This commitment is shown by the continually high level of investment and the ambitious plans for the site. Additional dyestuff capacities and a new factory for polyurethane starting materials are to come on stream in 1988, for example.

The works also has a future-oriented training policy. The first training center opened in Brunsbüttel in 1981, and it was expanded five years later. The number of trainees and professions that can be learned there has been rising steadily. Bayer is thus making a significant contribution to regional development and meeting the neighbors' expectations by improving opportunities for young people.

Bayer is already the biggest single employer on the West Coast, with a direct and indirect payroll of 2,000, of whom 1,700 are employed directly by the company. The plant is a target for major investment and there is still room for growth.

The "green-field" Bayer works at Brunsbüttel has advantages over the older plants which are subject to the constraints and necessities of long-standing operational integration. Experience gained from this evolutionary process elsewhere has been invaluable in developing a new overall concept.

Winning the fight against fungal diseases

The year 1973 saw the introduction of Canesten to the market. This antimycotic opened up new perspectives in the treatment of fungal infections. Unlike earlier products, which were frequently only effective against individual fungi, Canesten has a broad-spectrum efficacy able to combat all kinds of pathogenic agents.

Fungal infections, or mycoses, attack humans, animals and plants. For most people, fungi immediately bring to mind the mushrooms and toadstools found in nature. However, these "fruits" are only the outward growth of the plant itself—the mycelium that lies underground in the form of a mass of threadlike tubes.

Fungi belong to a large category of a lower species of plants which are often unicellular organisms and include such different forms as brewer's yeast and the plant disease mildew. A large number of these microorganisms are as unpleasant or dangerous to humans as mildew is to plants; they can lead to refractory skin or internal diseases, the so-called mycoses.

Modern antimycotic research began after the Second World War. This work has been intensified even more today because the incidence of these disorders is steadily on the increase. German estimates show that every third inhabitant of the Federal Republic will have had one or more mycoses of the skin or mucous membrane during his or her lifetime.

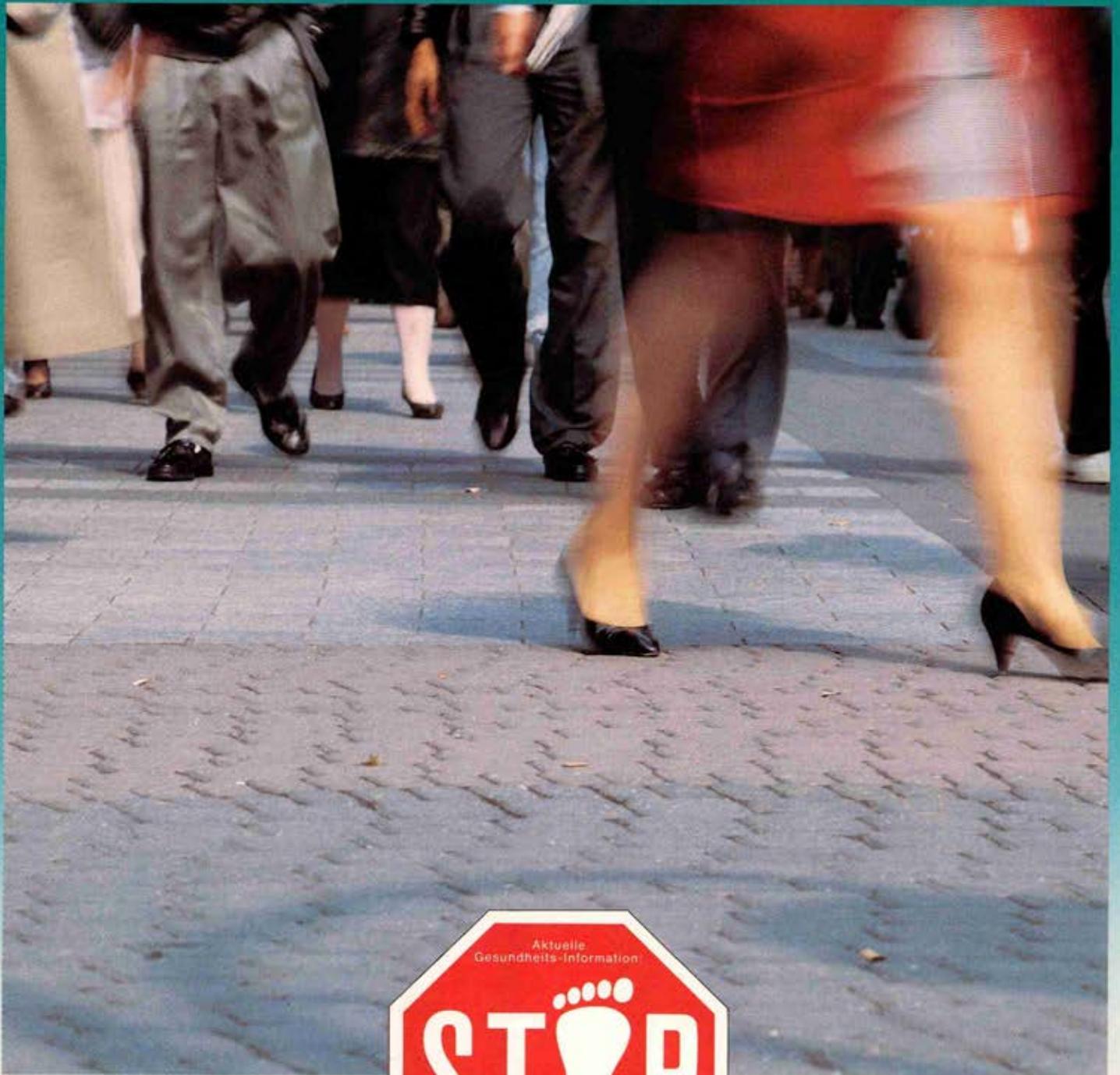
One reason for this higher incidence of fungal diseases lies in the greater mobility of society. Tourism, in particular, takes people to countries where they become infected with a mycosis, which they then return home with. A further reason is the increase of diseases that make the sufferer more susceptible to fungal infections.

Mycoses are as diverse as their many pathogenic agents. They range from athlete's foot to nail mycoses, large-surface skin disorders and infections of the mucous membranes to potentially fatal diseases of the inner organs. The serious forms are particularly prevalent in the populations of South America, Africa and the Far East.

Various substances, some quite potent, have been used with differing degrees of success against such plant diseases as mildew, smut and rust. These diseases threatened to wipe out whole harvests in the past. But human mycoses had long proved tenacious and, at the very least, troublesome

Fungal infections or, as they are known under their more scientific name, mycoses, are as different and widespread as their many causes. The symptoms can range from minor discomforts to infections of the mucous membranes and potentially fatal diseases of the inner organs.

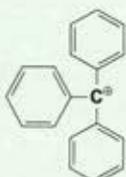
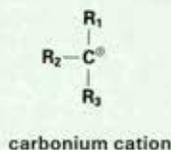
In 1973, Bayer introduced the broad-spectrum antimycotic Canesten to the market as a cure for a wide range of fungal infections.



Canesten and Mycospor

The theory that served as a model behind the development of an effective antimycotic substance was that compounds able to form reactive carbonium ions in vivo might be particularly suitable against mycoses. Reports in scientific

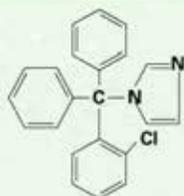
literature, for example on the efficacy of some triphenylmethane dyestuffs against certain parasites, gave rise to the hypothesis that trityl (= triphenylmethyl) compounds may also have a biological effect.



triphenylmethyl cation (= trityl)

Triphenylmethyl imidazoles were the first substances to be investigated. Canesten, which

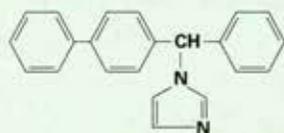
is known under the generic name clotrimazole, is a typical example of this category:



clotrimazole
Canesten

During the systematic variation of both halves of the molecule, scientists recognized that the trityl radical can be substituted by similar and different configurations and that other heterocyclic com-

pounds with nitrogen in the ring can take the place of the imidazole nucleus. An example of the resultant advanced development is Mycospor (generic name: bifonazole):



bifonazole
Mycospor

The important azol fungicides for the agricultural

market, Baytan and Bayleton, are described on page 546.

because there was no effective agent that did not have noticeable side effects.

In 1963, a special laboratory for medical mycology was set up in the Institute for Chemotherapy at Elberfeld. Its research target was to find a broad-spectrum antimycotic that would be largely free of side effects and easy to administer. It was more than just luck that this goal could be reached within only a few years. The decisive factor was that the two scientists in charge of the project persistently followed a clearly defined line of thought when it came to the specific form of therapy that was desired.



In 1966 and 1967, they succeeded in synthesizing an imidazole derivative that proved to have a slight but very broad inhibiting effect on almost all kinds of fungus in an extended series of tests. When the chemical structure of this compound was systematically altered, it became clear that a new class of active agents had been discovered. Among them were substances with extremely promising fungicidal properties.

But the good news did not end there. The compounds in question were so versatile that they could be developed for use in other sectors, too. Thus the original work of the researchers subsequently branched off into three different directions of application: the first led to agricultural fungicides for crop protection purposes; the second spinoff was mercury-free wet dressings for seeds, and the third resulted in the development of effective agents against the many forms of human mycosis.

Bayer applied for a patent for a particularly promising compound in 1968. This substance was subsequently developed into the Canesten product line (generic name: clotrimazole), which soon found a wide range of applications in the form of ointments, solutions, sprays and powder.

The extraordinary efficacy of this agent and similar compounds is based on the fact that they prevent the formation of a substance of vital importance for the development of the outer skin of the fungal cell. In this way, the product can be used very sparingly—an advantage which is even more pronounced in the successor product that has since been introduced under the name of Mycospor.

These new products have been instrumental in filling a hitherto serious gap in the therapeutic treatment of fungal infections. It is hardly surprising that they have become an essential part of the physician's therapy. Today, Canesten is used in over one hundred different countries. In the United States, the product is marketed under the name of Mycelex, and the same active agent is sold as Empecid in Japan and some other countries.

Almost all public swimming facilities today have installed disinfectant foot sprays in their shower rooms to help combat athlete's foot and similar infections. These precautions help prevent fungal diseases from spreading.

Bayer chronicle 1973

A centralized incineration unit for exhaust gases goes on stream in Dormagen. The capacity of the plant's central waste water purification facility is raised to 3,530,000 cubic feet per day.

Bayer signs an agreement on scientific and technical cooperation with the Federal Ministerial Committee for Science and Technology of the Soviet Union.

A group of Bayer experts accepts an invitation extended by Chinese foreign-trade organizations to visit Peking.

Bayer buys a site at Zárate on the Rio Paraná, where it will build what is to be one of Argentina's biggest chemical plants.

Bayer do Brasil moves its central administrative offices to São Paulo.

A new synthetic menthol plant starts production at the Haarmann & Reimer works in Holzminden.

Large-scale tests begin of polyurethane-based front bumpers on New York taxis.

Following the earthquake in Nicaragua, the German Red Cross erects 450 "igloos" made of Bayer polyurethane to provide temporary shelter for the homeless.

World events 1973

An agreement on an armistice in Vietnam is signed in Paris on January 27 and provides for the withdrawal of all U.S. troops.

Disarmament talks begin in Vienna on January 31; the Helsinki "Conference on Security and Cooperation in Europe" opens in July with delegates attending from East and West.

Chilean army stages a coup d'état on September 11. President Salvador Allende is shot during the storming of the government headquarters in Santiago de Chile.

The Federal Republic of Germany and the German Democratic Republic become members of the United Nations on September 18.

Yom Kippur War takes place from October 6 to 25. Egypt and Syria attack Israel but are beaten back after initial victories.

Radar echoes received by NASA show that the ring around Saturn consists of a thin layer of matter which has an average diameter of about one yard.

The U.S. space probe Pioneer 10 radios back data showing that the planet Jupiter has a magnetic field which is 50 times stronger than that of the Earth.

1974

Systematic expansion in the United States

If an international company wants to be successful in the chemical industry, it has to be appropriately represented in the United States. Bayer has been convinced of this policy right from the beginning. Its American foothold was established only a few years after the parent company was reincorporated. Pittsburgh has been the headquarters of Bayer's activities in the U.S. since 1974.

The United States is the world's most industrialized nation. There is no other country where so many different chemical products are manufactured and used. Research expenditures are higher than the combined sum spent in Japan, the Federal Republic of Germany, France and the United Kingdom. When Bayer was ready to reestablish its international network after the Second World War, it was obvious that major emphasis would be put on the United States.

The reentry was difficult. After two world wars, German assets and property had been confiscated for the second time. As a consequence of World War I, the rights to the Bayer name and trademark had been expropriated and subsequently acquired by the U.S. company Sterling Drug back in 1919.

The American chemical industry grew by leaps and bounds in the thirties and forties. And in doing so it had caught up with Germany's lead in the field of chemical engineering.

In 1947, Bayer's total exports to the U.S. market were worth RM 4,500, the equivalent of no more than 0.0013 percent of annual sales. But the following years saw a rapid growth in business, and by 1951, the year in which the "new" Farbenfabriken Bayer was incorporated, shipments to the United States already made up some two percent of sales. As a result, the United States occupied fourth place in the list of Bayer's top export markets. The company was reassured to see that its products were still in demand.

As gratifying as this development was, Bayer could not build up its U.S. presence to an adequate level on the basis of exports alone. Production facilities as well as a marketing organization and application technology service had to be set up in the country itself. The trouble was that capital was scarce in the 1950s, and at that time, Bayer simply did not have enough foreign currency to build or to buy its own plants. What the company did have though were new processes and products that looked like they would have a promising future on the U.S. market. This meant that it was not too hard to find

Bayer's interests in the United States are coordinated by the Pittsburgh-based holding company, Bayer USA Inc.

American partners willing to cooperate with the German firm.

The company's new crop protection products appeared to be of particular interest; even then, the United States was the world's biggest and most sophisticated agricultural producer. As early as 1950, Bayer provided the necessary technology for the Chemagro Corporation and subsequently acquired a 50-percent stake in the firm in 1956. Eleven years later, Bayer's holding company bought the remaining 50 percent from Pittsburgh Coke and Chemical Company. Chemagro moved its headquarters to Kansas City, Missouri, in 1957. In 1972, Chemagro took charge of Bayer's Florida-based Vero Beach Laboratories, where agrochemicals were tested under subtropical climatic conditions.

The polyurethane business in the United States developed in a similar way. In 1954, the joint venture Mobay Chemical Company was set up together with Monsanto to introduce Bayer's polyurethanes to the American market. The U.S. partner transferred its holding to Bayer in 1967, after the U.S. antitrust authorities opposed the cooperation of the two major chemical manufacturers. As a fully owned Bayer subsidiary, Mobay grew to be the biggest and most versatile supplier of polyurethane raw materials in the country. In subsequent years, Mobay branched out into other business fields such as industrial chemicals, synthetic rubber and thermoplastics. The company's headquarters is now in Pittsburgh, Pennsylvania, and two of its major plants are located in New Martinsville, West Virginia, and Baytown, Texas. Production began at the latter plant in 1972.

Bayer's successes in the the U.S. market were not limited to its new products. Dyestuffs and textile auxiliaries proved to be in great demand, too. In this case, the company also reached the decision that its position could only be maintained and strengthened if it had a U.S. manufacturing base.

With this strategy in mind, Bayer bought Verona Chemical Company and Pharma Chemical Corporation in 1957 and then merged these two firms to form Verona Corporation. Verona's facilities in Bayonne,

New Jersey, were not big enough to meet Bayer's needs, however, so the modern Bushy Park plant was built on the outskirts of Charleston, South Carolina. Over and above the three production companies Chemagro, Mobay and Verona, Bayer also owned small trading firms for the importation of synthetic fibers and fine chemicals.

The next step in the systematic expansion of Bayer's business in the U.S. came after the merger of Agfa AG in Leverkusen and Gevaert Photo-Producten N.V. in Mortsel, Belgium. In 1964, Agfa-Gevaert Inc. was established in Ridgefield Park, New Jersey. Today, Agfa-Gevaert employs some 1,400 people in 26 branches and agencies in the United States. The New Jersey company offers a wide range of products—from those of the photographic sector and including graphic systems, magnetic tape and motion picture film to X-ray diagnostic and nondestructive material-testing systems.

The future importance of electronics for the Bayer Group was underlined when Agfa-Gevaert acquired a majority holding in Compugraphic Corporation in 1981/1982. The remaining shares were bought in June of 1988. Based in Wilmington, Massachusetts, Compugraphic is a leading producer of computerized photocomposition equipment, a field of key importance to modern printing technology.

For example, with the acquisition of Matrix Corporation and a holding in Autographix Inc., the Agfa-Gevaert Sector in the United States is well-represented in the fast-growing field of information technology and has excellent prospects for the future.

After a long period of growth, the time came in the early seventies for a consolidation of Bayer's U.S. operations. In October 1971, the six American subsidiaries were amalgamated into a new, central company. Corresponding to the structure of the German parent company, the merged firms became divisions within the new organization.

It proved to be difficult to establish a completely new name for this entity so in 1974, Mobay Chemical Corporation was chosen for the company's name

**Herbert Grünewald, Chairman of the Board of Management
from 1974 to 1984**

Herbert Grünewald was born on September 12, 1921, into the family of a merchant who lived in Weinheim an der Bergstraße. After graduating from the Ziehen School in Frankfurt, Grünewald enrolled in the university in Frankfurt in 1940. His studies in chemistry were interrupted when he was drafted for military service in the war. He was not able to go back to school until 1949, after having returned from a prisoner-of-war camp. He graduated from Heidelberg in 1953 and obtained his doctorate in 1956 under Professor Otto Theodor Schmidt.

Grünewald joined Bayer's Intermediates (ZW) Department in 1956. After serving as head of the ANS unit, he moved to the A plant in 1959 and became departmental manager the following year. At the beginning of 1965, he was promoted to director of the ZW Department. Taking effect on January 1, 1968, Grünewald was appointed to the Board of Management. Besides his other tasks, Grünewald was given responsibility for personnel and welfare matters. With the reorganization in 1970, he was put in charge of corporate coordination and the newly formed corporate staff division.

When Grünewald succeeded Kurt Hansen as Chairman of the Board on July 3, 1974, the world economy and the German chemical industry were going through a period of radical change. The first oil crisis occurred in the

years 1973 and 1974; within only a few months, the prices of mineral oil-based feedstocks increased several times over. Serious bottlenecks resulted, which called for far-reaching adjustments. Grünewald saw this situation as a challenge. The first time he addressed the shareholders' meeting as Chairman of the



Professor Herbert Grünewald

Board in 1974, Grünewald said: *"In the short term, the oil crisis was a shock, but in the long term, it can be a lesson to us. Mineral oil is far too valuable a raw material to be used to such a large extent as a source of energy."*

Under Grünewald's leadership, Bayer mastered the situation and formed the basis

for consolidation and further growth. In order to broaden the company's base on the world market, more money was invested outside of Germany. Cutter and Miles were acquired in the United States in 1974 and 1978. Bayer also became the sole owner of Agfa-Gevaert in 1981.

cultural Chemicals Center in Monheim symbolizes this trend. Its construction began in 1979.

The shift in emphasis was also reflected in sales figures; by the time Grünewald stepped down as Chairman, health care, Agfa and agrochemicals had become Bayer's leading businesses. Other activities, such as fibers, were streamlined. And in 1978, Bayer sold its stake in Hüls AG to Veba.

A further challenge facing Grünewald was environmental protection. He saw no innate conflict between economic growth and modern technology on the one hand and the ecology on the other; in fact, the former was necessary to achieve the latter. He stressed the importance of dialogue with the public and tried to promote confidence in the chemical industry.

Herbert Grünewald, who has been Chairman of the Supervisory Board since 1984, did not limit his efforts to Bayer. In his opinion, supporting industrial associations and programs in the public interest belongs to a businessman's responsibilities.

The arts, sports, science and further education are among Grünewald's favorite pastime pursuits. He took personal interest in the development of the Carl Duisberg Society, the expansion of the university-level business seminars at Gracht Castle and the activities of the Cultural Committee of the Federal Association of German Industry.

and its headquarter operations were concentrated in Pittsburgh. With a total of 4,000 employees and annual sales of \$330 million, the newly merged Mobay immediately assumed a respectable place in the ranks of the American chemical industry.

The subsequent move was to expand Bayer's pharmaceutical business in the United States. Since there were limitations on the use of the company name and the famous Bayer trademark, the company decided to go the route of buying established pharmaceutical manufacturers. With the purchase of Cutter Laboratories in early 1974, Bayer had the additional advantage of expanding into new fields, such as blood plasma fractions. A further and even more substantial step came with the acquisition of Miles Laboratories, Inc., Elkhart, Indiana, which was finalized in January 1978.

In Miles Bayer had found a partner with very considerable experience in the fields of biotechnology and diagnostics. More details on these activities can be found in the chapter starting on page 514.

Together with the help of affiliated companies Molecular Diagnostics and Molecular Therapeutics, both of which are engaged in basic research, Bayer was able to establish a strong foothold in the American pharmaceuticals industry within the space of only a few years. Considering the past successes and present favorable developments, the company sees an optimistic future for its health care activities in the United States.

The standing of a company depends primarily on the performance of its staff, the quality of its products and the strength of its competitiveness. Many highly qualified university graduates who represent the management potential of tomorrow will prefer to work for a firm with a "name." And in competitive situations, a reputation based on tradition and reliability can make the difference in clinching a deal. This is, of course, no news to Bayer.

For these reasons, the agreement reached with Sterling Drug in 1986 on the use of Bayer's own name and trademark, at least for certain businesses, was

of major significance. It was thus a historic moment when former financial holding company Rhinechem Corporation was able to begin operations on July 1 of the same year as a central management holding under the new name of Bayer USA Inc. After over 67 "nameless" years, Bayer was once again able to call itself Bayer in the United States. There are, however, still some limitations in the health care market, and Sterling Drug continues to hold the rights to the Bayer cross trademark in the United States. The use of the name Bayer for industrial products is being systematically expanded now that it has once again become a registered company trademark in the United States as of April 19, 1988.

Bayer USA Inc. of Pittsburgh is responsible for the coordination of all Bayer's interests in the United States. The company attaches great importance to the fact that it operates as an American company within the American economy. The combination of the new management concept and the longstanding positive image of its international parent company has helped the firm gain nationwide acclaim as one of the country's top ten chemical companies.

Bayer's U.S. subsidiaries include Mobay and Miles, the latter having merged with Cutter in the meantime, as well as Agfa-Gevaert Inc., Compugraphic Corporation, Deerfield Urethane, Inc., Haarmann & Reimer Corporation, Wyrough & Loser, Inc., NRC Inc. and another U.S. subsidiary of the Hermann C. Starck Group that Bayer acquired in 1986.

These U.S. companies belonging to the international Bayer Group have in the meantime become a "group" in their own right. In 1987, Bayer USA employed a total of 24,400 people and achieved sales of \$4.2 billion. The highly diversified activities of its companies range from the traditional chemical sector to such future-oriented fields as communications technology, biotechnology and technical ceramic materials.

Bayer's U.S. companies are well-equipped to face the demands of the future; their close integration and shared wealth of experience form the basis for ambitious plans in the years to come.

Safety measures keep accidents to a minimum

Bayer launched its first safety competition in 1974. The idea originated at Dormagen and soon caught on at the other plants. Today, some 46,000 employees take part in these competitions, which have proved their worth again and again.

How can safety be the subject of a contest? After all, two pairs of protective glasses are no safer than one. Of course, the rules governing the Bayer competition had a totally different basis. The idea was to keep a year's accident frequency per thousand employees below the level of the previous year. Employees were assigned to separate groups; the bonus for each individual was assessed according to the success of the whole group. Thermometer-like indicators were set up at the works' gates to let everyone know the current ratings in the race for occupational health and safety.

The unremitting effort to maintain safety at the workplace has a long tradition. The work in the chemical industry has always called for special care and caution. Skimming through old documents reveals that notions about industrial safety were relatively simple a century ago, but nonetheless, remarkably few accidents took place. The point was that the industry was still small and manned largely by seasoned veterans of the factories who knew how to handle the chemicals of the day. Newcomers to the job benefited from the years of experience of the foreman, and the safety risks were more a question of the reliability of the equipment than the people using it.

The second important criterion for safe production of chemicals, i.e. plant safety, became increasingly significant as transmission-driven agitator vessels started to replace open vats, and pressurized containers were required for the new chemical reactions. Safety precautions in handling equipment also had their roots in the early founding years of the dye-works. They were developed by the plant engineers of the industrial companies in accordance with the federal regulations issued by trained authorities. The history of this important aspect of chemical engineering is the subject of a chapter beginning on page 500.

Appropriate safety measures were introduced step by step over the years for the immediate protection of the worker on the shop floor. Protective glasses, hard hats, special clothing, safety shoes and

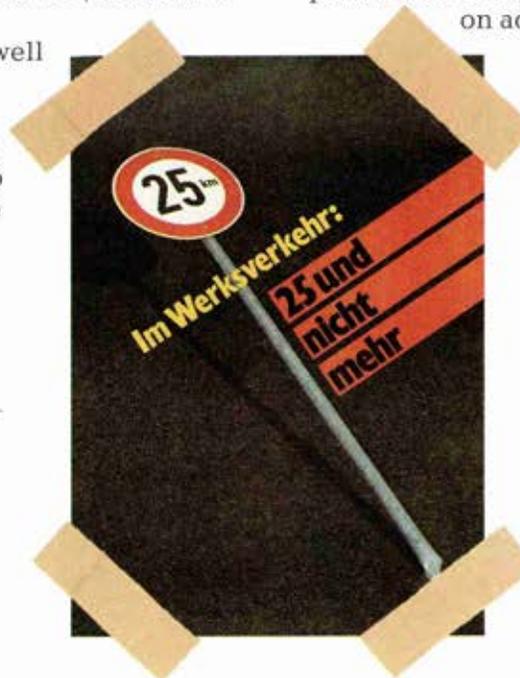
many other items soon belonged to the daily outfit of the worker. At the same time, Bayer instituted systematic safety training and launched information campaigns with the help of explanatory signs and posters. These steps were not only aimed at preventing serious accidents, but also at alerting people to the potential dangers in such routine jobs as filling, transporting and handling carboys, barrels, welding equipment and forklift trucks.

In order to guarantee that these methods be adopted in a uniform and systematic fashion and to achieve a constant improvement of safety standards, a department responsible for occupational safety was set up as a part of the administrative offices of each plant. The chemists, engineers and psychologists of these departments work closely with the company's physicians. Their partners on the employer's side are the so-called "Berufsgenossenschaften" (employers' liability insurance associations). These German organizations are responsible for taking out statutory accident insurance for all branches of trade and industry, and they assume an advisory and control function.

The professional association of this kind serving the chemical industry has had relatively few problems with its member firms of late, as accident rates have been gratifyingly low for many years now. In 1986, the German chemical industry counted some 36 accidents subject to registration per thousand employees. This average put it down at the bottom of the list of accident frequencies in the various branches. It was, for example, far below the textile and leather industry with 40 accidents per thousand and not much higher than the category entitled "commerce, finance, insurance and services" with 28.

For its part Bayer AG is very well placed within the industry; its accident frequency amounted to only 18 per thousand in 1986, and it dropped by six percent to no more than 16.9 accidents the following year.

Caution is the basis of occupational safety. The fact that accident rates have fallen to a gratifyingly low level in the chemical industry over the past years shows how successful corporate efforts have been in this field.



Top priority is also given to safety precautions taken to avoid traffic accidents within the boundaries of the plant. The maximum speed is limited to about 15 miles per hour.

It is interesting to note that only a fraction of these accidents can be considered "typical" of the chemical industry. The vast majority could have happened anywhere. They involved people walking, riding bicycles, climbing ladders or engaging in similar everyday activities. This good showing is the consequence of careful accident-prevention work and safe equipment, but the occupational safety departments have certainly also played an instrumental role.

The operations of these departments can be divided into four main areas: the first is concerned with the technical safety of the workplace and its immediate surroundings. All workplaces are taken into consideration, whether production facilities, laboratories or office buildings, whereby the factories naturally demand the most critical evaluation. The work of the experts includes making sure that all machinery, apparatus, tools and transportation equipment conform to technical safety standards.

Besides the individual workplace, the safety departments are also responsible for looking after the overall safety of production units and processes. "That's the way we've always done it" is no excuse; there is no such thing as a process that cannot be improved in some way or another. It is up to the safety experts to find out how it could be improved before, and not after, an accident occurs. Of course, this work involves a close and constructive cooperation with the responsible managers.

A third task encompasses the "training" of employees. One way of helping to improve their safety performance is the "thermometer" competition mentioned earlier. Less spectacular but no less important is the day-to-day job of spreading information on actual or potential dangers and how to avoid them. In this connection, every employee is given exact written and verbal instructions on the dangers inherent in his or her workplace. The same goes for persons who are only temporarily employed in a given work area.

Spot checks are made to determine whether the regulations are being adhered to. The behavior of an employee concerning matters of safety is even a part of the personnel department's individual evaluation.

More than ever before, occupational safety measures to prevent accidents are concentrating on human behavior. People often used to think that ingenious safety regulations and equipment were in themselves enough to prevent accidents. The premise was that the individual employee would look after himself "in his own interest." As reasonable as this seemed, it overlooked the fact that nothing is more tiring and frustrating than constantly being on the lookout when nothing untoward is happening.

Generally speaking, anybody who is learning a given skill—be it bricklaying, penmanship or tennis—feels an increasing degree of satisfaction when he or she sees that progress is being made. This feeling of success is undermined when the person is subjected to, in his or her opinion, unreasonably confining safety regulations without ever having been involved in an accident. Over the long term, it is therefore important to instill a feeling of common responsibility among all employees to keep up safety standards. Negligence is an offense against oneself and one's co-workers, nobody should bank on experience alone and "heroes" have no place in a chemical plant.

Unfortunately, it would be unrealistic to hope that accidents can be entirely eliminated in a chemical works or elsewhere. Therefore, when accidents do happen, they must be investigated with all those concerned. The conclusions gained from this experience are not only useful for the safety department but can also be incorporated into accident-prevention seminars staged for employees of all levels.

The fourth major activity of the safety experts concerns the materials processed in the plants. German law lays down that the air in areas where dangerous

substances are being handled must be constantly monitored by suitable measuring devices. Bayer decided to extend this measurement control program to cover materials that are only suspected of posing a health hazard. In 1980, a new group known as "workplace control" (ABU) was formed as a part of the employee protection system.

At the turn of the century, Ferdinand Flury of Würzburg, proposed a system of threshold values for the concentration of substances that could endanger health at the workplace. Within these limits, no health hazard is expected, even under conditions of long-term exposure. Now maximum allowable concentration values are applied to some 400 substances, as compared with only 100 fifty years ago. Bayer monitors the concentration of many more substances with the help of regular measurements.

In the Federal Republic as a whole, concentration values are reviewed annually by an independent commission of experts from the German Research Community and brought up to date, if necessary.

Bayer's measurement program always begins with an analysis of the work area: who is subjected where, how and for how long to dangerous substances? After taking 2,000 samples and 3,200 individual measurements in 150 works units, an initial result was obtained in 1984: 57 percent of all values measured were equal to only 10 percent of the maximum workplace concentration. In only 2.8 percent of all cases was this value exceeded; action to correct the situation in these areas was naturally taken immediately.

The results were even more encouraging in the case of carcinogenic substances, whereas only 0.3 percent of the 642 measurements showed concentrations exceeding the official

technical guidelines. Here, too, action was taken without delay.

On the other hand, it is not enough to search for dangerous substances in the air alone. Great importance is also attached to

Am I doing the right thing?
This is a question which every conscientious employee has to answer during his daily routine. Just because someone has worked for years without an accident, it is still no guarantee of safety. A series of posters warning about the different



dangers helps to remind employees of the risks. After all, safety regulations are there to protect the individual. This poster underlines the importance of safety glasses.

regular medical examinations of employees working with hazardous materials, including an investigation into whether and, if so, to what extent a toxic substance has passed into the human organism. In other words, the so-called ambient monitoring of the workplace is supplemented by biological monitoring of the body. Here, too, the experts have guidelines to work from. These biological tolerance limits are based, like the maximum workplace concentrations, on an eight-hour workday and a 40-hour workweek. A large number of examinations in the Bayer plants showed that the biological tolerance levels were adhered to almost without exception. In the few cases where the values were exceeded, necessary corrections were able to eliminate possible danger at the workplace.

The results of biological monitoring and individual examination are naturally subject to the doctors' professional code of secrecy. All results are, however, documented and filed—in the case of carcinogenic substances, the records are kept for a period of 60 years. These long-term records make it possible to determine who has worked with what substances for how long, which is extremely valuable for purposes of comparison. To the extent that it is permitted by personal-data protection regulations in Germany, these facts can be used for epidemiological studies. Only about six German companies are so advanced in this particular field of occupational health. Indeed, in biological monitoring, Bayer has no doubt set an example, and its work has been beneficial both to general and preventive safety efforts as well as to the employees of the chemical industry as a whole.

The amount of work invested in this area reflects an important aspect of Bayer's corporate philosophy. Taking the measurements is one thing; taking the consequences—even radical ones—is another. Flourishing branches of production, such as benzidine dyestuffs or PCBs, have been dropped from the product range when it was shown that unacceptable risks could arise from their manufacture or use.

Bayer chronicle 1974

Four Belgian subsidiaries Socochim, A.T.B.I., Sovatex and Belgo Pharma are merged to form Bayer Belgium S.A.-N.V. with headquarters in Brussels.

Swedish marketing companies Bayer Agro Kemi AB of Malmö, Bayer Farma AB of Stockholm, and the Gothenburg-based Bayer Kemi AB amalgamate to form Bayer (Sverige) AB with its headquarters in Gothenburg.

Bayer takes over the three operating companies of the Metzeler group: Metzeler Kautschuk AG, Metzeler Schaum GmbH and Correcta Werke GmbH.

Together with the Mexican industrial concern Cydsa S.A., the company sets up Cydsa-Bayer S.A. for the production of isocyanates. Construction work on a new plant begins.

Production of Ampicillin and Lewatit ion exchangers starts at the Belford Roxo works in Brazil.

A control van to measure sound levels is put into operation in and around the Leverkusen plant.

Cosmetic line under the tradename of Quenty is introduced to the market.

Staff vacancies begin to be advertised within the company.

World events 1974

Valery Giscard d'Estaing becomes the French president following the death of Georges Pompidou.

Chancellor Willy Brandt resigns on May 6, in the wake of a scandal involving the East German spy Günter Guillaume. He is succeeded by Helmut Schmidt.

A coup d'état takes place on Cyprus on July 15, in which Archbishop Makarios is deposed by army officers. A few days later Turkish troops land on the island. The Cyprus crisis leads to the fall of the military regime in Athens; a democratic civilian government is subsequently formed by Konstantin Karamanlis.

On August 9, President Richard Nixon announces his resignation as a result of the Watergate affair. Gerald Ford is sworn in as the 38th U.S. president.

The German Democratic Republic publishes a new constitution, from which any reference to a "German nation" has been dropped.

Adalat heralds a new era in cardiovascular medicine

Every second West German dies of heart failure, circulatory collapse or apoplexy. That makes some 360,000 fatalities annually. Introduced to the market in 1975, Adalat opened up new perspectives in the treatment of heart and circulatory conditions and gave new hope to the many sufferers.

Diseases of the heart and circulatory system kill far more people than cancer. However, this was not always the case. Back in 1925, it was not every second, but every seventh German who died of cardiovascular diseases. The shift in causes of death can to some extent be attributed to the successes achieved in the treatment of infections, whose incidence in the mortality toll today is almost negligible.

At the same time, growing prosperity in the Western world has led to a vastly increased frequency and significance of certain health risk factors: being overweight due to excessive eating and fatty foods, a lack of exercise because so many jobs have become sedentary, an increase in the emotional overreaction to the demands made on everyday life, which is more commonly known as stress, and an excessive consumption of nicotine.

In addition to all of these disease-promoting causes, another factor has contributed to the higher incidence of cardiovascular disorders. The average life expectancy was barely 45 years at the turn of the century. Today, one can expect to live over 70 years, and this average life expectancy is slowly increasing all the time. The heart and blood vessels of the elderly are naturally less resistant than those of younger people, so there is a rise in corresponding ailments for this reason, too.

The heart is the body's engine, and thus gives us life. It acts as a pump for the constant supply of nutrients and oxygen into all of the body's cells, right down to the tiniest capillaries. In 24 hours, it beats about 100,000 times and transports some 7,500 liters of blood in the process.

In the course of time, calcium compounds, fats and cholesterol begin to be deposited in the blood vessels, which subsequently become congested. This thickening and hardening of the walls can lead to calcinosis and arteriosclerosis.

The narrowing of the vessels means the heart has to work harder. Part of the effort goes into supplying its own coronary vessels with blood. When these arteries start to become congested, coronary sclerosis occurs, and the painful condition of angina



pectoris can be the possible consequence. In serious cases, this condition can lead to a cardiac infarction. In the Federal Republic alone, 83,000 infarcts occur every year.

The word infarction, or infarct, comes from the Latin "infarcire," which means "to stuff in." A clot stops up the already congested coronary vessels and thus interrupts the supply of blood to the heart.

Mankind recognized the role of the heart before all of the other inner organs. Many civilizations came to regard it not only as the center of life but also as the home of the soul. The cruel sacrificial rites of the Aztecs and even the hearts that lovers cut into the bark of trees give testimony to the deeply rooted conviction in both cultures that the heart is more than just a vital organ. The saying that someone has died of a broken heart even points to an age-old confirmation of psychosomatic conditions.

Despite this knowledge of the heart as a life-sustaining organ, serious heart therapy was developed relatively late in comparison with the treatment of other organs. It was not until the end of the 19th

century that the vasodilating effects of nitrates and nitro compounds on the coronary vessels were discovered. The explosive nitroglycerin—in the form of a diluted solution, of course—became the first medicine used against angina pectoris.

The heart-stimulating properties of the glycosides in the foxglove (*digitalis*) were recognized in 1879. And the production of strophanthin from natural bases began in 1887. All of these compounds were effective, but highly toxic substances. However, as Swiss physician and alchemist Paracelsus taught us, the fatal effect of "poison" is only a question of the dose.

Even in the early days of Bayer's pharmaceutical research, scientists looked for drugs to treat cardiovascular diseases. As a result of their work, Iodothyryn came on the market in 1896, Sajodin in 1907, Hexeton in 1922 and Padutin in 1930.

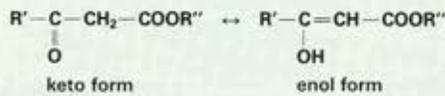
The rapid rise in heart and circulatory diseases in the years of growing prosperity during the fifties spurred researchers in industrialized countries to devote even more attention to this field.

Lucia Kellner's painting "The Threatened Heart" (above) was featured at an exhibition of works of art resulting from a competition sponsored by Bayer's Health Care Sector. In addition to the artistic content, the paintings were intended to draw attention to the risk of heart disease.

**Calcium antagonists, sympathetic nerve inhibitors
and beta blockers**

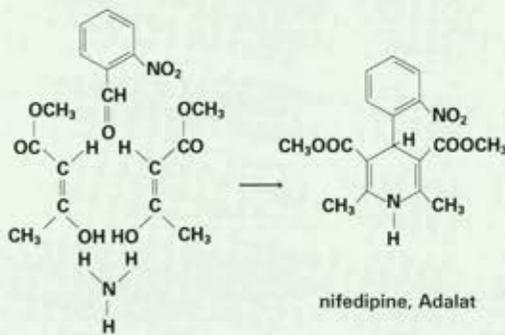
The calcium antagonists developed by Bayer belong to the class of the 1,4-dihydropyridines. Substances of this type can be obtained by using the method developed by A. Hantzsch, in which one molecule of an aldehyde

reacts with two molecules of a beta-keto-carboxylic acid ester and one of ammonia in an organic solvent. In the process, the keto-carboxylic acid ester reacts in its enol form:



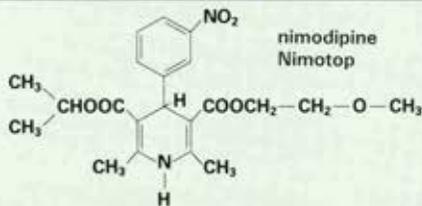
The general synthesis scheme can be described

using the example of nifedipine (Adalat):



Variation of the base materials allows the production of a wide range of dihydropyridines. This condition has considerably facilitated the

investigation of a large number of compounds in respect to their therapeutical potential. Nitrendipine (Bayotensin) carries the nitro group in the

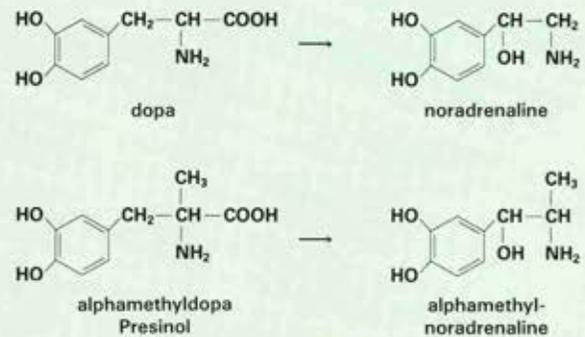


3' position and is a methylethyl ester. Nimodipine (Nimotop), which is particularly effective in the treatment of cerebral circulatory disorders, shows markedly larger structural differences compared with both of the simpler precursors.

Drugs used for the inhibition of sympathetic nerve functions have a formal similarity to the sympathetic nerve's carrier substances such as dopa, noradrenaline

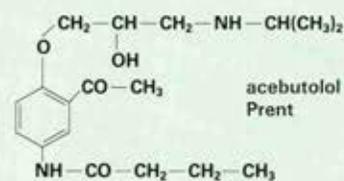
and others. Presinol, Bayer's first specific antihypertension drug (1964), is in fact an alpha-methyl-dopa. According to the opinion that was generally shared in former times, Presinol competes with the natural carrier substances and encounters the corresponding chemical changes, but without showing the same effects as the dopa or noradrenaline.

The analogy is demonstrated in the following diagram:



The third possible method of reducing blood pressure involves the "blocking" of the beta-adreno receptors—those points on the myocytes where the sympathetic stimuli are

transferred to the muscle. One such substance is acetobutolol, which is marketed in Bayer's sales program under the name of Prent:



It was not only a question of finding better therapies; diagnostic methods improved substantially with the development of new equipment. Thus, the electrocardiogram was supplemented by the ultrasonic echocardiogram; coronary angiography was developed as an X-ray display system for the coronary vessels, and doctors finally had computerized cardiogram and nuclear spin tomography at their disposal. Striking advances were made in surgery with bypass operations and the insertion of pacemakers. In 1967, Christiaan Barnard performed the world's first heart transplant.

Even taking all of these advances into account, the possibilities of an effective medication for therapeutic treatment had still not been thoroughly investigated. In 1948, Elberfeld chemist Friedrich Bossert was called on to initiate a search for a substance that would dilate the coronary vessels. He based his research on khellin, a natural product found in the seed of a plant and whose mild spasmolytic effects were already recognized in ancient Egypt.

Bossert discovered similar and even more effective substances, but their therapeutic application, particularly in prophylactic medicine, was not so simple. Continuing his work systematically, he came across the dihydropyridines in 1964. This group of substances had been known since 1882, but only now did Bossert and pharmacologist Wulf Vater find a large number of substances among these compounds that proved to be of major interest for heart therapy; and one of them showed particularly rapid and lasting effects.

The chemical name of this substance is not easy for the layman to grasp: 1,4-dihydro-2,6-dimethyl-4-(2'-nitrophenyl)-3,5-pyridine dicarboxylic acid dimethylester. Even chemists and pharmacologists try to avoid using such tongue twisters, so in this case the experts agreed to call it simply nifedipine.

The body's own regulation of the circulation of the blood through the heart depends on a complicated system of biochemical reaction mechanisms. The permeability of the cell walls of vessels and heart muscles for calcium ions plays an important role in this mechanism. Freiburg physiologist Albrecht Fleckenstein discovered in 1969 that certain substances could reduce this permeability; he gave these substances the name calcium antagonists. In an extended series of experiments, it was proved that nifedipine was a particularly effective calcium antagonist, and its overall properties made it very interesting for therapeutic uses. The active agent dilated not only the coronary arteries, but also the vessels in peripheral areas.

When nifedipine was evaluated in clinical tests after the usual comprehensive preparatory work, it was shown that in 70 to 80 percent of all patients suffering from angina pectoris, attacks either became much less frequent or stopped altogether. Large-scale investigations subsequently confirmed that Bayer had found an unusually promising substance in nifedipine. After a suitable technical synthesis of the starting materials had been developed, nifedipine came on the market in early 1975 under the trade name of Adalat.

The new medicine was remarkably successful. Five years after its introduction, Adalat was awarded the "Prix Galien" at the 8th European Congress for Cardiologists in Paris in June 1980. This highly regarded prize had been instituted by the French medical journal "Pharmacie Mondiale" in 1969. The name stems from Galen,

the famous physician of ancient Greece. Awarded by leading experts, it recognizes either pharmaceuticals that demonstrate outstanding therapeutical performance or particular scientific studies. Adalat was the first drug from Germany to have received the award.



Only a few years after the introduction of Bayer's Adalat, this drug was awarded the Prix Galien in Paris in 1980, as the first German pharmaceutical ever to win this highly prestigious prize.

In the discussions at various international congresses and conferences, cardiologists have frequently voiced the opinion that the advent of Adalat marked the beginning of a new era in cardiovascular medicine. Professor Fleckenstein even named the product "a pharmacological direct hit."

After a decade of practical experience with this drug under the widest range of conditions, Adalat's excellent efficacy has been proved in long-term therapy, and only a very small number of patients suffer from side effects during treatment. Results have been especially good in the case of older patients. Adalat has also shown itself effective as a support drug after heart operations.

This kind of success cannot be repeated every few years. Even for a company like Bayer, which spends an enormous amount of money on research, an element of luck is involved in such a discovery. In any case, patent laws only allow an inventor or a producer a limited time to enjoy this success alone.

The patent is applied for when the active agent is initially discovered.

But the entire development takes place during the patent protection period, which lasts 20 years in most countries. Going by the rule of thumb, it now takes between 10 and 15 years until a new drug is ready to be marketed, whereby some 10,000 substances will have been synthesized and some DM 250 million spent in the meantime. The time left to amortize these huge investments is thus reduced to only some five to seven years.

The great therapeutical success of Adalat prompted numerous firms, not themselves active in the research field, to produce nifedipine once the patent had

expired in 1985. In other words, they had not been faced with any of the necessary and massive expenditures that the original manufacturer had invested in the research, development and registration processes.

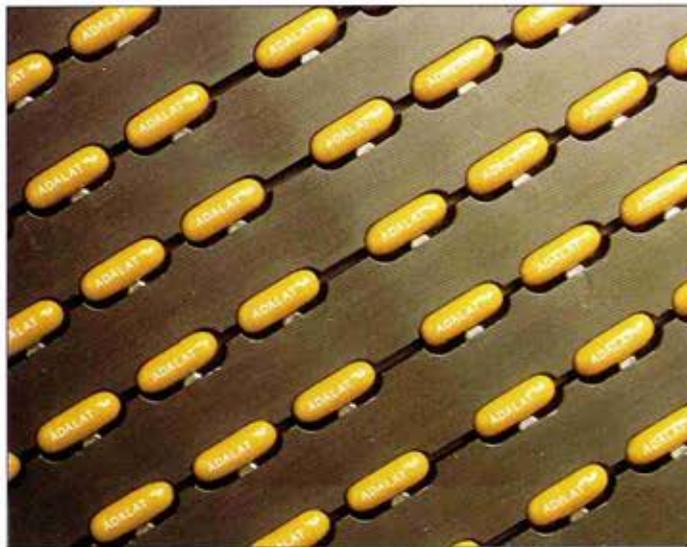
In fact, the work on a product does not end for a research-intensive company after a pharmaceutical has been registered. The continuing research on a drug insures that it can be further improved. Experience gained during the long development phase is an excellent basis for these continuous improvements. At the same time, research must constantly endeavor to identify and synthesize new drugs.

There is no sector of medicine in which a single panacea can cure all aspects of a disease. In the case of the treatment of heart and circulatory disorders, new principles for drug therapy have even emerged. One of them resulted in the development of the beta blocker group of pharmaceuticals.

The control of a large number of vital functions in the organism depends on the relationship between two nervous systems: the sympathetic,

which stimulates, and the parasympathetic, which relaxes. This principle also applies to the functioning of the heart. To receive the stimuli of these nerves, the heart muscle is equipped with receptors. Stimuli received from the sympathetic nerve always bring about a contraction of the heart muscle, a narrowing of the vessels and consequently an increase in blood pressure.

As early as 1964, Bayer introduced a drug that inhibited the sympathetic function. Marketed under the name Presinol, the product was aimed at reducing blood pressure. In 1977, the company's sales program



The above picture was taken during the production of Adalat. The finished capsules—filled and identified—are fed onto a sorting tray for individual inspection.

was supplemented by another product which weakened the transfer of the sympathetic stimuli to the beta receptor. This drug was developed together with the French chemical concern Rhône-Poulenc. Bayer sold it under the trade name of Prent.

Acebutolol, the active agent of this beta blocker, combines the reduction of blood pressure with a number of other important effects, which makes it of particular value for people who have high demands on their physical stamina both at work or in their leisure activities.

Apart from its other specialties, Bayer has two particularly effective medicines for the treatment of heart and circulatory diseases in Adalat and Prent. Advanced research has shown that a highly balanced system of medicinal treatment can be attained by the combination of different products, which are aimed to meet the patient's various needs. These findings led to the introduction of Sali-Prent in 1982, Sali-Adalat in 1984 and Tredalat in 1985.

Two important further developments in the field of calcium antagonists also occurred in 1985: a modification of the nifedipine molecule led to the discovery of a new substance known as nitrendipine, which is especially effective in the long-term treatment of patients suffering from high blood pressure and thus represents a therapeutical supplement to Adalat. It is sold under the name of Bayotensin.

In the meantime, it had also been determined that the efficacy of dihydropyridines is not limited to the dilation of the coronary vessels or the reduction of blood pressure. Certain substances of this class of compounds also work well in countering circulatory disturbances in the brain. Nimodipine was introduced to medical therapy under the Bayer trade name of Nimotop. This drug is a valuable aid in helping to avoid apoplexy in older patients.

In the past two decades, Bayer has thus achieved considerable successes in the fight against typical "civilization diseases." The company has been able to build up a position in this important sector of public health similar to the one it attained over 50 years ago in the fight against tropical diseases.

Bayer chronicle 1975

Bayer AG introduces payments of wages on a monthly basis for all employees.

The three French subsidiaries merge to form Bayer France S.A.

Bayer Pharmaceuticals (Nigeria) Ltd. is established in Lagos.

Large-scale facility for the production of monomer chloroprene by the butadiene process opens in Dormagen.

Biological waste water purification plant goes into operation in Uerdingen.

A shift foreman in Antwerp is awarded BFr. 317,000, the equivalent of DM 21,100, for a suggestion in connection with increasing caprolactam production yields. It is the highest bonus of this kind granted to date.

Women's choir is formed in Leverkusen.

Bayer 05 Uerdingen joins the top German Football League.

World events 1975

Three Southeast Asian nations turn Communist: on April 17, the Red Khmer occupy Phnom Penh, subjecting Kampuchea to a rule of terror which is to last until 1979; on April 30, the Vietcong and North Vietnamese troops occupy Saigon, marking the end of the Vietnam War; Laos becomes a People's Republic.

American probe Apollo 18 and the Soviet spacecraft Soyuz 19 meet in space on July 17.

Death of General Franco at the age of 82 ends 39 years of dictatorship in Spain. Prince Juan Carlos of Bourbon is instated as king and he subsequently leads the country to democracy.

Andrei Sakharov, the banished Russian nuclear physicist, is awarded the Nobel Peace Prize.

Plant safety is not left to luck

Making a plant safe means constructing, assembling, operating and controlling a facility in such a way as to obviate all possible dangers. For many decades, this had been a central and successful principle at Bayer. The Seveso accident occurred on July 10, 1976. Like many other companies, Bayer chose this occasion to review its safety concept.

The major raw materials of the chemical industry, such as mineral oil, natural gas, coal or other minerals, are relatively inert substances. If they are to be processed into new products, they generally need to be treated in quite radical ways.

For example, concentrated acids or caustic solutions are used under pressure or at high temperatures in order to obtain intermediates that are much more reactive than the original raw materials. These intermediates are then exposed to other reactants until finally, at the end of a sometimes long and complicated manufacturing process, the finished products are ready. These final products must show high stability, as in plastics or textile fibers, or specific active properties, as in the case of pharmaceuticals or agrochemicals.

Within the production units, large quantities of substances are processed that are potentially harmful to humans or materials. Since they are often flammable, corrosive or toxic materials, faults in the production processes can lead to fires or explosions. For these reasons, all possibilities of malfunctions must be eliminated before they can occur.

Occasional plant breakdowns and rare, but often spectacular accidents have led to a widespread belief among the public that the chemical industry is a particularly dangerous branch and that the chemical worker is constantly putting his health and life on the line. The facts prove otherwise. In the past 30 years, chemical production has increased to several times its former volume, while the number of accidents, which was low to begin with, has shown a substantial decline.

One reason for this improved situation lies in the exhaustive use of so-called process checklists that specify in detail every single step of a procedure for the systematic safety control of processes and corresponding equipment. These checklists have become mandatory safety instrument at Bayer.

A supplementary appendix to this list describes methods of applying technical safety controls and the necessary techniques for chemical analysis. It also includes a comprehensive catalog of questions



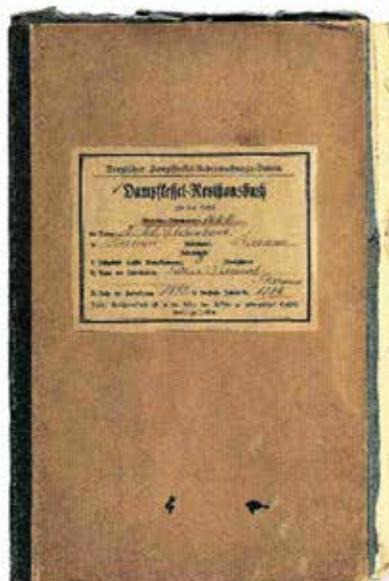
covering important facts on technical safety. Control checks on safety are carried out according to a predetermined schedule. The continuation of planning and construction work and the plant operation itself is contingent upon the positive results of this check.

Bayer has had its own technical supervision service since 1898, when it hired two engineers with government-accepted qualifications that empowered them to control "steam vats," as the steam-heated pressure vessels and reaction boilers were called back in those days. Like the steam boilers in machine shops, they were quite dangerous pieces of equipment in the early Industrial Age. It was not uncommon in Germany for a boiler to burst, quite often resulting in casualties.

The government had soon recognized this hazard and introduced regular boiler inspections as early as 1872. In contrast to the examinations formerly performed by building inspectors, these controls were carried out by specially trained engineers.

Even before the government had implemented the new inspections, the companies themselves had set up their own "steam boiler control associations" and manned these organizations with experienced personnel. The authorities soon came to recognize the competence of these associations and their expert engineers. Thus, official inspections in those firms that used this method of controlling their equipment were dispensed with.

A similar exception was made for larger companies when they made use of their own highly qualified engineers who were not dependent on a particular factory to perform these inspections. The authorities granted these companies the right to let the so-called "control engineers" carry out the statutory inspections. With this ruling, the basis was created for an in-house technical control system.



The chemical industry uses large quantities of substances that could pose a danger to both materials and humans. In an exhaustive procedure that is designed to guarantee problem-free processing, all possible operational faults have to be determined before production

starts. As early as 1898, Bayer set up its own technical control system. Each boiler had a so-called "steam boiler audit," which was actually a logbook containing details of all its inspections and repairs.

Factory and central workshops at Bayer

Photographs of Bayer's workshops exist from the period before the First World War. Those workshops were equipped to meet the requirements of the prevailing technology at the turn of the century: there were workshops for toolmakers, boiler-makers, coopers (wooden vats were still in use for stirring chemicals) and cartwrights. But the actual duties of these workshops were very similar to what they are today. They repaired existing installations and, where necessary, constructed the apparatus or single parts themselves.

Although the workshops have taken on a very different appearance over the decades, one very important principle is still valid: smooth operation of production facilities can only be guaranteed if routine maintenance and repair work or minor alterations can be carried out without delay. This is why the engineering department of each Business Group operates a whole series of on-site workshops adapted to meet the specific needs of a single unit or several facilities. The plant engineer can thus make sure that jobs necessary for day-to-day operations are done rapidly and with a minimum of red tape.

Specialization in the various sectors of engineering technology has brought with it a considerable investment in machinery. Major repairs, complicated new constructions or work with special materials have to be carried

out by the company's Central Workshops. The alterations that these workshops have gone through in the past thirty years show the extent to which modern process technology, new construction materials and greater demands on safety and environmental protection standards have called for traditional crafts to



Repairing a pressure vessel by welding a wire strip.

be replaced by previously unknown professional skills.

In the 1950s, for example, the construction of apparatus involved the use of conventional iron and steel materials plus a few types of stainless steel. Protective surface coatings were mainly limited to rubber and lead. Today, the range of available materials, and that includes all of the metals and non-metal products currently on the market, has risen tenfold. This situation necessitated the introduction of new processing

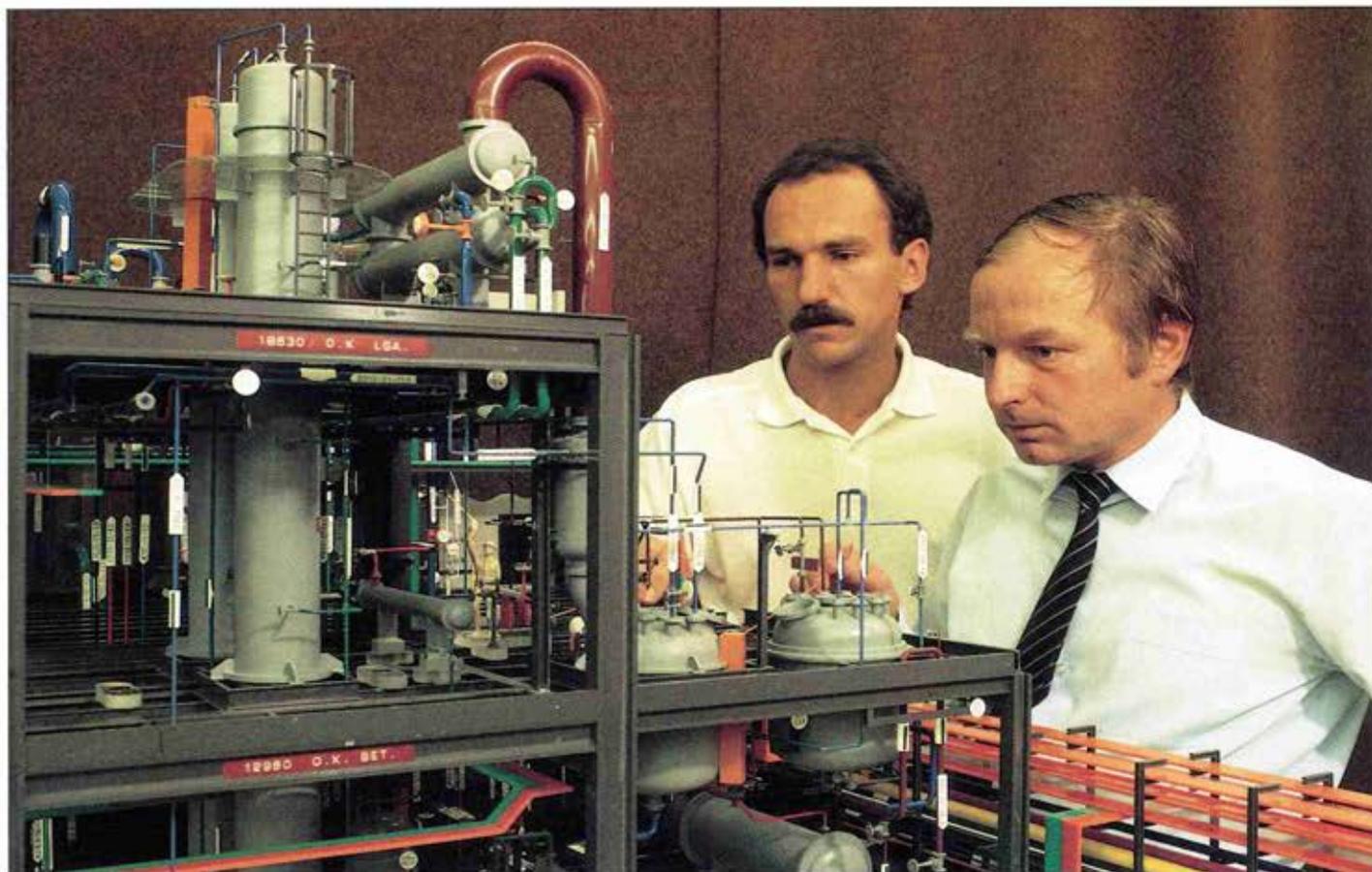
techniques in the modernized workshop units. Personnel had to be trained, and an in-plant advisory service had to be set up.

The strong position of Bayer AG in the field of high-performance plastics facilitated the creation of an efficient plastics workshop and the successful and economically efficient in-

drainage systems. And it was only natural that the control by process-control computers of even the most complicated work on tool machines was soon established in workshop technology.

The dynamic developments of the past three decades have not only led to a marked improvement in the kind of work a workshop can offer and to a faster completion of orders, they have also opened up all sorts of new job opportunities to workshop employees. The company telephone directory provides a summary of just how many different types of work are necessary to assist operations: apparatus construction, machine building, molding and testing machinery, pipe assembly, plastics workshops, elevators and hoists, pump workshops, steel constructions, building and air-conditioning services, pipelines and overhead piping systems, welding technology and more.

Some of these workshops are themselves big enough to be large business establishments in the trade, as far as the equipment and their capacities are concerned. Their experience and close ties to the actual chemical manufacturing units help them when it comes to performing construction and assembly jobs for new installations. Of course, the long-standing cooperation between Bayer and major manufacturers of equipment still remains the basis for large-scale investments.



Today, tests are to an increasing degree carried out by non-destructive methods. These methods include regular monitoring by an internal "periscope" and a video camera, use of X-rays or gamma rays, or ultrasonic testing.

The growing importance that Bayer assigns to safety problems is also reflected in its various restructuring measures. In 1986, for example, a special Plant Safety and Technical Inspection Section was set up within the Central Engineering Service Division. This consists of the traditional technical inspection unit, as well as departments responsible for materials technology and for process and plant safety.

The experts in materials technology look for materials that are most suitable for the specific operating conditions of a given plant. Sometimes these materials are not yet available on the market, so in these cases, the company has to attempt to meet specifications, for example, by adapting alloys of available materials. However, it may even turn out to be necessary to develop a completely new material.

For this reason, research expenditures account for a substantial part of the budget of the materials technology group. It encompasses both in-house

R & D and co-operations with suppliers or technical universities whose research efforts on certain subjects are supported by Bayer. Examples of developments of this kind are the range of high-molybdenum alloyed austenitic steels and the high-silicon alloyed chromium-nickel steels used for concentrated sulfuric and nitric acid.

When a new process is in the planning stage, material and reaction testing for technical safety invariably begins in the laboratories of the process and plant safety group. All known, and in fact all conceivable malfunctions and breakdowns are rehearsed at a pilot plant scale or run through the computer. These "disturbances" may include the potential repercussions of human error in operating the plant, such as mistaking the identity of a given substance or substances. Defects that are virtually inconceivable in the finished facilities themselves are also simulated, and mini-explosions are staged to test the behavior of chemicals and installations under extreme conditions. When all possible interactions between materials have been tested, the results are collated to form a comprehensive material and process data report.

The next preparatory work takes place in the pilot plant itself, where a new process is subjected to

In the planning stage of a plant—above a typical scale model—all safety considerations have to be taken into account and subjected to repeated checks. One member of the planning team is responsible solely for plant safety.

extensive technical safety tests. With the help of these findings, a safety concept is developed and subsequently, a so-called process manual which incorporates the conclusions reached in the concept. This manual then serves as a basis for upscaling procedures to industrial-level production and for safety requirements specially geared to this process. After this work has been completed, the plant handbook is the last step.

When all of this documentation has been collected, the actual application for approval can be submitted. After approval has been granted, plant construction may begin. Experts from the respective technical departments then supervise building and issue the inspection reports. Even then the plant is only ready for a trial run. All details of the facility and its maintenance requirements are recorded in the operations manual. As soon as the production plant actually goes on stream, continual supervision by factory staff and regular control inspections by technical safety experts begin. Where necessary, representatives of other departments are called in for their advice.

All safety measures are aimed at preventing irregularities and malfunctions in the plant—or at least keeping the consequences of such disturbances within acceptable bounds. It is the very knowledge of the potential dangers inherent in chemical production that have been responsible for a long tradition of extreme safety-mindedness. The number of industrial accidents at Bayer, some 17 per thousand employees in 1983 and subsequent years, is well below the average of 38 for the industry as a whole.

The word "safety" can, of course, mean no more than "almost complete safety." There is no such thing as zero risk—either in the chemical industry or elsewhere.

Bayer chronicle 1976

Bayleton, a systemic fungicide used in agriculture for the fight against harmful fungi, is introduced to the market. It proves such a great success that threatened wheat and barley crops in Latin America, Australia and New Zealand can be saved after its application.

Extramycin, a broad-spectrum antibiotic, is launched in the United States by Bayer in cooperation with Schering Corporation.

Production of Perlon comes to an end, which results in a temporary short-time work situation at the Dormagen plant.

Environmental protection efforts in Leverkusen are supported by the opening of a new central laboratory.

A controlled dump for solid waste is opened for use in Dormagen, and an incineration plant with a flue gas filter begins operation in Leverkusen.

Biggest hydrazine plant in the world goes on stream in Baytown, Texas.

Kieler Veterinär- und Pharmaprodukte (KVP), a company which markets animal health products and pharmaceuticals, becomes a 100-percent subsidiary of Bayer.

World events 1976

The World Health Organization announces that the world has been freed from the scourge of smallpox.

On July 10, TCDD (2,3,7,8-tetrachlorodibenzodioxin) escapes from a plant for the production of trichlorophenol operated by the chemical company Icmesa at Meda, Italy. As a consequence, 700 acres of land surrounding the communities of Seveso, Cesano Moderno and Desio are contaminated, and a total of 855 people have to be evacuated. Some of the victims—mainly children—suffer from chlorine acne.

The People's Republic of China loses its leaders with the death of Chou En-lai at the age of 77 on January 8, and Mao Tse-tung at age 85 on September 9. On April 5, President Chiang Kai-shek of Taiwan dies at 88.

A military junta headed by Jorge Videla deposes Argentinian President Isabel Perón on March 24.

National Cancer Institute of the United States opens an information center on carcinogenic substances. At that time, some one thousand agents are known to cause cancer in animals and about 40 in humans.

Medical therapy enters the antibiotics era

The antibiotics era began at the end of World War II with the metabolic product of a mold fungus. Bayer started selling semisynthetic penicillins in 1960. Further developments were its acylureido penicillins (1977) and, in 1987, the fully synthetic ciprofloxacin.

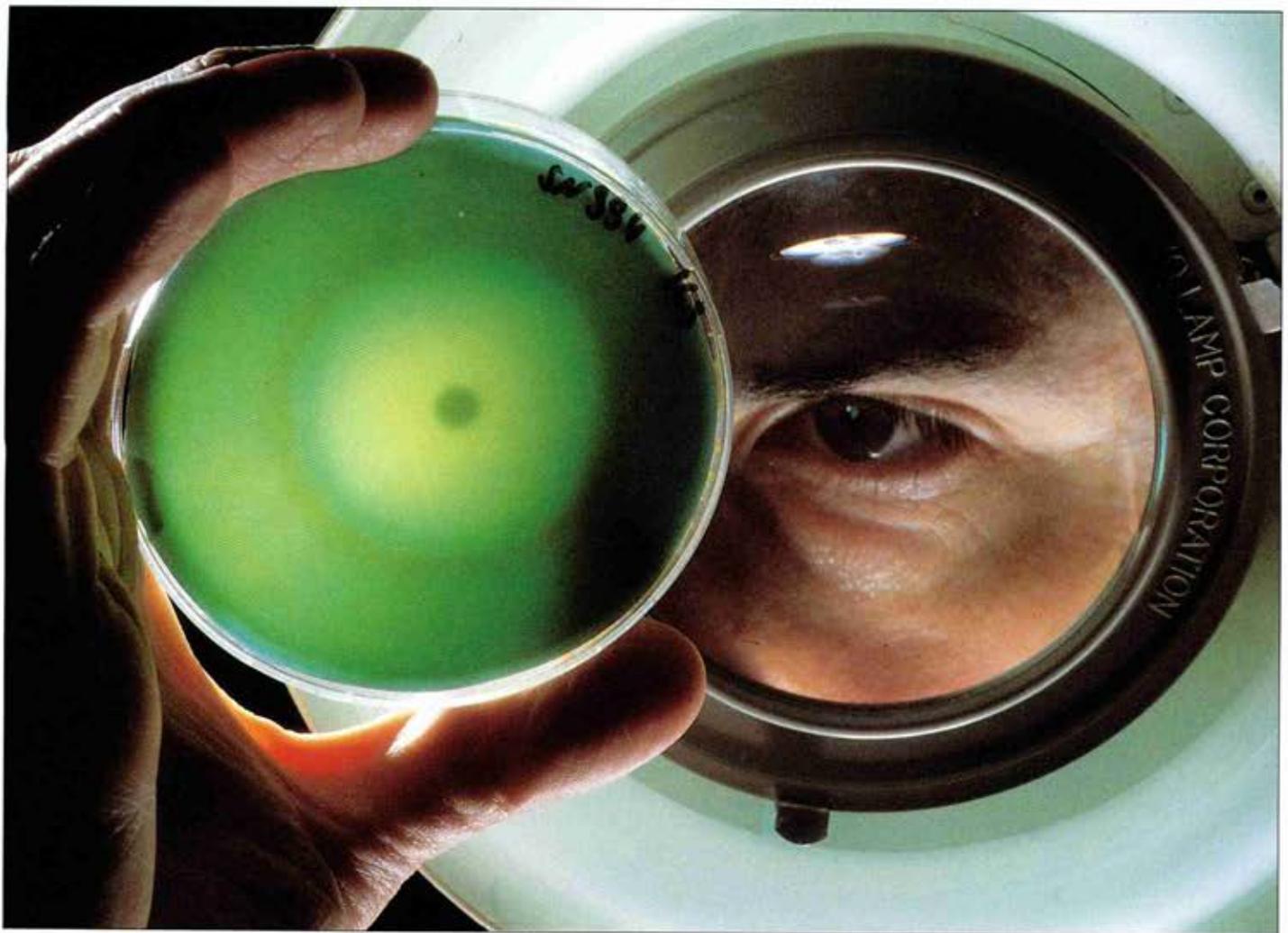
Alexander Fleming once said that he could have been too preoccupied with thoughts of a young woman, or been suffering from the effects of a heavy meal or just simply been too lazy to notice anything in particular in the laboratory on that specific day. The significance of his statement lies in the thought of how easily a historic moment in medicine might have been overlooked and a revolutionary discovery might well have ended up in the garbage can.

In September 1928, the bacteriologist was carrying out routine tests at St. Mary's Hospital in London on the growth of staphylococcal strains that he was breeding on a culture medium. To his annoyance, Fleming saw that one of the cultures was spoiled again. A fungus spore had apparently found its way into the medium and grown into a mold, destroying some of the staphylococci in the process. He was about to throw the culture away when he suddenly stopped to think. What had destroyed the dreaded pyogenic organism? The mold must have secreted a substance which killed the staphylococci. Fleming took the fungus out of the medium and identified it as *Penicillium notatum*. He called the as yet unknown active agent penicillin.

Fleming followed up on his observation and discovered that the mold containing his penicillin killed not only staphylococci, but also streptococci, pneumococci, anthrax bacilli, diphtheria bacteria and other bacterial pathogenic agents. He published his findings in two British journals, one of them the famous "The Lancet." He worded his conclusions very cautiously: *"It is assumed that penicillin could be an effective antiseptic agent..."*

Experts were skeptical. There had been so many reports in the press about the discovery of new wonder drugs against infectious diseases.

It was difficult to isolate penicillin and produce it in a pure form, and even then yields were low. A group of chemists at London's Institute for Tropical Diseases finally gave up trying. The instability of penicillin appeared to make it unsuitable for human use. When Fleming heard Gerhard Domagk present



a paper to the Royal Society on the discovery of sulfonamides, he came to the conclusion that he himself had found “nothing in particular” and consequently decided to concentrate his research efforts on sulfonamides.

For 13 years, little was heard of Alexander Fleming and his discovery. Eventually Ernst Boris Chain, who had emigrated at the beginning of the war from Germany where he had been a chemist at the Charité Hospital in Berlin, started looking for possible substances to prevent the growth of bacteria. Working in an Oxford laboratory in 1940, he injected 50 mice with lethal doses of streptococci and subsequently treated 25 of them with penicillin. The treated mice survived.

February 12, 1941, went down in the annals as a historic date. A 43-year-old policeman who had cut himself while shaving developed blood poisoning. It appeared that there was no hope of survival. But an intravenous injection of penicillin worked a miracle, and his condition improved rapidly—until Chain ran out of penicillin. The patient subsequently died.

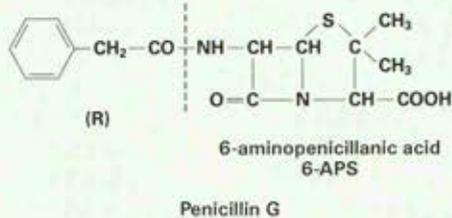
The problems seemed insurmountable: the mold grew too slowly, the processing of the culture solution was too complicated and time-consuming, and the yields were too low. Although penicillin was desperately needed during the war, its introduction in Britain seemed unrealistic under these circumstances. Chain and his Oxford superior Howard W. Florey therefore traveled to the United States, where they felt that they might have a better chance of finding help.

In Peoria, Illinois, they visited a British scientist who was looking for molds with a better yield than *Penicillium notatum*. One of his assistants gave him a moldy melon that had been thrown out by a grocer. The mold turned out to be *Penicillium chrysogenum*, which yielded four hundred times the amount of active agent that could be obtained from the *Penicillium notatum* discovered by Fleming. This strain could easily be bred from steeping water that occurs as a waste product in corn milling, and it provided an ideal source for the production of cultures.

In the search for new antibiotics, countless strains of bacteria that will be used to test new substances for their efficacy are bred in scientific laboratories. The above picture shows a culture of tuberculosis cells. Easily visible close to the center of the petri dish is the

area around an antibiotic into which the bacteria are unable to penetrate.

Penicillin and other antibiotics

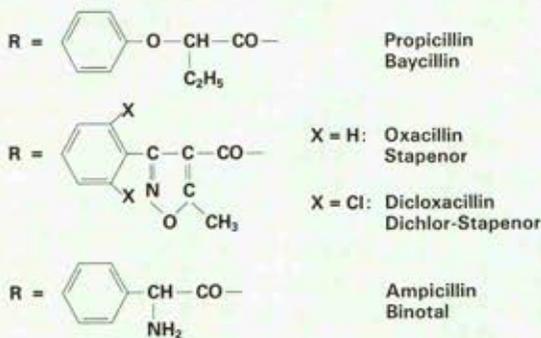


Natural penicillin, or penicillin G, has the chemical constitution shown above. The component to the right of the broken line is 6-aminopenicillanic acid or 6-APS. With its extremely unusual grouping of a four-membered beta-lactam ring, this substance is the basis for all types of penicillin and the carrier of the biocidal properties.

The side chain shown on the left is the rest of the phenylacetic acid. Its replacement by other acid groups alters the way in which the drug takes effect and thus opens up possibilities of improving performance,

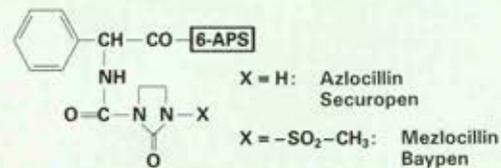
for example, in stability or tolerability. Initial attempts in this direction failed because the application of conventional chemical methods had the undesirable side effect of opening up the highly sensitive beta-lactam ring, which resulted in loss of efficacy.

The molecular biological research of the British firm Beecham and the development of a technical process by Bayer that involves the fermentative cleavage of penicillin G to obtain any desired quantity of a 6-aminopenicillanic acid opened the way to numerous new syntheses. Some examples are:



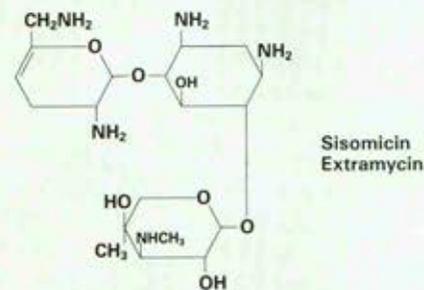
The synthesis of acylureido penicillins is based on ampicillin. Radicals containing urea groups have been added to the free amino groups of the ampicillin molecule by a reaction with monoisocyanates or correspondingly substituted carbamic acid chlorides. It was shown that a particularly favorable relationship is obtained between

efficacy and tolerability when the second nitrogen of the urea grouping is integrated into an imidazolidinone ring as a further heterocyclic system. A further improvement, particularly in respect to water solubility, was obtained by substituting the imidazolidinone ring with a methyl sulfone group:



The natural antibiotic streptomycin, discovered by Selman A. Waksman in the United States in 1943, and Leukomycin, introduced to Bayer's pharmaceutical program in 1952, have very complicated

structures. Sisomicin, developed in cooperation with Schering Corporation and sold by Bayer under the name of Extramycin, is with its amino sugar components vaguely similar to streptomycin:



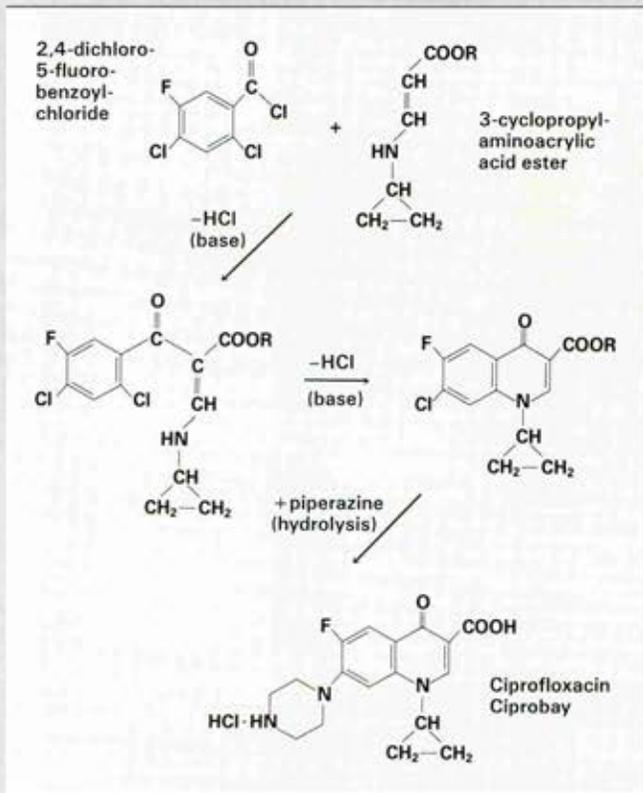
Used primarily in the treatment of infections of the urinary, genital and respiratory tracts and in cases of blood poisoning, ciprofloxacin

is a fully synthetic product whose discovery was made possible by the development of new synthesis methods by Klaus Grohe of Bayer's

Two bacterial cultures can be seen in the special nutritive medium to the right. The glass plates show where bacteria have been spread across the surfaces horizontally and vertically. Growth is particularly strong at the start of each of the strokes.

Main Scientific Laboratory in Leverkusen. On the basis of ortho-halogenobenzoyl chlorides and open-chained secondary enamines, it is possible to produce numerous new derivatives of 4-quinolone-3-carboxylic acid. In the case

of ciprofloxacin, this method is illustrated by the following diagram. Since heterocyclic compounds play an important role in pharmaceutical syntheses, this new reaction is of fundamental significance.



Ciprofloxacin has a very interesting method of functioning. Even in an extremely diluted form, it inhibits the bacteria's DNS gyrase, an enzyme which is instrumental in lodging the very long DNS strand within

the minute space of the bacterial cell. Since the DNS can no longer take on a particular convolution, the micro-organism dies.

Florey was able to convince government authorities and the pharmaceutical industry in the United States that it was possible to go into large-scale production. By 1944, the United States was turning out enough penicillin to keep the Allied armies supplied. Unfortunately, there was not enough as yet to take care of the civilian population.

When a friend of Fleming's fell ill with a complicated case of meningitis and was given up for lost by his doctors, the British scientist himself did not possess enough penicillin to be able to help. In a desperate effort to save his friend, Fleming contacted Chain to obtain the necessary quantity. One month later, the cured patient was released from the hospital. Fleming, who in the meantime had been knighted, received the Nobel Prize together with Chain and Florey in 1945.

During the war, the search had continued for new and more efficacious drugs. In the meantime, penicillin itself and other germicidal agents produced by microorganisms had been classified under the name antibiotics as a new category of therapeutically interesting substances. By attacking the actual metabolic system, antibiotics damage the pathogenic agent to such an extent that, for example, its cell walls burst. Those antibiotics that do not damage vegetable, animal or human cells in the process are obviously of considerable value for therapeutic purposes.

In 1943, Selman A. Waksman discovered streptomycin in the United States; chloramphenicol followed two years later. Over the subsequent years, further antibiotics came on the market under various names, among them Aureomycin in 1948, Neomycin in 1949 and Terramycin in 1950. Today, over five thousand antibiotics are known; about a hundred of these substances are of practical use in the treatment of infectious diseases.

By 1946, the production of antibiotics in the United States had reached the point where exports became possible. Despite the tremendous headstart of the American pharmaceutical industry, Bayer began research into further developments of penicillin



immediately after the war. Initial work had in fact begun long before then.

When the Oxford scientists published their first clinical successes in 1941, the news had found its way across the front and gave rise to research work in I.G. Farben's own laboratories in Elberfeld. In the search for a suitable mold, a source was discovered in 1942 that turned out to be right in front of the German researchers' very door; research samples from the banks of the Wupper contained a fungus that could be isolated and bred on an artificial culture medium.

One milliliter of liquid culture yielded 20 active units of penicillin in two to three weeks. This was about a tenth of one milligram of the valuable agent. Although the amount was not sufficient for any therapeutical purposes, it was a satisfactory basis for in-house research work. New products were urgently being sought, particularly because sulfonamides were unable to combat the entire range of infectious illnesses.

With the help of this preliminary work, it was possible to set up a production facility shortly after the war had ended. After settling the patent questions, "Penicillin Bayer" appeared on the German market as early as 1950.

The following year, the company was able to introduce a marked improvement in its production process; an American firm had sold Bayer a penicillin strain whose yield had been raised by mutation from 100 to 600 units per milliliter. This strain put Bayer in the mainstream of development and enabled the firm to manufacture penicillin on an industrial scale.

The penicillin G that had been most commonly used until then had considerable disadvantages because it was insufficiently stable and had only a limited performance range. This particular type of penicillin could only be given to patients in the form of injections, and they had to be repeated every few hours since the substance was quickly discharged from the organism.

In the first half of the 1950s, the penicillin manufacturers launched an intensive search for more

stable forms that could also be more easily administered. At Bayer this research resulted in the products Aquacillin and Solucillin, which demonstrated improved solubility, as well as the depot drug Tardocillin. An Austrian product with particular resistance to stomach acids was subsequently introduced to the market by Bayer under the name of Oratren. The postwar era also saw the addition of further antibiotics to the company's sales program, among them Streptomycin "Bayer" in 1951, Leukomycin (chloramphenicol) in 1952 and Tetracyclin "Bayer" in 1955.

Toward the end of the decade, this progress seemed to slow down. Unfortunately, the pathogenic agents were becoming resistant to the antibiotics, which consequently became less effective against the agent the more they were used. The prime aim of research was therefore to discover new penicillin derivatives that were more stable and thus did not permit this resistance to arise.

The difficulty lay mainly in the sensitivity of penicillin during attempts to make chemical modifications of the molecule. This molecule consists of a characteristically larger amount of 6-aminopenicillanic acid, which is responsible for the antibiotic effect, and a side chain. The modification of this chain was hoped to result in therapeutically advantageous new derivatives. The trouble was that conventional chemical reaction processes led not only to the separation of the natural side chain, but also to the damaging of the main component and thus the loss of the efficacy of the compound.

Beecham Laboratories in England was able to make important progress when its researchers succeeded in obtaining free 6-amino-penicillanic acid from the fermentation liquor of the penicillin mold in 1959. Unfortunately, the acid could only be isolated from the liquor with great difficulty, and the yields were also low. This meant that the process was unsuitable in this form.

The real breakthrough came in the Biochemical Laboratory of Bayer's research center in Elberfeld. Scientists developed a simple process by which the



side chain could be separated from penicillin G and thus large quantities of pure 6-amino-penicillanic acid could be obtained.

Beecham and Bayer exchanged licenses; at last the basic substance needed for the development of the so-called semisynthetic penicillins had been made available. It proved surprisingly easy to equip the 6-amino-penicillanic acid with a series of different side chains. After the usual comprehensive tests, Bayer was able to develop new and successful drugs from the abundance of newly formed compounds. For example, Oralopen was introduced in 1960 and Baycillin, Stapenor and Dichlor Stapenor two years later.

The new penicillin derivatives made treatment of bacterial infections much easier and broadened the range of indications for antibiotics. On the other hand, some goals had not been reached. For example, a satisfactory answer to the problem of the pathogenic agents developing resistance to the drugs had still not been found. And with time, more and more infections were being caused by so-called gram-negative bacteria.

These bacteria got their name from Danish physician Hans Christian Gram (1853–1938). In 1884, he invented a system for the staining of bacteria by which numerous strains of bacteria could be dyed. They were then divided into two groups: those showing up blue under a microscope were termed "gram-positive," while the red bacteria were called "gram-negative."

The interesting situation was that due certainly in part to the increased use of antibiotics, the incidence of illnesses caused by gram-positive agents, which were sensitive to penicillin, declined in favor of those based on gram-negative bacteria. Certain gram-negative pathogenic agents came to be a problem because they were less susceptible to therapeutic treatment with antibiotics. And thus the search for new drugs continued.

The research could have basically taken one of two different directions, but the company decided to follow both of them. One path was to look for antibiotics outside the penicillin system. Such substances as tetracylin, chloramphenicol and streptomycin were already known.

During the production of active agents at the Elberfeld plant, samples for laboratory analysis are regularly withdrawn under sterile conditions from new batches. Every batch is thus subject to constant purity and quality control. Even the smallest departure from

the norm means the destruction of the whole batch, regardless of the cost of production.

Medical therapy enters the antibiotics era

Scientists at Schering Corporation in the United States had derived a promising antibiotic, which they called Sisomisin, from the fermentation liquors of the fungus *Micromonospora inyoensis*. It demonstrated better properties than existing products with a similar constitution, especially in the fight against gram-negative bacteria. In cooperation with Bayer, a drug was produced from the new active agent that could save lives even in problem cases. Bayer subsequently marketed it under the name of Extramycin in 1976.

The second approach to developing new antibiotics originated from the penicillin system. Bayer's researchers in Elberfeld came up with a particularly significant innovation when they added a side chain to the semisynthetic penicillin, ampicillin. This side chain included a urea grouping, which is why the new category is called acylureido penicillins. Their introduction led penicillins to a comeback since they not only worked over a broad spectrum, particularly against gram-negative bacteria, but because they were also extraordinarily tolerable. Large doses could even be given to babies.

Outstanding products of the acylureido penicillin group are Securopen and Baypen, which were made available to doctors in 1977, and the penicillin combination drug Optocillin, which has been on the market since 1980.

Experts at international symposiums were full of praise for this new category, but they also expressed concern that research in this field of antibiotics might have reached its limits. Their fears were unfounded: ten years after the introduction of Securopen and Baypen, Bayer introduced Ciprobay on February 9, 1987. Its active agent is ciprofloxacin or, to be exact, 1-cyclopropyl-6-fluoro-1,4-dihydro-4-oxo-7-(1-piperazinyl)-3-quinoline carboxylic acid. Munich professor Dieter Adam commented on Bayer's new drug, "We are now witnessing something completely new."

The basis for this development had been work with nalidixic acid, which had been known as a means to combat bacterial infections of the urinary tract since



the early sixties. However, because of all of its disadvantages, it had never found a place in clinical practice. Chemists all over the world investigated over 10,000 forms of this antibacterial substance, but without success. Most of the scientists gave up the search around 1970.

The path from the discovery of a new active agent until its approval for market distribution is long and weary. The stacks of files above contain the approval documentation involved in the introduction of Ciprobay, Bayer's latest drug, to the German market.

After having developed new methods of synthesis, Bayer made this category of active agents a major research target. Success came on April 23, 1981, when a substance was discovered that turned out to be a thousand times more effective than the starting material. A total of 20,000 different bacterial strains were subjected to this active agent, and 98.3 percent of them proved sensitive. Furthermore, ciprofloxacin hardly left any way open for the strains to develop resistance.

This remarkable efficacy results from the ability of ciprofloxacin to inhibit gyrase, an enzyme that is important to the metabolism of the bacteria. Ciprofloxacin works against almost all clinically significant pathogenic agents, including those bacteria that have until now been resistant against all other antibiotics.

In the subsequent years, ciprofloxacin has been tested for clinical efficacy on 10,000 patients in 37 countries around the world. The extremely positive results were the main reason for its registration in about half the usual time, in other words, only some five years after its discovery.

Bayer chronicle 1977

Bayer buys a 136-acre plot in Monheim for the construction of an agricultural chemicals center.

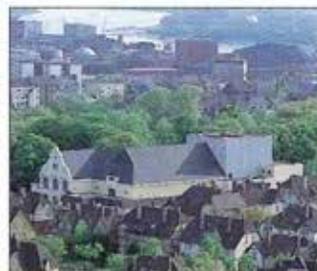
Goltix, a selective herbicide for root crops, is introduced.

Prent, a beta-receptor blocker, is marketed for therapeutic treatment of heart and circulatory complaints.

The U.S. holding Rhinechem Corporation buys Harmon Colors of New Jersey.

Special on-the-job training program is launched for young people without a high school diploma.

After serious damage from a fire, Bayer's recreation center in Leverkusen (below) is expanded and given a "facelift."



The foundation stone is laid for the Brunsbüttel plant of Schelde-Chemie, a joint venture of Bayer and Ciba-Geigy.

Production of toluylene diisocyanate, a starting material for polyurethane chemicals, begins in Brunsbüttel.

World events 1977

On January 20, James E. Carter is inaugurated as 39th president of the United States.

Menachem Begin becomes prime minister of Israel on May 17. At the end of November Egyptian President Anwar al Sadat visits Jerusalem.

The first free elections in 41 years are held in Spain. Victor is the Union of the Democratic Center; Adolfo Suárez heads the new government.

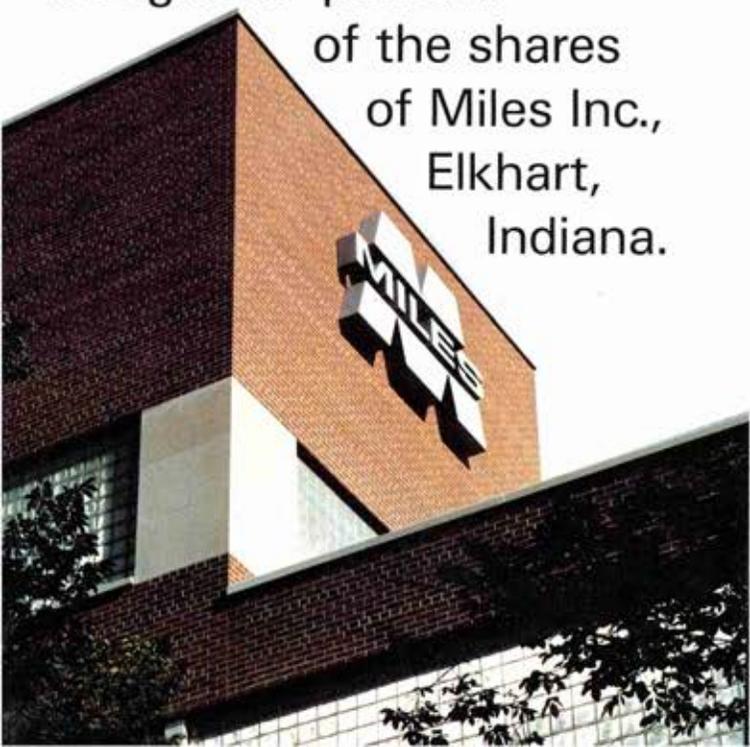
German terrorists murder Federal Attorney General Siegfried Buback and Jürgen Ponto, Chairman of the Board of Management of Dresdner Bank, and kidnap Hanns Martin Schleyer, President of the National Association of Employers. On October 13, Arab terrorists hijack a Lufthansa plane with 86 passengers, who are freed five days later in Mogadishu, Somalia, by a special team from the Federal Border Police. Terrorists Ensslin, Baader and Raspe commit suicide in a Stuttgart prison. On October 19, Schleyer is found murdered.

Working independently, Briton Frederick Sanger and American Walter Gilbert find different methods for determining the exact position of nucleotide elements in deoxyribonucleic acid (DNA). In 1980, they receive the Nobel Prize for their work; it is Sanger's second.

1978

Miles — an ideal partner for Bayer

A good business transaction is when both partners benefit, and both sides benefited when Bayer acquired Miles. On January 5, 1978, Bayer's U.S. holding company Rhinechem Corporation bought 97 percent of the shares of Miles Inc., Elkhart, Indiana.



Two weeks later Professor Herbert Grunewald, who was Chairman of Bayer's Board of Management at the time, said in Elkhart, "As a century-old company with a wealth of know-how, lots of experience and a worldwide reputation, Miles is the ideal partner for Bayer."

At the time of the acquisition, Miles had 55 plants in 21 different countries and a stake in 31 joint ventures. The company had 8,500 employees, some 3,500 of them employed outside the United States. Its production program included Alka-Seltzer, multivitamin specialties, household products, citric acid, industrial enzymes and diagnostics. Annual sales exceeded \$500 million. And the Elkhart firm had been listed in the Fortune 500 rating since 1958.

The history of Miles is the story of a typical American family company. After attending medical school, Franklin L. Miles, born in 1845, settled in Elkhart, Indiana, as a country doctor. The young physician soon made a name for himself as an enthusiastic scientist. He mixed quite a few of his own medicines, which turned out to be so popular with his patients that he decided to start selling them to drugstores. He also had stationery printed with the letterhead "Dr. Miles Medical Company." The day it was delivered, March 7, 1884, has since been regarded as the date the firm was born.

Business did not exactly flourish at first; the ledger shows an annual income of \$63.47 in 1886. But Miles refused to give up hope, and in 1889, he recruited two people for the firm; one was Albert R. Beardsley, who had originally run a general store and a starch



The official acquisition of Miles Laboratories, Inc. by Bayer on January 5, 1978, marked the merger of two companies with long and illustrious histories. Both firms had grown up from modest beginnings. For both Bayer and Miles, the takeover meant a gain of additional

know-how, an expansion of the production program and the strengthening of the sales force.

"Dr. Miles' Restorative Nervine" was the initial marketing success of the company. In 1943, Miles was the first firm to introduce a multivitamin product in tablet form. It is still sold today and is also available in special shapes for children.

factory, and the other was banker and investor George E. Compton. These men were the first in the line of the three families that were to manage the company until its acquisition by Bayer.

The first product to hit the market was "Dr. Miles' Restorative Nervine," a remedy to sooth the nerves and give relief in the fight against insomnia. Beardsley, who was a mastermind in marketing, pushed the hard-sell approach to advertising from the word go. In one campaign, he offered \$5,000 to anyone who could come up with a better product against nervousness than Nervine.

A particularly effective advertising medium was the "Miles Almanac," which first appeared in 1902. It became so popular that, as the story goes, Miles at one point employed more printers than chemists. The almanac, which made the company name known throughout the country, eventually reached an astonishing circulation of 20 million before its publication was brought to a halt in 1942 because of paper shortages during the war.

A virtual synonym for Miles was and is Alka-Seltzer, a relatively simple product made of acetylsalicylic acid, citric acid and bicarbonate of soda. The company, in fact, invented the effervescent tablet as a form of administering the medication. In 1969, Alka-Seltzer-Plus, targeted especially for treating colds, came on the market and in 1984, the chewable Alka-Mints antacid tablets. To keep the long-established trademark in the public eye, all new product names were followed by the phrase "from the makers of Alka-Seltzer."

The first vitamin tablets in the United States were introduced in 1934. They contained a single vitamin, were only accessible by prescription and were little-known and expensive. In October 1940, Miles launched its One-A-Day tablets, which incorporated vitamins A and D. The introduction to the market was accompanied by an information campaign explaining the necessity of vitamins for the organism. The company added vitamin B in 1942. The following year, Miles came out with the world's first multivitamin product in tablet form.



An office in the Soviet Union

On October 11, 1978, Bayer opened an office in Moscow. With this move the company hoped to establish a direct and fast communication line to its customers in the Soviet Union. Both sides were certain to benefit. Five years earlier, Bayer had signed a cooperation agreement with the Soviet State Committee for Science and Technology.

The relations between Bayer and Russia have a long tradition in the company's history. Back in 1913, the company's biggest single foreign production unit was actually located in Moscow. After the October Revolution in 1917, the new Soviet government wanted to resume contact with Bayer. The idea was to acquire modern chemical know-how that could be put to use in joint ventures. Unfortunately, these plans were never realized.

After a short period of connections in the twenties, Stalin's policy of self-sufficiency and the Second World War led to a complete break. The Soviet Union did not again become interested in establishing contacts to the West until the 1960s, when cooperations with such German chemical companies as Bayer became more and more appealing.

The highly effective agrochemicals that Bayer could supply were of particular importance to the Soviet Union in order to boost its agricultural production. But Bayer also had other products to offer; plastics, fibers and pharmaceuticals were equally

in demand on the Soviet Union's market. And the country's own chemical industry was, and still is, interested in the sophisticated technology of leading industrial companies of the West.

People gradually recognized that healthy economic development in the Soviet Union could be promoted by open exchange and competition with the West. Isolation from the rest of the world and complete state control were not the answer.

Bayer showed its readiness to take part in the development of the Soviet economy by opening up its own office in Moscow. Despite all differences in the economic and social systems, the company had once again demonstrated its willingness to trade in all parts of the world and to cooperate in the economic development of all international markets.



In 1876, Bayer first ventured into Russia by establishing a small production unit in Moscow (above the office of the dyestuffs warehouse in Moscow).

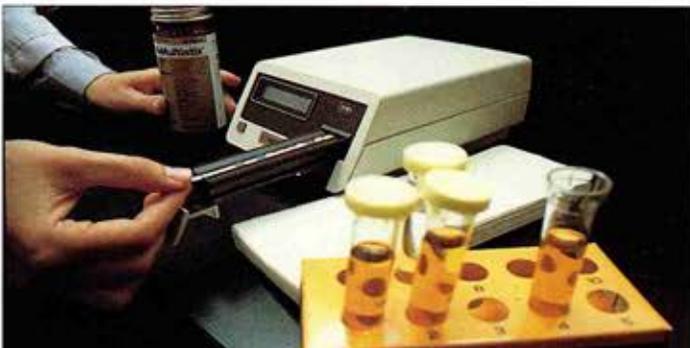
Miles Medical Company changed its name to Dr. Miles Laboratories, Inc. in 1932. Management also decided to diversify its production program. Under the trade name S.O.S pads, General Foods had been selling a steel-wool oven and pot cleaner that had been developed in 1917. Nobody really knew how the product got its name; one legend claims that it is an abbreviation for "Save Our Saucepans." When the Miles executives heard that General Foods had to divest the product together with the production plant in Chicago, they moved immediately.

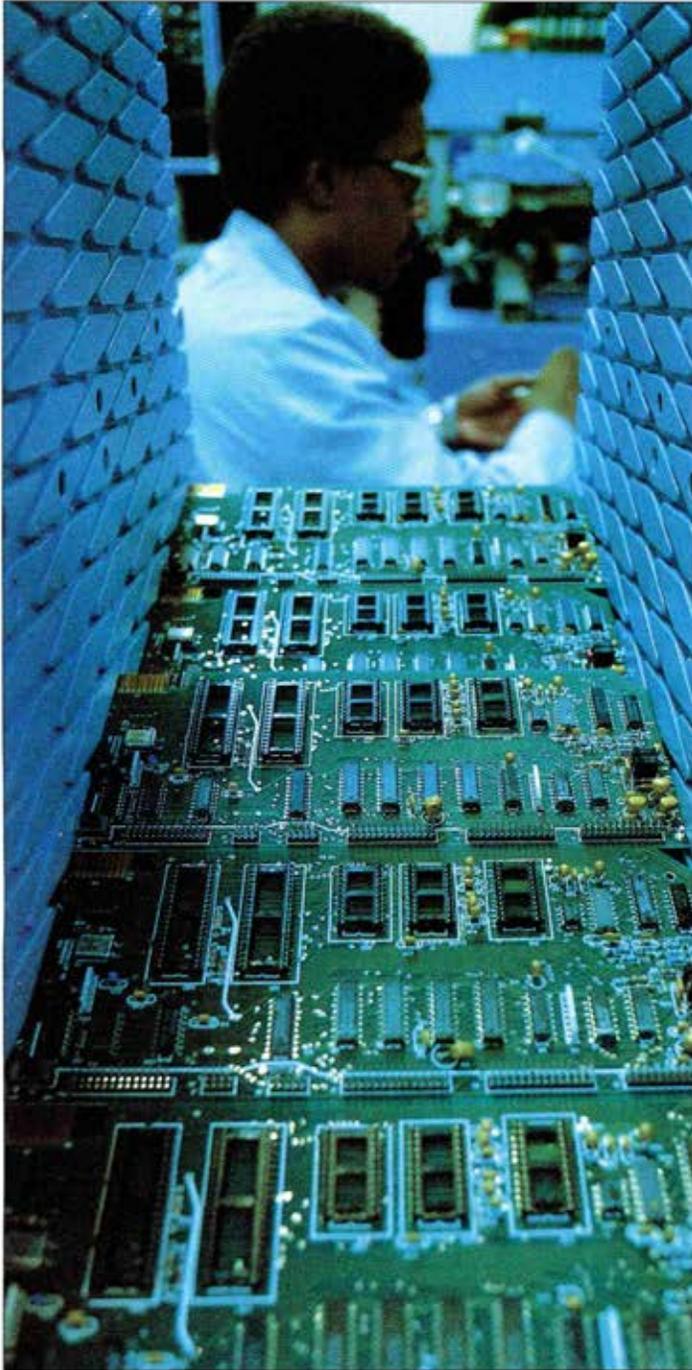
On a Friday afternoon in September 1968, just before the banks closed for the day, Walter Beardsley and Walter Compton turned up at Citibank in New York and asked for a credit line of \$55 million. They purchased the S.O.S soap pads business and at the same time, laid the foundation for the company's Household Products Division. Today, the Chicago works turns out some billion pads a year for use in 32 million American households.

Since the acquisition, the synergy of Miles' Household Products Division and Bayer's Consumer Products Business Group has been of great value. Now Miles is increasingly taking over responsibility for the marketing of Bayer's products from this Business Group in the United States.

In the meantime, Miles has also become a major international supplier in another field: diagnostics. This business goes back to the 1941 invention of Clinitest, which is a reagent to determine sugar content in urine samples. It is produced in the form of effervescent tablets.

Back in those days, two important developments could hardly have been predicted. One was that diabetes was to become so widespread as a result of the increased consumption of food containing glucose. The other was that 40 years after Clinitest's introduction, a reliable diabetes diagnosis would take only a matter of seconds. In former times, such tests could only be carried out in major hospitals because it involved complicated procedures and a large number of personnel. Miles itself was





Miles has become one of the world leaders in the field of diagnostics. Its program today includes a broad range of rapid-analysis kits, as well as electronic diagnostic instruments, which the company develops and manufactures itself.

instrumental in developing the quick and convenient diagnostic process.

Clinitest had in essence provided the basis for a whole new industry, i.e. in-vitro diagnostic testing. It needed far-sighted entrepreneurs, however, to venture into the costly area of research connected with clinical chemistry.

Miles formed the subsidiary Effervescent Products, Inc. in 1930, which was given the name Ames Company (the maiden name of Walter Compton's grandmother and his middle name) in 1944. "Ames" was not such a mouthful to pronounce and was easier to remember. In 1965, the company was subsequently incorporated into Miles as the Ames Division. Today's Ames Division of Miles operates 19 plants in 14 different countries and has sales agents almost all over the world.

Ames celebrated a research triumph in 1956: its scientists found a way to dispense with tablets in determining urine sugar levels. A much simpler means, although less precise at first, was the test strip. This principle came to be known as the "dip-and-read" testing method. The strip, specially prepared with enzymes and chemicals, bore the trade name Clinistix. The sugar content of the urine sample could be detected by the color change at the end of the strip: yellow meant a normal sugar count, orange high and red signaled that the patient was sick.

A further development led to the introduction of Albutix in 1957, which permitted a reading not only for glucose but also for urine proteins. Other diagnostic strips followed, among them Combistix, Hemastix, Labstix and Phenistix. No fewer than 25 different urine-analysis tests were gradually developed for such indications as ketones, bilirubin, urobilirubin, ascorbic acid, nitrites and pH values. In 1985, Multistix 10 SG was introduced, which made ten tests possible simultaneously.

The Ames Division expanded its R&D and production activities in the field of diagnostic instruments and consequently bought the specialized Atomium Corporation of Massachusetts. An important advance was the introduction of the Clinitek system in 1976.

This equipment allowed the calculation of 37 different urine analyses within 30 seconds. A further boon for the doctors' office was the Seralyzer, which came on the market in 1984 and made hitherto complicated diagnostic tests both simple and reliable.

If simple urine analyses were possible, the same must be possible for other body fluids, and in particular blood. Ames thus came up with the Glucometer for the electronic analysis of blood sugar in 1981. It was intended for self-application by the patient. Four years later saw the introduction of the more sophisticated Glucometer II, which was more compact and worked faster. Since 1979, Ames has also been manufacturing fluorocolorimeters to measure the concentration of medication in the patient's serum: Fluorostat, Clinistat and Optimate.

Another business activity developed as a result of its role in Alka-Seltzer production: citric acid. In 1893, German chemist Carl Friedrich Wilhelm Wehmer observed that mold growing on sugar secreted citric acid. Following a long series of experiments with various types of microorganisms, it was discovered that the fungus *Aspergillus niger* yielded the highest citric acid concentration. Thus, the door was opened to large-scale biotechnological production.

Miles had already been thinking about setting up its own citric acid facility before the war. The company wanted to base its production unit on a more improved process. This so-called submersion process, which had been largely developed by Miles itself, took place in closed tanks.

Management calculated that output would exceed the company's own requirements, a fact that would open up a promising new line of business. Citric acid demand was rising fast as more and more industrial applications were found. Today, the product is used as a flavor additive, as a food and color preservative, in soft drinks, pharmaceuticals, cosmetics and, as a consequence of environmental concerns, to an increasing extent in detergents that are to be made phosphate-free.

Miles finally began producing citric acid in Elkhart in 1952 and subsequently opened plants

in Mexico, Colombia and Brazil. In 1977, a further U.S. facility went on stream in Dayton, Ohio.

Jokichi Takamine, who gained world fame when he isolated adrenaline, developed the first enzyme for industrial use in 1890 and sold it under the name of Taka-Diastase. Some fifty more patents followed. He set up a laboratory in Clifton, New Jersey, to supply enzymes to bakers, brewers, butchers, etc.

Enzymes are efficient biological catalysts. They had been in use for thousands of years before their actual nature was recognized. Among other things, they bring about the fermentation process needed to make cheese, beer, bread, wine and many other products in daily life.

In 1956, 34 years after Takamine's death, Miles took over his laboratory together with its highly qualified enzyme experts. Miles' Enzymes Department was thus born.

Ten years later Miles acquired the 60-year-old Marschall Dairy Laboratories, Inc. in Madison, Wisconsin, which produced enzymes for the dairy industry. The new subsidiary provided marketing know-how, and Miles assisted with more advanced research. Miles developed more and more new variations and was able to synthesize starter cultures that cut the cheese maturing process in half and allowed a standardization of taste, color and consistency.

In time, Marschall products found a number of markets outside the cheese industry. Today, after two decades as part of Miles, the Marschall Division has sales of \$60 million. Its own plants are spread all over the world and a major facility is located in the traditional cheese country, France.

In 1959, Miles acquired Dome Chemicals, Inc., a New York City producer of dermatological and anti-allergenic specialties. Dome had also achieved successes in the field of cancer therapy; its Stilphosterol against prostate cancer had already been on the market for 20 years. Miles subsequently introduced a product against skin cancer in 1975.

And yet even with all these achievements, Miles did not have the funds to establish itself in the

Miles introduced a new international logo in the fall of 1987. The older version of the trademark can be seen on the first page of this chapter on page 514.

prescription pharmaceuticals market. Despite its firm foothold in the over-the-counter sector, in household products and in the field of industrial enzymes, Miles needed the help of a strong partner in order to penetrate the ethical products market. That partner turned out to be Bayer.

In 1980, the Dome Division was renamed Miles Pharmaceuticals. Marketing, applications technology and in-house research were then concentrated in West Haven, Connecticut, which is also the end of the "pipeline" for Bayer pharmaceutical products imported into the United States.

Bayer's policy is to export only the top products from its pharmaceutical research to the American market. The first Bayer specialty to be approved there was Canesten in 1978. This was followed by Adalat in 1981 and Cipro in 1987, which is the U.S. trade name for Ciprobay.

The "pipeline" transported not only products but also know-how—and synergy went in both directions. Some of Bayer's newest products were developed in part by Miles. In ciprofloxacin research, for example, project groups in Elberfeld and in West Haven continuously exchanged their findings.

By the time Cutter Laboratories merged into Miles in 1983, some 50 firms specializing in the field of biotechnology and genetic engineering had already been set up in the United States. Their cooperation had to be sought in order to contain the company's own research costs. Some of the most well-known researchers in this sector work at universities. Since it was not possible to employ them directly, another path had to be taken. The solution was to make them into partners of joint ventures.

Bayer maintained particularly close contact to Yale, which is situated very close to Miles' West Haven operation. As a result, the joint venture Molecular Diagnostics was established in 1982 and Molecular Therapeutics two years later.

In January 1988, the first phase of a new pharmaceutical research center was completed at Miles' West Haven facility. Its research projects include work on rheumatism and immune deficiency.

MILES

Bayer chronicle 1978

In May, Bayer commissions seven different firms of architects to submit their proposals for the construction of a new agrochemicals center in Monheim.

Haarmann & Reimer opens the world's biggest synthetic menthol production plant at Bushy Park, South Carolina.

Bayer sells its holding in Chemische Werke Hüls AG to Veba and its participation in the Duisburger Kupferhütte to the Rio Tinto Zinc group.

The following units are opened:

- Liquid-waste pressure oxidation facility in Uerdingen
- Second biological purification unit in Dormagen
- Central pharmaceuticals warehouse in Dormagen
- Nitrobenzene facility in Antwerp
- New ortho-phenyl-phenol plant in Uerdingen.

Tests carried out over a number of years in Canada show that aspirin can reduce the risk of a serious stroke in people with circulatory problems by almost 50 percent.

Dunova, a new kind of acrylic fiber that combines the advantages of natural and synthetic products, is introduced to the market.

World events 1978

On February 12, the dollar falls below DM 2.00 for the first time ever when it is traded at DM 1.9920.

Terrorists of the Red Brigade kidnap the Italian politician Aldo Moro, who is found murdered eight weeks later.

Three popes reign in one year: Paul VI dies on August 6. His successor, John Paul I, himself dies after only 33 days in office, and he is subsequently succeeded by the Polish Cardinal Karol Wojtyla as Pope John Paul II.

Egyptian President Anwar al Sadat and Israeli Prime Minister Menachem Begin



meet at Camp David in the United States to sign a peace agreement. Both men are subsequently awarded the Nobel Peace Prize.

First "test-tube baby" is born in a London clinic on July 26.

Take a break in the canteen

German philosopher Ludwig Feuerbach coined the phrase, "You are what you eat." If this is true, Bayer employees must be something special because they definitely eat well. The works canteens have been offering à la carte menus since 1979.



The lunch break has been a traditional "institution" of the working day. After all, a typical employee spends some 200 hours a year at lunch and coffee breaks.

In the early days of industrialization, companies did not feel that it was their responsibility to worry about how and what its employees ate for lunch; that was the job of the wives who brought their husbands' lunch baskets to the works every day. As time passed, clever businessmen soon had the idea



of selling ready-made hot meals outside the entrance to the plant.

Things changed at Bayer in 1902 when the company opened the first works canteen. Paragraph One of the relevant company statute stated that *"The works canteen shall offer the workers at the Leverkusen dyeworks the opportunity to obtain hot and cold meals and coffee in the factory on working days at low prices."*

Bayer was not the only industrial corporation that was trying to make company life more attractive for its workers. A manual on the subject of works canteens published in 1919 pointed out that merely supplying meals was not enough: *"Other factors must be taken into consideration when trying to induce the appetite and improve the wholesomeness and digestibility of the food. These*

Before the first canteen was opened at Bayer, employees' wives used to bring lunch baskets to their husbands at the works gate. Today, one of the specialties of Bayer's restaurant for guests is the selection of imaginative, alcohol-free cocktails.



include the succession of the courses and the conditions under which the meals are eaten, as, for example, the furnishings of the canteen and so forth."

Photographs of Bayer's canteen in 1912 prove that the company had already learned this lesson. There were plants in the windows, pictures on the walls and a menu that varied from day to day.

For many decades, there was one fixed meal per day. It was not until the sixties that employees were able to choose between the standard menu and one alternative. By the beginning of the 1970s, some canteens offered up to three menus.

A complete change came about in 1979 when the so-called "free-flow system" was finally introduced. The fixed menu disappeared, and one can now select his own appetizers, entree and dessert. This system also offer the freedom to choose how much the individual is prepared to spend.

In order to be able to keep prices down, it was necessary to streamline procedures without adversely affecting quality. Cold storage facilities were cut down to a minimum by having the meat delivered daily and potatoes and vegetables supplied by outside firms. Pressure cookers reduced cooking times to one-third of the original time, while "frying lines" where foods could be prepared

on an "assembly line" basis meant that the innumerable pans of old could be dispensed with. Everything was made faster and more convenient—for the customer as well as for the canteen staff.

To reduce the time needed for paying and changing money, Bayer is currently in the process of introducing an employee credit card that can be used instead of cash. The individual checks are added up and the total is deducted from the salary at the end of the month.



In addition to the new-style restaurants, there are still conventional canteens with two fixed menus. Food and drink are also obtainable round-the-clock from vending machines, which are particularly popular with shiftworkers.

Every plant also has a special, more "elegant" restaurant at its disposal. This so-called "Kasino"—the German word originates from the meaning "officers' mess"—is intended in particular for entertaining visitors and guests in style. The Leverkusen plant also has a separate executive restaurant for guests, an on-site hotel with conference and club rooms and, in the nearby Cologne suburb of Flittard, a guest-house. These facilities offer the proper setting for a wide range of celebrations and other social events.

As it was and as it is: the top picture, taken in 1912, shows that even the canteens of the early days were made as cozy as possible. The two other photographs illustrate modern catering facilities in Leverkusen's kitchen and canteen.

Works Security keeps order and protects the plant

Up until 1921, the "gatekeepers" and, in particular, the fire department had the responsibility of maintaining order and security at the works. A security service department was then created, which became the forerunner of today's Works Security Department. The regulations that were instituted for the Leverkusen, Dormagen and Elberfeld plants in 1921 named security officers, gatekeepers and watchmen as the permanent security personnel. The department functioned accordingly until 1945.

Today, the department in Leverkusen is responsible for security in all German plants and advises Group companies at home and abroad. In the Leverkusen plant alone, the Works Security Department has a staff of some 330. Two hundred of these employees belong to the largest group of security personnel: this staff maintains order at the entrances to the works and in the office buildings that have a public access. Women have been employed in positions dealing with the reception of visitors since 1984.

The staff entrusted with protecting the plant itself and its equipment are also part of the Works Security Department. These employees control specially designated areas during the daytime and carry out "on-the-beat" control checks after working hours.

What the police force does in the interest of public order, Bayer's Works Security Department does at the plants: it is responsible for keeping order and protecting the plant.



Others again are responsible for supervising the often heavy traffic within the plant and the parking lots.

Special staff work within the plants to investigate violations of regulations and criminal offenses. If an offense has been established, the alleged guilty party is questioned in the presence of a member of the works council. The evidence is presented to a special committee manned jointly by representatives from management and the works council and which is empowered to impose sanctions. Charges are pressed in the case of serious offenses.

The Works Security Department is also confronted with industrial espionage and other subversive activities. Precautionary measures help to guard against possible terrorist attacks aimed at property and human life.

More routine tasks encompass such jobs as the control of goods entering and leaving the plant. One important duty here is to check whether shipments of dangerous goods conform to corresponding transport regulations before they leave the plant.

Keeping order is an important prerequisite for maintaining security. Good security personnel must have a wide range of knowledge and the talent to get along with people. After all, the employees must have confidence in their Works Security Department.



Bayer chronicle 1979

Sales of Bayer AG pass the DM 10-billion mark, and sales of the Bayer Group exceed DM 25 billion worldwide.

The foundation stone for the Monheim Agricultural Chemicals Research Center is laid on September 28.

The company introduces its glass-fiber reinforced plastic called Bayflex and the corresponding RRIM processing technology. This technology is first applied in the Porsche 924 Carrera GT model.

Bayer 04 Leverkusen and Bayer 05 Uerdingen football teams both enter the first division of the German Football League.

Bayer's male-voice choir of Leverkusen gives a concert to an audience of 100,000 in Rio de Janeiro's football stadium. Bayer do Brasil forms its own men's choir.

World events 1979

On January 16, Shah Reza Pahlavi leaves Iran for exile. Shiite leader Ayatollah Khomeini returns to Teheran after 15 years in exile and proclaims the establishment of a Revolutionary Islamic Council.

On March 28, the worst malfunction in a nuclear power station to date takes place at the Three Mile Island site near Harrisburg, Pennsylvania.

On May 3, Conservative Party leader Margaret Thatcher becomes British prime minister.

Jimmy Carter and Leonid Brezhnev sign the SALT II agreement on the limitation of strategic offensive missiles in Vienna on June 18.

On November 4, Iranian students storm the American embassy in Teheran and take 70 hostages.

An agreement is reached on December 12 whereby NATO will station medium-range missiles in Western Europe if negotiations with the Soviet Union fail to bring about a reduction in their medium-range missiles.

Soviet troops march into Afghanistan on December 27.

The Works Security Department has an important and many-sided role to play in the Bayer plants. Their duties even include checking the safety of the bicycles that are licensed for on-site use. The small picture from the archives shows a 19th-century gatekeeper. The initials "FFvFB&Co."

on his cap indicate that he was one of the security staff members at Farbenfabriken vorm. Friedr. Bayer & Co. in Elberfeld.

Tower Biology : high-tech waste water treatment

They are one of Leverkusen's landmarks: four turquoise towers, each a hundred feet high. The Tower Biology facility was completed in 1980 and is tangible proof that biological waste water treatment can be performed efficiently in a small area, with a minimum of noise and odor, and using only a quarter of former energy requirements.



These closed containers 98 feet tall are characteristic of the Tower Biology process, which permits energy-saving, low-noise aeration with no smell nuisance. Located in the Leverkusen suburb of Burrig, they treat liquid waste both from the Bayer plant and from the city.



The main Leverkusen plant alone used some 28 million cubic feet of water per day in 1986. Of this amount, some 90 percent was fed through the cooling system of the works. Consequently, it does not come into contact with chemicals and can be drained off again directly. However, some 3.2 million cubic feet of liquid waste from the plant's chemical operations have to be biologically clarified.

The facility built in Leverkusen in 1980 was, in fact, the second stage of a sewage treatment plant that had been erected by Bayer and the Wupper authorities responsible for the local communities in 1966. The open basins of the first unit had handled the treatment of both the communal sewage and part of Bayer's liquid waste.

However, it had soon become clear that a second stage of effluent management was going to be necessary. And it was equally obvious that the technical capabilities had to be created for a facility which would be able to function effectively and economically in the foreseeable future.

Apart from these purely technical considerations, there was also a problem in connection with the neighborhood that had to be solved. Plans for the first stage of the treatment unit had already been hindered by the shortage of space, a problem characteristic of the Leverkusen site. This situation meant that the mouths of the Dhünn and Wupper rivers had to be relocated, and that a complicated highway bypass had to be built instead of the normal intersection system.

After the plant had gone on stream, it turned out that depending on the prevailing weather conditions, the noise of the agitator mechanism of the basins could be heard in residential areas some 275 yards away, and pretty offensive smells frequently reached the neighbors.

These inconveniences were largely eliminated after alterations to the first unit, but for the second phase, a solution had to be found from the start to rule out these difficulties completely.

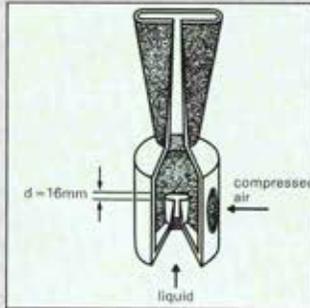
The easiest way to tackle these problems was to build a closed unit. The principle of such a facility

The principles of Tower Biology

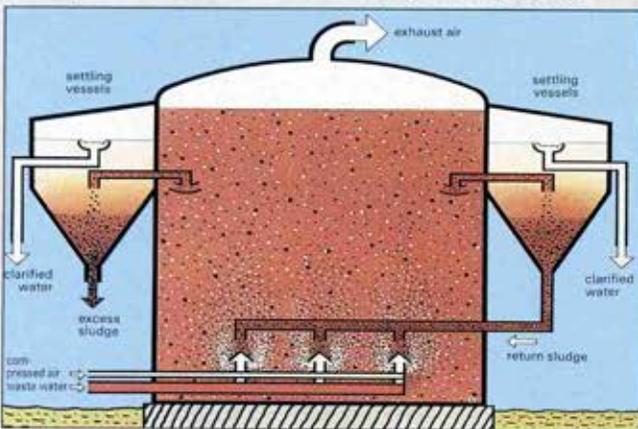
The biological efficiency and energy savings inherent in the Tower Biology process result from the almost complete release of oxygen from the air bubbles during their ascent to the surface of the liquid. This improved influx of oxygen was made possible by the new injectors developed by Bayer's engineers (diagram at the right). They work according to the following principle: liquid is sucked out of the activated sludge mixture and driven through a pipe into narrow jets. Air is then pumped into these injectors through a second pipe, swept up and swirled around by the stream of liquid before being dispersed into micro-bubbles at the exit of the injectors.

These injectors have now been installed at all of Bayer AG's waste water treatment plants—after having been subjected to various technical modifications.

The diagram below illustrates the way in which the entire



system functions. The ejected jet stream of bubbles rises, giving off oxygen on the way up. The sewage mixture overflows into the settling vessels situated around the top part of the tower and separates into clarified water and activated sludge. Most of the sludge is fed back into the tower (right) where it reenters the mixture above the injectors and is swirled by the rising gas streams. The excess sludge resulting from the cell division of the microorganisms is drawn off (left) and disposed of.



had, in fact, been known for some time already. A treatment plant could be erected on a relatively small site if tower-like reactors could be used to replace the expanses of open basins. Unfortunately, another technical difficulty arose when Bayer's engineers first tried to convert this concept into reality.

With open basins the constant supply of oxygen could be obtained simply by stirring the air into the liquid waste. In the case of large closed towers, finely dispersed air would have to be forced from below into the mixture of activated sludge and waste water. This method posed technical problems because conventional jets produced far too large bubbles, which would not have had time on their way up to the top of the tower to release their oxygen into the surrounding liquid mixture.

Bayer's engineers came up with an ingenious solution: a specially constructed jet released doses of air bubbles which were so small that by regulating the flow rate, the oxygen could be almost totally used up by the time the bubbles reached the surface of the liquid.

This method of providing sufficient oxygen content turned out to be much more efficient than the use of surface agitators. In practice, a much greater flow rate is created in order to make sure that the clarification procedure is not disturbed due to a lack of oxygen.

This new principle proved extremely advantageous in other aspects, too. Besides saving space on the site, the high level of oxygen utilization from the injected air allowed a considerable savings of energy for air compression. The exhaust gases withdrawn from the aeration towers are collected for heat treatment to guarantee that all odors have been reliably eliminated.

A large number of pilot plant experiments demonstrated that the new system was unobjectionable both economically and ecologically, and the responsible authorities even came to the conclusion that this was a decisive step toward a promising new waste water treatment technology. As a result, the

Liquid waste from the plants is fed into special conduits leading to the Bürrig treatment plant. Samples are taken regularly from the sewage system for analysis in the company's environmental protection laboratories.



company lost no time in constructing its "Tower Biology."

Soil conditions at the Brunsbüttel works had precluded open basins from the start, so tower-type aeration units were set up there as early as 1977. This was Bayer's first biological waste water treatment unit to be equipped with the new jets. The company thus had a large-scale "working model" at its disposal, which could provide important experience for the much more extensive plant planned for Leverkusen.

In Leverkusen the towers of the new treatment plant soon shot up out of the ground. Around their upper rim, they are fitted with cone-shaped overflow containers in which the bacterial sludge eventually settles. These funnels are partially hidden by the silver-gray "cumberbund" on the outside, which has become the distinguishing mark of Bayer's Tower Biology units.

Such a complex system with its towers, storage tanks, pump house and sludge separators resembles an enormous living organism. Its most

important operation, the treatment of waste water, is indeed a process determined by the metabolism of countless microorganisms and thus not an operation that can be switched on or off at will.

The control and supervision of a plant of this kind naturally calls for the most sophisticated process-control equipment, and it is thanks to this electronic "nervous system" that the Tower Biology has an exemplary operation record. Over and above the regular monitorings, a whole series of chemical, physical and biological tests are performed on both a routine and a spot-check basis to control the incoming and outgoing waste water.

The nightmare of every sewage plant manager is that, despite all analyses, a substance is able to get

into the system whose concentration is so high that it has a toxic effect on the bacteria. At the very least, this mishap would lead to a marked loss of efficiency and at the worst, to the plant losing its ecological balance.

Experts had long been on the lookout for a way to install an early warning system in the plant that would enable the necessary countermeasures to be taken in time. Bayer recently managed to discover just such a method.

Some living organisms, such as glowworms, are equipped with so-called bioluminescence. This "glow" starts to fade when they have not had enough to eat. Bacteria whose degree of brightness is an indication of their health are the answer to deter-

mining the state of the waste water.

Bayer's Tower Biology has in the meantime been recognized as an ideal solution for plants with similar locational and liquid waste conditions as Leverkusen. At the same time the Leverkusen unit was being constructed, Bayer built a similar Tower

Biology facility at its Thane works in India. This example illustrates Bayer's philosophy that its plants outside of Germany, and particularly those in developing countries, should also benefit from the parent company's technological progress in the field of safety and environmental control.

Tower Biology has since won wide recognition outside of the company, too. A number of industrial concerns are now using similar installations to handle their waste water treatment. And its application is not confined to chemical plants; two major breweries have also installed Tower Biology units at their facilities.



"Waste water watchers" could be a name for the luminescent bacteria used by Bayer for spot analysis of liquid waste in water purification plants. Depending on how brightly they glow, the microorganisms indicate whether sufficient oxygen is present in the waste water

of the Tower Biology unit for the bacteria to survive. The brighter the glow, the better they work. Environmental protection as a prerequisite for quality of life and quality of work is the message of the logo above.



Keeping production under control

Thousands of products in Bayer's sales program are manufactured according to uniform standards of quality that take both economic and environmental criteria into account. Formed in 1980, the department responsible for process control technology works to guarantee unvarying properties in products, improve safety standards, save energy, utilize raw materials better and to reduce costs.

The "recipes" and the manufacturing processes for Bayer's products have been becoming more and more complicated ever since the company was first formed. The lower the allowable quality tolerances have become, the less the company has been able to rely on the experience and "instinct" of its most skilled workers. To make matters worse, precise and reliable measuring devices with which it was possible to ascertain what was happening inside the production tanks were not available until well into the 20th century. The first devices were separate instruments, which meant the foreman had to keep running back and forth between indicators in order to follow what was happening.

Measuring apparatuses with remote indicators and remote-controlled adjusting equipment did not come into use until the 1950s. They finally permitted centralized supervision of all indicating and control devices. The production flowsheets on the walls of these central observation posts resembled the track diagram of a railroad switch tower. Instead of lines, crossings and signal points of a train station, they showed pipelines running between the apparatuses that were fitted with corresponding test-value indicators and process control devices.

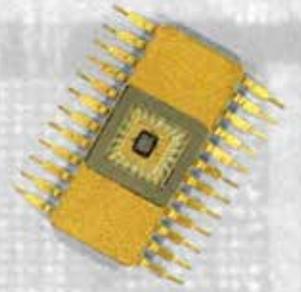
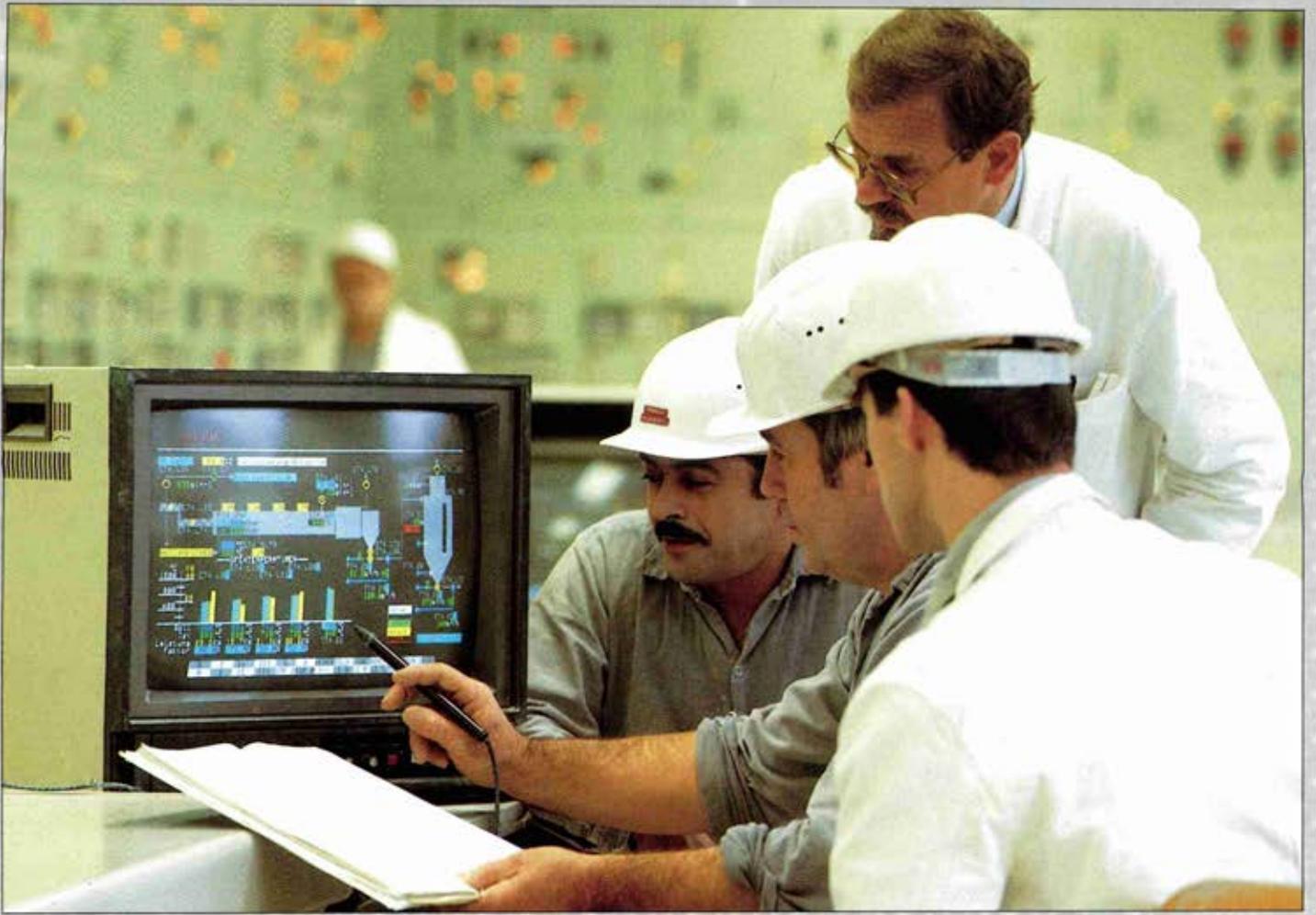
Production facilities with these kinds of central control rooms were a great improvement over the old decentralized system of localized indicators. They offer a broad range of data simultaneously; plant operators can use these data to make decisions on necessary adjustments to the process.

Since the mid 1970s, progress in the field of microelectronics has opened up new perspectives for a large degree of automatic control procedures. The use of microchips allows the replacement of conventional electromechanical or pneumatic measuring and control equipment by digital systems based on computer technology.

In today's process control centers, the operator sits in front of a color TV monitor that shows the production flowsheet with a wide range of details. This monitor automatically registers irregularities

Plants could be run in the early days of the chemical industry on the basis of personal experience and instinct. Things are not that easy anymore; in today's complicated processes, exact reaction conditions have to be maintained. It is hardly

surprising that, since the inception of microelectronics, computer hardware and software have come to play a central role in process technology.



Special tasks for physicists and process engineers

Process technology and applied physics both play an important role in the research activities of a chemical company. At Bayer these two areas of responsibility are concentrated in the Central Research Service Division.

The first physicist to be hired by Bayer joined the company in 1920. His duties initially centered on developing measuring methods for such important physical values as density, steam pressure and viscosity. This work soon led to the creation of a physics laboratory, which carried out routine measurements of this kind for various "customers" in the company.

The high technical standards laid down for Bayer's production processes determine to a large extent safety and environmental criteria, in addition to the overall costs. Processes also frequently have a direct influence on product quality and properties needed for subsequent applications. While the basic stages of almost every production process, such as distillation, crystallization or drying, are well known technologies, they can be optimized in virtually every new process.

The centralized process technology section is responsible for this task and consequently acts as a clearing house that keeps track of whether the technical know-how gained while working on product A for one Business Group can be applied to

product B of another Business Group.

Chemical engineers also have the task of introducing completely new processing possibilities for the company as a whole. The value of this section is underlined by the large number of problems it has solved and the developments which have resulted from cooperating with other departments of the company.



Distillation in the applications pilot plant in Leverkusen.

Bayer's Tower Biology waste water clarification process and its specially designed jets are a good example of an economically and technically advanced solution in the important field of environmental protection.

Today's level of data processing has permitted the development of new process control methods, as well as major progress in theoretical process technology. Even the most complex stages of a process, and frequently its key chemical phases, will soon be

simulated in the form of a model. This progress will enable improvements in product quality, ecological requirements and production costs.

While the production process is in the forefront of process technology, applied physics has much more to do with the product itself. The main aim here is the improvement of physical properties

properties of polymer materials from data on their base substances. The aim is to simplify and shorten the formerly time-consuming preparatory stages and thus facilitate the creation of "custom-made" polymer materials.

In the field of pigment chemistry, physicists have determined and mathematically expressed the relationship between the particle form and particle-size distribution of pigments and their optical or magnetic properties. It is possible to calculate the exact parameters of the particles for products in which the customer demands specific optical or colorimetric properties.

For example, pigments for colored plastics, concrete blocks or roof tiles or color coatings can be manufactured to specification; the same is true of high-performance pigments with specific properties for audio, video and computer tapes.

So-called biocatalyst chemistry also makes increasing use of physics in the development and improvement of pharmaceuticals or crop protection chemicals. An important consideration here is the relationship between structure and efficacy, for example, in the interaction of active agents and cellular membranes. Scientists attempt to forecast, in quantitative terms, what this correlation will be by developing corresponding models.

in existing or new products. The past few years have seen a change in the role of the physicists. Most of them used to be experts for specific physical methods and their adaptation to the practical demands of the laboratory or the plant. Today, their work is primarily problem-oriented and calls for an all-embracing approach to the development of new processes.

With the help of computer simulation, physicists can thus tackle such tasks as working out the technical

Principles of process technology are presented to apprentices with the help of a "toy." This digitally controlled model railroad simulates situations in the plant.



such as increases in temperature or excessive flow rates and reacts with flashing lights. In this case, or at any time he feels it is necessary, the operator can call up details about what is happening in the process by tapping a pencil-like, light-emitting pointer on the screen of the monitor. With this pointer, he can also open or close valves or intervene in the process in any way that might be required. But in fact, with the greater sophistication of today's equipment based on modern process control technology, it is not necessary to intervene in the flow of the process as often as it was in former times.

If this is true, is a human operator still needed at all? The answer to this question can be explained more vividly using the cockpit of a modern aircraft as a comparison. The whole room is packed to the ceiling with all kinds of indicators and control apparatuses. During a flight, the pilot and co-pilot only have to press a button to check any data they might need concerning position, course, flying time, fuel consumption, weather conditions and so on. They might not even have to touch the controls for extended periods of time because normal in-flight routine is handled by the instruments. All of these devices make the crew's flying and navigational work easier and thus help to enhance safety.

Despite all of that valuable assistance and as intricate as this equipment may be, airplanes still rely on their pilots. Taxiing, takeoffs, radio communications, decisions about the course or the landing and the landing procedure itself cannot be left up to instruments. Although instruments may be able to keep to a predetermined course and altitude better than the most experienced aviator, the pilot bears the ultimate responsibility.

The situation is comparable in a modern chemical plant. However, while aircraft are produced in series, every chemical works—in spite of all basic similarities—is technically unique.

When a plant is to be built, experts of the Process Control Systems Section are consulted right from the first stage of planning. Their task is straight-

forward: they collect all the process parameters that determine the exact conditions under which a process is to take place, and work them into a detailed computer program. For example, they calculate under what conditions in the unit and at which given temperature and pressure levels material X and material Y at a mixing ratio of Z can be induced to react.

After the plant is finally in operation, this computer program will be used to steer the production process in the same way a built-in program does in a washing machine. The whole process is divided up into a series of exactly defined individual steps that follow in a given order. The programming of a chemical reaction is, of course, far more complicated than that of a washing machine, but with the help of the process control systems, the "routine" part of the various stages of production can be established.

The monitoring equipment has highly sensitive sensors, i.e. control probes that measure temperature, pressure, concentration of a starting material and other values and pass them on to process control. The computer system can itself react to the continuous flow of data on the basis of the intricate program and, if necessary, change flow rate volume, increase the reaction temperature or activate the cooling system. Just like the pilot in his cockpit, the plant operator is then free to concentrate on specific problems or unforeseen occurrences in the production process.

It did not take a very long time for modern process control technology to develop from conventional measuring and control methods into a discipline of its own. And today it has joined the ranks of other sciences in university curricula. The rapid growth of process control has made the whole aspect of data evaluation an important factor of production that now ranks on a par with manpower, raw materials and energy, among others.

Further progress in perfecting production technology is taking two different directions. One of these approaches is closely tied to advances in the



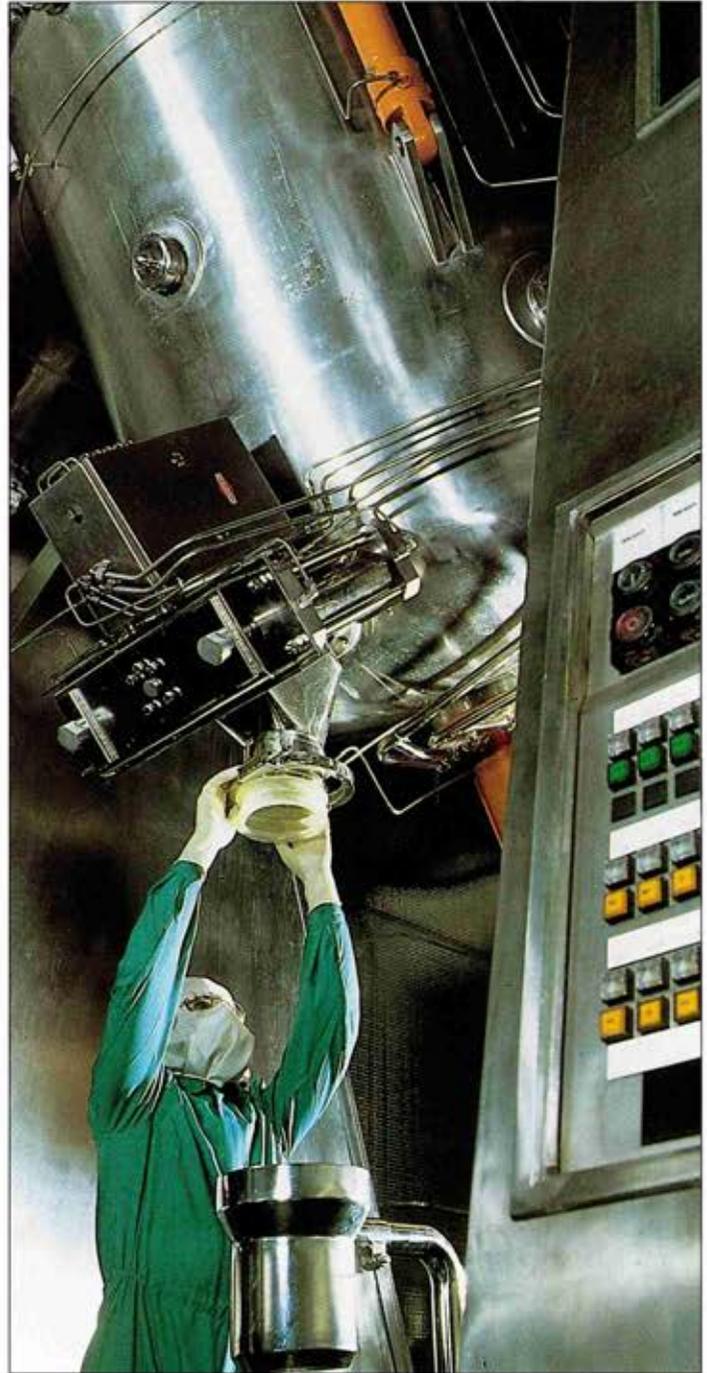
fields of microelectronics, sensors and activators. Although product quality may be much more consistent today than ever dreamed possible in the days of manual operation, the separate components of the process control system and their integration into a whole unit are still open to improvement.

Even more important than the development of appropriate hardware is the progress made in creating the corresponding software to allow use of all the process control system's technological potential in the entire plant. Being able to conduct a production process in an extensive but nevertheless closed unit is certainly a remarkable accomplishment in modern times. But it remains only a single aspect of a particular process and thus a limited part of a company's overall activities.

Whether and to what extent a given product is going to be manufactured at a given time depends primarily on immediate demand and the market for this particular material. It is not just a question of the volume of orders received for that product but also the current amount of stocks available, as well as other factors.

On the other hand, if a given volume of a product is to be produced, the necessary feedstocks have to be present in sufficient quantities, or they must at least be able to be delivered by the time production begins. And last but by no means least, the plant where the product is to be produced must be ready for operation.

Such considerations affect several different parts of any corporate organization, each of which is itself dependent on computer support. For example, let us imagine these responsibilities as a system of various levels in a hierarchy, and each level has to exchange information with the others on a regular basis. Through the communications between the computers at the various levels, an information network is created that can facilitate decisions on corporate- and factory-level matters. Some of those time-consuming meetings are thus no longer necessary.



Plants can only operate properly if their logistics are carefully planned. This work includes the timely ordering of sufficient quantities of raw materials, making sure that enough storage space is available and determining the demand situation in the market.

All of these considerations are taken into account when preparing the process control programs.

Bayer recognized this potential early on and in 1980 merged all operations involved to form the Process Control Systems Section of Central Engineering. Since then, its experts have been working on new process control "tools" and methods for use throughout the company.

This section is well-staffed and well-equipped to help out those in the company—even experienced production managers—who know too little about this subject or find it too complicated, or too boring, and are thus unable to make use of the opportunities offered. As a consequence, the section not only has the task of installing process equipment and providing the necessary software, but also of instructing all concerned on the principles and advantages of modern process control systems. It also operates test centers in which "customers" from within the plant can learn about the new technology.

Bayer is currently in the midst of a reorganization program aimed at a broader use of process control. This step will take time but the target is clear: the company should be able to produce goods faster, more economically, of a higher quality, and with more attention paid to environmental considerations while, at the same time, reducing administrative costs. The more extensive application of this modern technology does not mean a transition to the robot-controlled factory. Men and women in the chemical industry will always remain the decision-makers, just like the pilot in his cockpit.

Bayer chronicle 1980

Adalat becomes the first German pharmaceutical to win the Prix Galien, France's highest award for pharmaceutical products and scientific achievements.

Biltricide, a drug against schistosomiasis developed jointly by Bayer and the German pharmaceutical company E. Merck, is introduced to the market.

Lewatit process for the treatment of water with ion exchangers is offered to customers.

Hydrogenation facility at Mobay's plant is inaugurated in Bushy Park, South Carolina.

Sodium bichromate production plant goes on stream at Zarate, Argentina.

A rescue float for emergencies at sea and equipped with radar reflectors made



of metallized fabric made from Bayer textile fibers is successfully tested in the North Sea.

World events 1980

On April 25, the attempt of the United States to rescue American hostages held in Teheran since November 1979 fails.

Mount Saint Helens volcano located in the state of Washington erupts on May 18,



blowing off one-seventh of the 10,000-foot mountain peak.

The 22nd Summer Olympics in Moscow are boycotted by 57 nations because of the Soviet invasion of Afghanistan.

Failing economy gives rise to a wave of strikes in Poland. Communist Party chief Edward Gierak has to resign on September 6. Free unions are formed. The Gdansk shipyard worker Lech Walesa is named head of the parent organization "Solidarity."

Gulf War begins on September 21 when Iraqi troops invade Iran.

Bayer's fire department sets an example

A new sort of fire engine made the headlines in 1981. Based at the Dormagen works, the "Hilfszug" has since become standard equipment in Bayer's fire department. A convoy vehicle with trailer, the "Hilfszug" is virtually a mobile chemical plant.

The catch basin forming part of this unusual piece of equipment is made of a special metal alloy and can hold up to 740 cubic feet of liquid or liquefiable chemicals. If necessary, the liquid can even be neutralized on the spot by a chemical reaction. The "Hilfszug," which has since been patented, is also available for use outside the Bayer plant.

When the Bayer fire department answers a call, precise information is of decisive importance. For example, if one of the fire alarms goes off in the control center at the Leverkusen plant, a monitor shows the exact location from which the signal was activated. But that is not all.

The fire fighters also have immediate access to data on the substances produced or stored in the vicinity of the alarm. They also receive necessary information on the direction and velocity of the prevailing wind. Comprehensive details on a wide range of critical factors are instantly available; not only Bayer's 15,000 safety data sheets, but also information from numerous other chemical companies provide particulars.

Before the fire engine has reached the scene of the fire—within about three minutes—works security and the medical department have already been alerted. Via a plant-wide intercom system, employees can find out details about the fire calls. In case of an emergency, the fire department itself can use this system to contact specific factory units or building complexes.

On-site information, as important as it is, does not suffice when an alarm is given in a chemical plant. Up until 1978, the fire protection legislation of the state of North Rhine-Westphalia, which is applicable for the Leverkusen, Dormagen, Elberfeld and Uerdingen works, established that works fire departments only had to inform community fire authorities if they were unable to tackle the fire alone. At first glance this law looks both reasonable and adequate. It did not, however, take into account that the local population may have a need for information even when the works firemen have everything under control.





When a fire alarm is set off anywhere in the Leverkusen plant, the central control room can immediately determine which substances are produced or stored in the vicinity and from which direction the wind is blowing—and with what force. The chemical fire-fighting

"Hilfszug" based at the Dormagen plant has belonged to the equipment of Bayer's fire department since 1981. Its catch basin can hold up to 740 cubic feet of liquid chemicals, which, if necessary, can be neutralized on the spot.

If large clouds of smoke or vapor emerge from a chemical facility, it is construed quite differently than the trail of smoke rising from a burning house. Unfortunately, it is not enough for the on-site firemen to know that the threatening white cloud is the perfectly harmless consequence of extinguishing the fire. Nor is it a sufficient explanation to say that according to the company's analyses, the strange smell is due to a minute concentration of a particular chemical and totally without toxic effects. An amendment to the state law now requires that local authorities be informed about fires and accidents in cases which could lead to concern in the public, even if there is no actual danger.

The chemical industry in general and Bayer's fire fighters in particular have no doubt become much more conscious of actual dangers over the past decades. And they also have come to realize that the less the people know, the worse the dangers—or rather, subjective dangers—appear to be. The company experts therefore started considering long ago how Bayer's neighbors can best be kept informed, over and above the bare legal requirements.

These considerations have led to an early-warning system, in which municipal fire companies and local authorities are alerted in every instance where there is even the slightest chance that an incident could become noticeable outside the boundaries of the plant. This information is not tantamount to a request for outside aid nor does it mean that a general alarm has to be given and the public warned. It does, however, mean that all important people with contact to the public are forewarned of what could appear to be dangerous.

After this system had been introduced and proved its worth, Bayer took steps to elaborate on the original concept and agreed with the Leverkusen authorities on an even more detailed exchange of information. Both partners laid down the corresponding follow-up measures in an agreement that was finally concluded on July 4, 1980.

The headquarters of the municipal and the Bayer fire departments are connected by a direct telephone

line. Both parties have identical checklists at hand. When the Bayer fire service answers an alarm, the city's fire department is informed about the character of the incident, its location, the wind direction and possible effects, as well as the nature of measures being taken and envisaged. All of this takes place quickly and clearly.

For example, a report that a Bayer fire crew has moved out to investigate a leak in which it is likely that no measures will be taken by the department but which may mean an odor nuisance for the neighborhood is reduced to the code message "B one, C one-one, D two" and generally answered by no more than a "Thank you. Roger." If a fire has broken out or some other major disturbance has occurred, detailed information is passed on as soon as it is available.

This system has worked so well that it has been adopted elsewhere. In 1987, the city of Cologne introduced the early-warning system, and the municipal authorities subsequently extended this "Leverkusen model" to all other industrial operations in the Cologne vicinity.

Over the years, all fire departments in the chemical industry have accumulated know-how in this very special field of fire fighting. And this kind of data on safety measures is far from being kept a company secret. On the contrary, there is a lively exchange of information between the leading producers of the chemical industry.

After every major incident in any of the world's chemical facilities, Bayer's experts get together to analyze the cause and examine the action taken. This invariably leads to the question, "Could it happen to us?" After the disasters in Seveso and Bhopal, the verdict of Bayer's experts was that it would not be possible at Bayer.

Attention was focused more than ever before on the possible adverse effects of extinguishing water after the major fire in a Swiss chemical installation





near Basel in 1986. After this terrible accident, Bayer facilities all over the world in which potentially critical substances are stored were subjected to renewed scrutiny. The company investigated whether existing fire protection measures would have prevented the major river pollution that followed the Basel fire. The results were comforting. Nevertheless, additional precautionary measures were taken at individual locations.

Many years of experience and constant efforts to improve plant safety even further have led to continuous improvements in the equipment of the Bayer works fire departments. They have a number of unusual units at their disposal, in addition to the more conventional equipment.

One of these extraordinary pieces of equipment is a vehicle, nicknamed "Wendelin" by the firemen, with a triple-jointed extinguisher arm capable of directing 210 cubic feet of water or 2,800 cubic feet of foam per minute over 180 feet high in the air or up to almost 400 feet in the distance; even seemingly inaccessible areas can be reached with its help. There are

three such "Wendelin" vehicles in Bayer fire fleets. Bayer's fireship, christened "Polymer," has been docked at Dormagen since 1970 and, in the case of accidents on the Rhine or in installations close to the river, it can either use water for extinguishing purposes or lay a foam carpet on the river surface. In Leverkusen a tugboat, also with state-of-the-art equipment, is in service.

Municipal fire companies primarily have to fight fires in residential and office buildings or else they have to provide technical rescue and support services. This goes for a works department, too. But a works fire service in a chemical plant is more than just a fire department.

Special training is necessary for all Bayer firemen over and above their normal courses. In municipal fire departments, one fireman is statistically calculated for about every 10,000 inhabitants; in the chemical industry the proportion is one per hundred employees.

The fire departments of Bayer's plants—like the team from the Leverkusen works shown here with their vehicles—have access to special equipment for special cases. One such device is the "Wendelin" unit seen in the picture on the left whose triple-jointed extinguishing

arm can pump 210 cubic feet of water or 2,800 cubic feet of foam up to heights of 180 feet or distances of 400 feet every minute. Thus even difficult areas can be reached.

Logistics — juggling with numbers and tons

Up to 16 million metric tons of a variety of products pass the gates of Bayer's five German works and the Antwerp plant every year. If this amount were to be packed into 20-ton freight cars, it would fill up a train some 6,200 miles long that would reach a quarter of the way around the globe.

Almost 1.5 million shipping orders to external destinations and nearly a million requests for transports within the plants have to be handled by Bayer annually. With suppliers and customers located all around the world, an intimate knowledge of the international transportation sector is a must. In order to make the best use of railroads, road transportation, ocean and inland-waterway navigation and air freight services, or any combination of these, Bayer's logistics staff must pay attention to all the intricacies of import and export regulations, customs and excise requirements, dangerous transport ordinances and much more. This kind of work calls for specialists to handle the orders and shipments as well as the permanent flow of logistics data.

Since the customers are every bit as logistics-minded, they make an effort to manage with low stocks and to keep their supply situation well-organized by precisely timing deliveries. Without an integrated and electronically operated data processing system to handle this kind of shipping traffic, Bayer would be unable to provide the services demanded by the market, especially in light of its current load of 700,000 shipments annually.

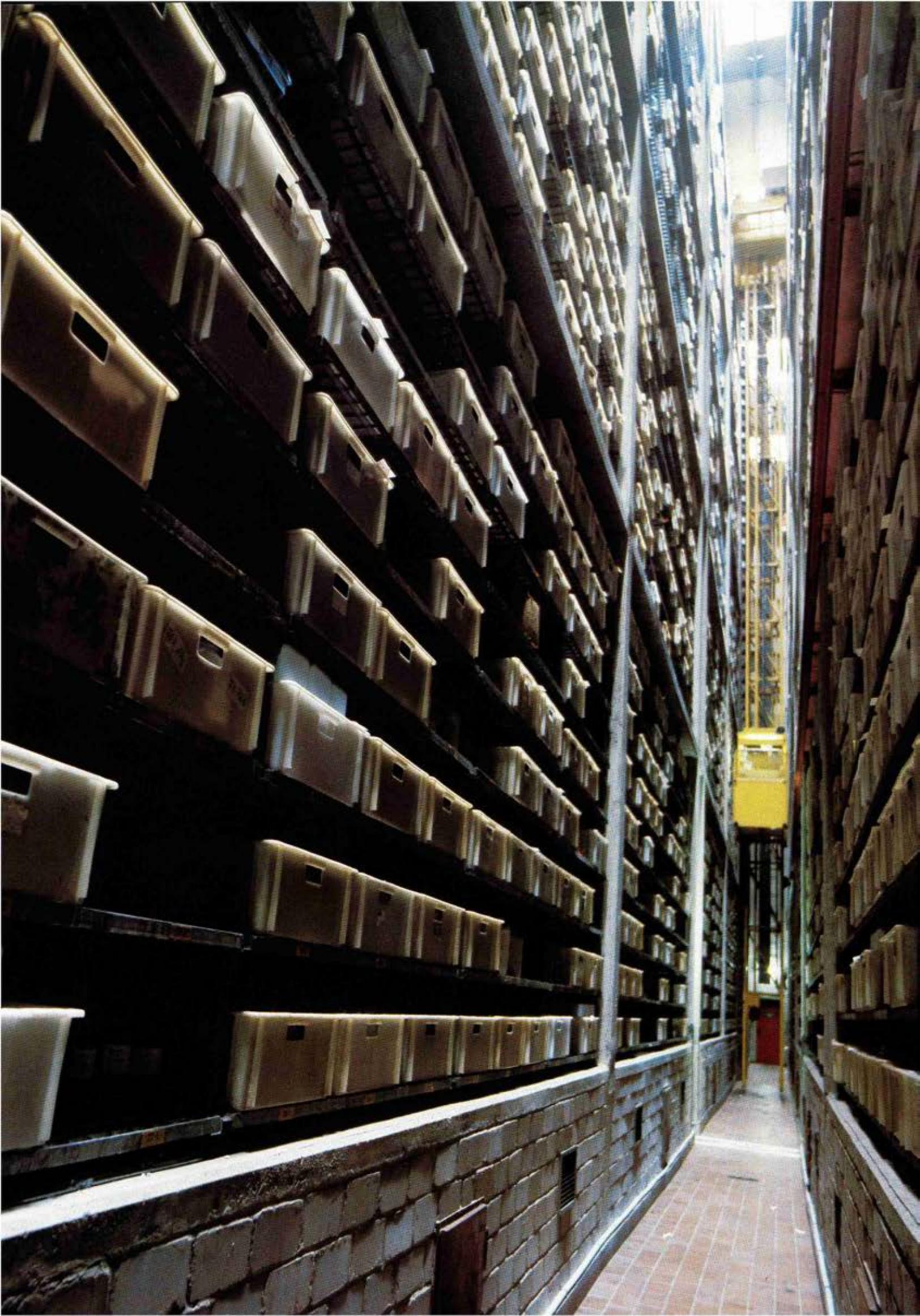
The planning, control, execution and supervision of this gigantic operation are all complex, and the costs are correspondingly high. According to an American study, the expenditure on logistics in the chemical industry in the United States is calculated to be somewhere around 24 percent of sales. Although an internal study for Bayer AG came up with a share of "only" about 15 percent, it still means expenditures that go well into the billions of marks.

Logistics experts bear the responsibility for all sorts of things. They make sure that: production units always have enough feedstocks while at the same time keeping the materials in stock as low as possible; the power stations have sufficient fuel; customers in the processing industries have enough of the products they need from Bayer to keep production going, and the village pharmacist does not run out of Aspirin.

A freight train carrying the entire volume of goods leaving Bayer's five German plants and the one in Antwerp in the course of a year would reach a quarter of the way around the world. Among the busiest loading points are the Rhine quays at the Leverkusen works.

The crane nicknamed "Herbert" that has been in operation since the spring of 1987 can handle both bulk goods and containers.





Linguists do not agree on the origin of the word "logistics," but it was taken over from the military and put into general use by the business world after World War II. Today it is taught at universities.

The logistics operations of a company can only be really successful if they are treated as a whole. This domain of responsibility includes not only storage, transport, loading and unloading, but also proper packing for the various kinds of shipments, exact identification and labeling, dispatch scheduling and all the corresponding flow of information. Safety and reliability of the shipment itself are just as important for the chemical industry as service and costs.

Long before the public had cast a critical eye on the transport of chemicals, Bayer had already accorded a high priority to the question of safety en route. By interlinking the classification of goods with the product number—as stipulated by national and international laws, it could be guaranteed that shipping orders made by computers include all necessary data or the statement "non-hazardous" on the freight or cargo. An order is not allowed to be processed without this information. Where statutory regulations are considered insufficient, Bayer goes one step further than the law with its safety measures.

Wherever possible, Bayer transports its products by rail or water rather than by road. Of increasing importance here is a combination of the various forms of transport, linking the advantages of rail and water for long-distance shipments with the flexibility of the truck in the collection and distribution of goods. New container transloading centers, for example in Leverkusen, help to shift transport to and from seaports away from the highways and concentrate them on railroads and inland waterways.

The efforts in the interests of safety go hand in hand with top quality service and cost-conscious deliveries—an enormous task in view of the fact that Bayer has some 150,000 customers around the globe. Optimizing safety, service and price is a continuing challenge for the company's logistics staff.

The computerized warehouse in the Leverkusen plant (left) plays an important role in helping to solve the gigantic logistics problems when it comes to keeping track of the huge volume of raw materials and finished products.

Bayer chronicle 1981

Agfa-Gevaert Group becomes a fully owned subsidiary of Bayer AG.

Bayer sells its stake in Progil-Bayer-Ugine (PBU), which had been formed as a French joint venture in 1959 for the production of polyurethane raw materials, to Rhône-Poulenc.

Multizone foaming process is introduced for the production of auto seats with reinforced edges.

A special mobile unit, the so-called "Hilfszug," is brought into use to handle, among other things, traffic accidents involving chemicals.

An agreement is signed to cooperate with the Max Planck Institute for Breeding Research in Cologne in the field of basic research. The major emphasis of this cooperation is placed on molecular biological plant research.

The Herbert Grünewald Foundation is established for the promotion of sports for the handicapped.

World events 1981

Ronald Reagan is sworn in as the 40th president of the United States on January 20. On the same day, Iran releases the 52 American hostages who have been held prisoner for 444 days.

On January 25, the "Gang of Four," among them Mao Tse-tung's widow Chiang Ching, are sentenced to death in Peking. However, the executions do not take place.

General Wojchiew Jaruzelski is appointed prime minister of Poland on February 12. He subsequently declares martial law for the entire country on December 13 and outlaws the independent trade union "Solidarity."

On March 30, President Reagan is wounded by a shot in the lung in Washington. Pope John Paul II is seriously injured in an attempt on his life in Rome on May 13. Egyptian President Anwar al Sadat is assassinated on October 6.

The first reusable space shuttle, the "Columbia," takes off on April 12 and lands safely two days later in the Californian desert.

A research center for the agricultural sector

In May 1982, some two and a half years after the foundation stone had been laid, the first laboratory of Bayer's Agricultural Chemicals Center was opened in Monheim. About a 20-minute drive from the Leverkusen plant, a research installation began to take shape that has no match.

Seen from a distance, the Agricultural Chemical Center looks like the huge campus of a modern university transplanted into the setting of the Lower Rhine countryside. On a 136-acre site surrounded by fields, meadows and trees, the Monheim complex has grown in just a few years into the center of all of the activities of the Agrochemicals Sector, with the exception of production. And there is still room for further expansion. After the entire project is completed in 1988, Bayer's 125th anniversary year, some 1,800 people will be employed there, among them a large number of scientists.

The visitor is struck immediately by the sheer size of the site. The administration building first catches the eye with its unusual architectural structure. Behind this block and looking over the water plants and reeds of a small lake is a central structure with a circular shape designed almost like an island. This building houses auditoriums, canteen and restaurant facilities as well as an unusual tropicarium that looks like a glassed-in jungle.

Set around this focal point and located within comfortable walking distance are several multistoried blocks containing everything necessary for a comprehensive agrochemicals research program: a complex for chemical research, a unit for product development and ecobiology, institutes for product information and quality control, a special center for metabolism research, buildings for biological research, central literature and laboratory documentation, institutes for pest control, herbicide and plant-disease studies, plus individual laboratories and pilot plants for formulation technology. All in all, it is a unique concentration of modern research and development installations.

Although Monheim is the largest and most important facility of its kind within the Bayer organization, major research centers in the field of crop protection are also located in the United States and Japan. This breadth of research work underlines the company's long-term commitment to the work of the Agrochemicals Sector for the international agricultural market.

Bayer's Agrochemicals Center in Monheim is only a 20-minute drive from the Leverkusen plant. All of the diverse activities of the Agrochemicals Sector with the exception of production are concentrated at this 136-acre complex. At the center of the site is a circular building

which houses, among other things, the tropicarium—the "jungle under glass." Here, tropical plants, such as the banana trees shown in the greenhouse (right), grow and bear fruit.

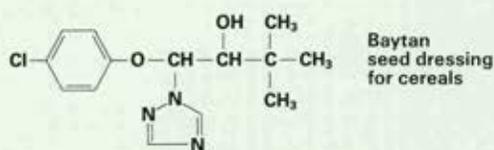
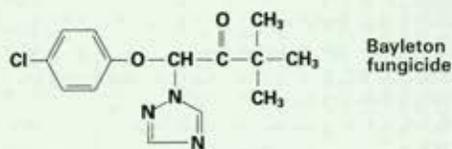


Bayleton and Baytan

These two specialties are good examples of how systematic studies of the basic principles of chemical and biological mechanisms can result in the development of active agents with significance for both medicine and agriculture. Building on the hypothesis that compounds able to form reactive carbonium ions can have fungicidal properties, a search was initiated for appropriate substances. The triphenylmethane derivatives that can form triphenylcarbonium ions presented themselves as an alternative. The corresponding formulas are described in the chapter on the develop-

ment of Canesten, which resulted from this line of research as a remedy to counter the many human fungal diseases.

Further work showed that the triphenylmethane configuration is not absolutely necessary in order to achieve the desired effect. After examining a very large number of compounds with a modified constitution, additional active substances showing promising results were discovered, among them the agrochemicals Bayleton and Baytan. They have the following composition:



Bayleton and Baytan, like otherazole fungicides, inhibit the formation of ergosterol in the fungi, a sterol needed by the fungi to build up their cell membranes. The fungus is damaged when chemical substances are used to interrupt the biosynthesis of the

ergosterol from its primary products.

The formula shows a departure from the original triphenylmethane hypothesis. The heterocyclic ring, which is also present in Canesten, has basically been retained. In this case, however, a 1,2,4-

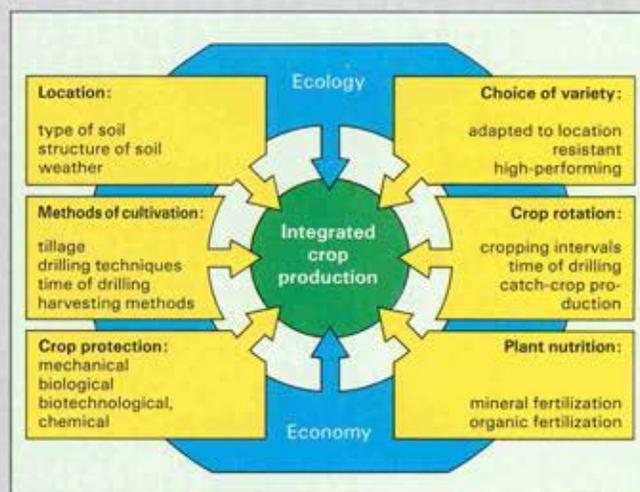
triazole ring replaces the imidazole.

Baytan was able to take the place of seed dressings with a mercury content and thus play a particularly important role in the protection of seed products.

Bayleton has both a prophylactic and a therapeutic effect against fungi and

belongs to the category of systemic agrochemicals. This means that it is absorbed into the plant organism in order to fight against the fungus from within the plant.

The system of "integrated crop production" mentioned in the main text of this chapter is illustrated in outline form by the following diagram:



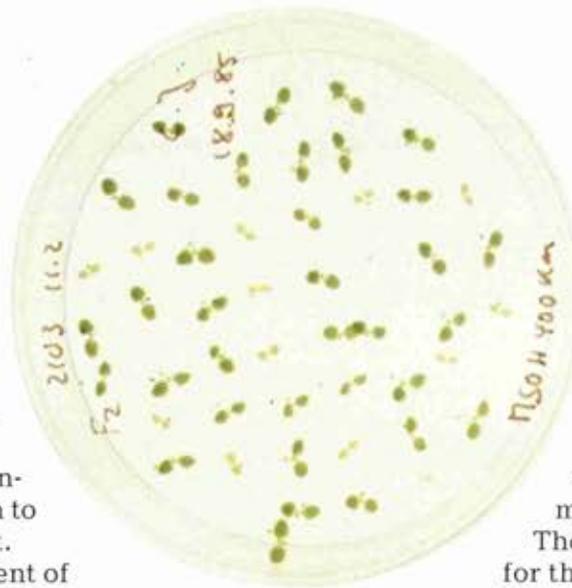
From the beginning of civilization and continuing right up through the ages, one of mankind's major concerns has been to secure a means of nourishment. Even in our times, over 30 percent of potential crops worldwide fall prey to various pests and plant diseases. A wide range of different measures and methods are therefore necessary to contain this natural loss of food. For example, with the various climatic zones, there is a huge variety of weeds and pests in the different regions of the Earth that each require individual crop protection programs.

In any case, seeds have to be protected from rotting before they can be planted, the growth of plants and fruit has to be promoted, attacks by disease and insects have to be warded off and the final crop has to be kept from spoiling.

Since the early days of recorded history, men and women have plowed their fields, weeded their plots and, wherever possible, applied fertilizer. The results were readily visible in "good years." But all the hard work went unrewarded when the crops were attacked by an army of pests. Products to combat pests were therefore one of the first priorities of research in the chemical industry for the agricultural market. As early as 1892, Bayer introduced its Antinonin, a substance aimed at the caterpillar of the nun moth, which was responsible for destroying whole forests in those days.

The beginnings of systematic research for the agricultural industry came much later. Bayer developed the seed dressing Uspulun in 1915, which proved to be an indispensable aid for arable farming.

Successful crop protection calls for comprehensive basic research. All characteristics of cultivated plants and their reactions to various influences have to be observed carefully—starting from the germination of the seed right up to the ripening of the fruit—first in



At about the same time, the company began to hold lectures and publish information on modern forms of crop protection. The opening of a special institute for this new field of operations in 1924 is described earlier in this book.

The favorable position of the reestablished Farbenfabriken Bayer in the agrochemicals industry in the early 1950s made it obvious that the company would be able to get off to a good start again. Before the war had ended, the family of phosphoric and thiophosphoric acid esters had been recognized as a promising source for a range of insecticides and were gradually being developed. The actual breakthrough came, however, with the development of the systemic crop protection chemicals on this basis. In the meantime, there has been a radical change in the agricultural economy of Germany, Europe and indeed the whole world. In 1950, the world's population amounted to no more than two and a half billion; by 2000, it will have passed the six-billion mark. In 1980, some 15 million people starved, a further 500 million were undernourished and 1.5 billion suffered as a result of insufficient food supplies.

These figures would be even more dramatic if agriculture had not succeeded in keeping up a steady improvement in yields, without a corresponding rise in acreage. Around the year 1900, a German farmer was able to feed five people with his produce; today he can feed 64. However, the world average is still only about five.

In the 20 years between 1961 and 1981, a historic change took place in the worldwide situation; food production rose

the laboratory and later in field tests. The pictures show three laboratory cultures of plant seedlings in nutritive solutions.

by 57 percent and thus faster than population growth. In addition, all of the developing countries taken together experienced a 68 percent increase in their total harvest. And yet in spite of all these advances, serious problems still remain, mainly because this growth in food production has not been equally distributed. Even if world crops were distributed equally around the world, the food shortage would still not be solved because it would mean having a worldwide deficiency instead of only local shortages.

Right from the beginning, agrochemicals have played a major role in the battle to produce enough food. Bayer was well-prepared to meet worldwide demand. The phosphoric acid ester compounds formed the basis for a broad assortment of insecticides, and other active agents were developed for a variety of uses in the agricultural market. Important landmarks in Bayer's emergence as a major agrochemical producer were the introduction of Baylucid, Baygon and Sencor, all of which have been discussed elsewhere in this book.

As one of the world leaders in the crop protection market and a company with a wealth of experience and know-how in this field, Bayer has taken the

whole question of the ecological implications of agrochemicals very seriously. The company is thus engaged in comprehensive research programs on the effects of its products on the environment.

Today, Bayer is pursuing two lines of strategic thinking in its work. One of them is a natural consequence of the public debate on the use of chemicals in agriculture and is aimed at providing complete and honest information to the outside world. These efforts had their origin in the agrochemicals bulletin published by Bayer under the title "Pflanzenschutz-nachrichten," and efforts have intensified considerably over the years.

This information policy encompasses more than just instructing farmers on how to use the company's chemicals properly, and it certainly extends beyond the bounds of customer service; it also addresses the general public as the actual consumer of agricultural produce. The "educational campaign" to inform the public about chemicals for plant treatment is not accomplished just by publishing articles and distributing brochures. At Bayer, it also involves giving guided tours and lectures and organizing discussions in the new Monheim center for all kinds of different groups of visitors.



The second approach to Bayer's strategy is directed at developing more advanced crop protection products and processes to secure the crop yields. The key to the company's success lies in its widely diversified research efforts, which have a long tradition at Bayer. During the seventies, before the research facilities were available at Monheim, important progress was made in creating products with very specific effects but which required that only small quantities be applied.

Up until the late 1940s, farmers needed about two to five kilograms of lead arsenate or the same amount of sulfur for every hectare (approximately 2.5 acres) of arable land in order to obtain an effect. Even approximately one to two kilograms of DDT were required per hectare in order to see results. With today's modern insecticides, often no more than 20 grams per hectare, are used, or 100 to 300 grams in the case of fungicides. Bayleton, which has frequently saved whole harvests from fungi, only has to be applied in amounts of between 125 and 250 grams per hectare, i.e. only one-tenth of the quantities that were formerly needed.

In former times, it was hardly possible to dispense with mercury in seed dressings. Although dressings containing mercury could be marketed that were acceptable even by today's ecological standards, the demand for products without any of this metal gained momentum. Bayer's mercury-free product marketed under the trade name of Baytan provided an alternative. By the early eighties, Bayer was able to offer farmers complete assortments of crop protection chemicals for highly varied fields of application. The products included insecticides, fungicides and herbicides as well as seed dressings and a range of household specialties and products to help in the control of public health problems.

The scope of the activities pursued in Bayer's various institutes in Monheim shows that modern agrochemical research goes much farther than the synthesis of new chemicals and the testing for their efficacy and environmental acceptability. There

has been a fundamental shift in emphasis. In the traditional approach to research in the field of agrochemicals, scientists took a specific problem facing farmers, such as the occurrence of an individual pest, and began looking for an answer on the basis of existing chemical know-how. Bayer soon came to realize that this "linear thinking" was insufficient to solve major agricultural problems in the long run.

All over the world arable and livestock farming techniques form part of an integrated system, which means that alterations in one detail almost invariably lead to repercussions in one or many other parts of the system. This applies to the choice of seeds and fertilizers, the cultivation of the soil and the methods of crop protection.

The best overall results in crop yields can thus be obtained when individual measures are carefully coordinated. The ultimate target resulting from this way of thinking is called "integrated crop production." The fact that agrochemicals are an integral part of the overall agricultural sector was taken into account in planning the research center at Monheim with the highly diverse activities of its various institutes.

This concept also called for changes in management structure. In the years between 1984 and 1986, all of Bayer's various operations that were connected with farming were merged to form the Agrochemicals Sector, which is the company's single largest organizational unit. It comprises the Business Groups Crop Protection, Consumer Products and Animal Health. The new organization provides for an efficient research and development system based on close communication and the exchange of information. This is all the more important because research work within the individual fields is not only becoming more extensive and costlier, it has to an increasing extent also set new research parameters.

Bayer's strong commitment to biotechnology is an example of this new approach to research. Biotechnology involves the use of microorganisms,

The products and methods used in modern crop protection are being constantly improved. Today's main challenge is to guarantee good crop yields without neglecting the balance of nature.

A research center for the
agricultural sector



vegetable or animal cells or cell elements for the industrial-scale production of given substances. The fermentation of grape juice to wine and the brewing of beer all the way to Bayer's production of aminopenicillanic acid and the manufacture of citric acid in the United States by Miles are based on biotechnological processes. In principle, such methods are also exploitable for crop protection, either to obtain an insecticide or to apply a microorganism directly to a plant without prior isolation of the active agent.

Genetic engineering methods can be used to produce microorganisms with improved yields of the desired active substance. It is also quite conceivable, although still far from being successfully put into practice, that properties such as resistance against a specific herbicide could be genetically transferred to a plant.

Modern crop protection is no longer a matter of chemistry alone but takes all aspects of an agricultural system into account. The central responsibility for this research effort at Bayer is concentrated at the Institute for Biotechnology founded in Monheim in 1983.

During its first phase of operations, this institute has had the task of collecting and collating both the problems and the solutions and subsequently coming up with reliable valuation criteria. In order to pursue this new direction of research work, close cooperation is sought with universities and other research organizations. For example, Bayer and the Max Planck Institute for Breeding Research in Cologne-Vogelsang entered into an agreement for basic research in 1982.

The road from Uspulun to the broad spectrum of modern crop protection products was a long and laborious one, but it was also remarkably successful. The research capacity and potential of the Agrochemicals Center at Monheim guarantee that this progress will continue.

Birds are constantly on the lookout for food. Unfortunately, germinated seeds make a favorite meal. The Monheim researchers have developed substances for seed treatments that spoil the appetite of our feathered friends without doing them any harm.

Bayer chronicle 1982

Following the death of Professor Otto Bayer on August 1, the Otto Bayer Foundation is set up to honor and to further natural scientists engaged in research. First laureate, in 1984, is Professor Gerhard Wegner, of the Max Planck Institute for Polymer Research in Mainz.

After ten years of intensive research and development work, a method is introduced for the reprocessing of used sulfuric acid. Bayer subsequently stops dumping diluted sulfuric acid in the North Sea.

The Brunsbüttel plant introduces the incineration of liquid wastes as a new technology for waste disposal.

Agfa's Munich camera works ceases production.

Agfa-Gevaert acquires a majority holding in Compugraphic Corporation in Wilmington, Massachusetts. Bayer forms Molecular Diagnostics, Inc., in West Haven, Connecticut.

Baycor, a fungicide for fruit, vegetable and flower growers, is introduced to the market.

Agfa-Gevaert presents its newest innovation: the P 400 electronic printer with LED module for printing out texts and graphics from data or text processing units onto standard paper.

World events 1982

On April 4, Argentinian soldiers occupy the Falkland Islands. The United Kingdom sends in forces and regains control of its Crown Colony on June 14.

Israel returns the Sinai Peninsula to Egypt on April 25. On June 6, the Israelis intervene in Lebanon to expel the Palestinian Liberation Organization (PLO) from areas near its border. On June 26, some 6,000 PLO troops are evacuated from Lebanon. After the assassination of Lebanese President Beshir Gemayel on September 14, Christian militiamen kill more than a thousand Palestinians in two refugee camps near Beirut.

The government of the Federal Republic of Germany changes hands on October 1 when Helmut Kohl forms a coalition between the CDU/CSU and the FDP. This new government thus ends a 13-year coalition between the SPD and the FDP.

Eighteen years of the "Brezhnev Era" come to an end when the Soviet party chief dies on November 10. He was responsible both for the Brezhnev Doctrine that limited the sovereignty of Communist states and for efforts to reach a compromise with the West.

Bayer in the U.K. has its origins in Manchester

The company called itself Bayer for the first time in Britain in 1906. The Elberfeld Farbenfabriken Company Ltd. had been formed in Manchester ten years earlier, but the name was too long and clumsy to establish itself in the market. The change to The Bayer Company Ltd. proved successful, and Bayer soon became a well-known trade name in the United Kingdom.

Britain was the world's first industrialized country. As long ago as the mid 19th century, there were already more people employed in industry in Britain than in agriculture. This would not be the case in Germany for another 50 years.

The modern iron and steel industry, machine-building and, last but not least, the textile industry all had their roots in England. In fact, the first-ever synthetic dyestuffs plant began production there as early as 1856. When Bayer was first founded in Germany, Britain had long earned the reputation of the "workshop of the world."

Bayer's first business with Britain involved the sale of Alizarin Red to Scottish dyehouses in the 1870s. Initially, the company worked through a local trading agent. After only a few years, however, Carl Rumpff saw to it that Bayer had an agency of its own. He set up an organization under the name of Bryce & Rumpff as a joint venture with a British businessman. This company had its offices in Glasgow; Scotland was still the major regional market for Bayer within the United Kingdom at that time.

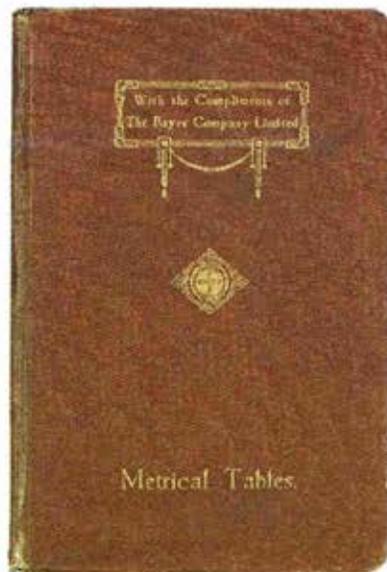
Once Bayer had developed its azo dyestuffs for the direct coloring of cotton, the situation changed. Success in the huge British cotton industry—then the biggest in the world—resulted in an increasing shift of interest to northwestern England. Sales skyrocketed and Bayer soon became market leader.

On January 1, 1896, Bayer's first subsidiary was founded in Manchester, the metropolis of the Lancashire cotton trade. Using Manchester as its base, Bayer began supplying the Indian market with its dyestuffs in 1888. Branch offices were opened in Glasgow, Bradford and London, where the pharmaceutical business was concentrated.

The First World War resulted in a massive setback for Bayer in the U.K., as in many other countries. It was not until after World War II that the company was able to resume business where it had left off in its flourishing days before 1914. Particular problems arose from the longstanding controversy concerning the use of the company name and trademark, primarily in the pharmaceutical sector. In the United

The booklet (above right) for the conversion of Imperial measurements into the then almost unknown metric system was presented to British customers early this century "With the Compliments of the Bayer Company Limited." The first Bayer product to be

sold to the U.K. was Alizarin Red; it was delivered in 1870. This initial commercial connection has developed over the years into an operation headed by its own holding company, the Newbury-based Bayer UK Ltd. in Berkshire county.



Kingdom, as in the United States, Sterling Drug Inc. had bought up the Bayer Company and all its rights during the First World War. A compromise was reached between the wars, but the conflict was resumed after 1945. However, Bayer was able

to demonstrate that the Bayer cross and the corporate name in the U.K. were still linked to the German parent company. In April 1970, the company was successful in winning back the exclusive rights to the "Bayer" trademark and the Bayer cross. This decision applied worldwide with the exception of the United States and the pharmaceuticals market in Canada.

Up until World War I, there had been only one Bayer company in Britain. After the Second World War, different agencies were entrusted with the task of building up the businesses of the various divisions. Chemicals, which at the time also included plastics, were distributed by J.M. Steel & Co. Ltd., and Baywood Chemicals was set up to market Bayer's agrochemicals. Initially, Industrial Dyestuffs Ltd., and later Bayer Dyestuffs Ltd., sold the company's dyestuffs in the U.K. Fibretex Ltd. was responsible for the textile fibers business, and FBA Pharmaceuticals marketed the health care products.

After an interruption of almost half a century, Bayer Dyestuffs Ltd. had become the first British subsidiary to bear the parent's name in its title in 1963. The following year Bayer Chemicals was established as the successor of J.M. Steel & Co. which had been founded in Glasgow in 1891 and marketed Bayer's chemicals after the war. Bayer had first purchased a holding in the firm in 1954

and subsequently acquired the remaining shares. In 1968, Bayer U.K. Limited was formed as a British holding company, and six years later all the subsidiaries were united in this one firm. Up until 1983, Bayer U.K. was based in the London suburb of

Richmond. In 1981 work began on a new headquarters complex at Newbury, Berkshire. Today, all of the business activities in the U.K. are managed and coordinated there.

In the past decades, the British economy has gone through radical change. The industries of the early Industrial Revolution which helped to make Britain the world's first industrial power, i.e. coal, steel, shipbuilding and textiles, have all shrunk considerably. And as a member of the European Community, the U.K. has also seen a readjustment of its channels of trade. All this could not have taken place without economic repercussions and social problems. But today, at the end of the 1980s, the British economy is showing above-average growth rates.

The regained strength of British industry promises a successful future for Bayer U.K. as well. In this context, a statement made by a British executive in the so-called Böttinger Festschrift of 1907:

"In view of its brilliant past, its successful present and its promising future, one can predict with a degree of confidence that an even better development is in store for The Bayer Company Ltd."

Though times have changed, this prediction has lost little of its original validity.



Bayer helps employees help themselves

A comprehensive social service system has always been a part of Bayer's corporate culture. In the early days, it was designed to help employees master real economic emergencies. This system continues to play an important role even today, as is illustrated by the new statutes of the company's pension scheme that were instituted in 1983.

In the early years of Bayer's history, there were not only opportunities to show a social commitment, it was already a matter of necessity for the company. The foundation of a social "safety net" for employees was provided by the services of the Bayer Relief Fund of 1873, the Factory Workers' Relief Fund formed four years later and the Bayer Pension Fund, which was established in 1897. The rapid expansion of the plant at Leverkusen, situated in the rural area between Cologne and Düsseldorf, brought with it other needs such as housing, shopping facilities and leisure programs. As a direct consequence of this situation, the company built employee residential areas, set up the Bayer department store, supported the founding of clubs and built a recreation center.

Today, the Federal Republic has one of the world's most comprehensive federal welfare systems. Almost all basic needs are satisfied and, as far as possible, all risks covered. This does not mean that corporate social service systems have become superfluous. They now take the form of an important supplement to private and federal welfare benefits. The company's social services include an old-age pension scheme, saving programs, a corporate health insurance fund, health care, catering, various advisory and social organizations and the choice of recreational programs.

One of the most important of these services is the corporate pension program. For more than a century, this system has been adapted over and over again to keep up to date with the frequent changes in social security policy; the most recent reform came in 1983.

Bayer's pensions are aimed at allowing former employees and their dependents to retain the standard of living after retirement that they had achieved during professional life. Together with private insurance plans, this program acts as a supplement to the federal social security benefits. Since 1983 it has been recognized as a separate system so that its development remains independent of the statutory pension. Bayer's pension program is one of the many examples of how corporate services

The benefits provided by the "Factory Workers' Relief Fund" of 1877 and the Bayer Pension Fund of 1897 were the basis for employee welfare. Corporate old-age pension scheme are today an important part of the company's social framework.



Statut
der
Fabrikarbeiter-Unterstützungskasse
der
Friedrich Mayer & Comp.
eingetragene Genossenschaft
in
Wien
Wien,
Karl von S. Mayer & Co. Verlags-Druck.

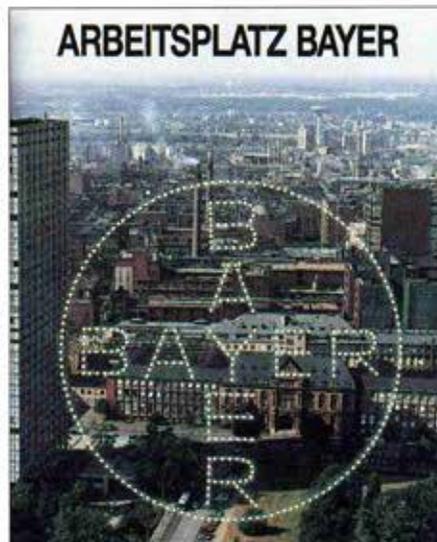
complement the social policy of the federal government and the trade union of the industry.

The necessity to review and adjust social services to suit the changing times is illustrated particularly well using the example of Bayer's housing support. In order to provide employees with affordable dwellings, the company itself used to build houses and apartment blocks. Bayer had to make a considerable effort after the Second World War, when the cities were thoroughly destroyed and the payroll was growing fast. Since the 1960s, Bayer has had some 20,000 apartments at its disposal, which it has either built or whose construction it has supported.

Today's housing market is largely saturated and the demand has decreased accordingly. In the years to come, the company therefore plans to reduce the number of its housing units to a level adequate for corporate needs and which can be maintained without subsidies. Tenants will consequently be given the opportunity to buy the houses and apartments that they have been renting on favorable terms.

Since 1948, the purchase of over 18,000 houses and apartments has been aided by low-interest loans from the pension fund totaling DM 2.5 billion. This amount does not include the DM 300 million in the form of interest-free employer loans that help finance the purchase of apartments or houses.

The company has also contributed to employee savings programs. Only a few days after the shares of the former "Farbenfabriken" were listed on the German Stock Exchange in 1953, Bayer introduced the so-called "employee shares." Initially, employees were able to acquire shares on the basis of a percent-discount in relation to the stock market price. Subsequently, Bayer offered employees a discount in the form of a fixed DM sum.



At first, these new shareholders had to hold onto their shares for a certain period of time before they could dispose of them, but this rule was dropped in 1984. By 1987, more than 80 percent of all Bayer AG employees and over half of the employees of the Group's German subsidiaries had taken advantage of this benefit.

In the early seventies, the company looked for ways to improve the opportunities for employees to accumulate capital ("Vermögensbildung"). On June 6, 1973, the Bayer Employee Funds were set up as a kind of staff mutual fund. On behalf of participants, capital is invested in a broad portfolio in order to

offset any possible consequences resulting from excessive fluctuations in the market prices. An investor has no influence on a regular investment fund, but the situation is different with an employee fund.

The fund is administered by a professional management company, the "Deutsche Gesellschaft für Fondsverwaltung m.b.H." (DEGEF), of Frankfurt, which also provides advice on investments. DEGEF is a fully owned subsidiary of the Deutsche Bank.

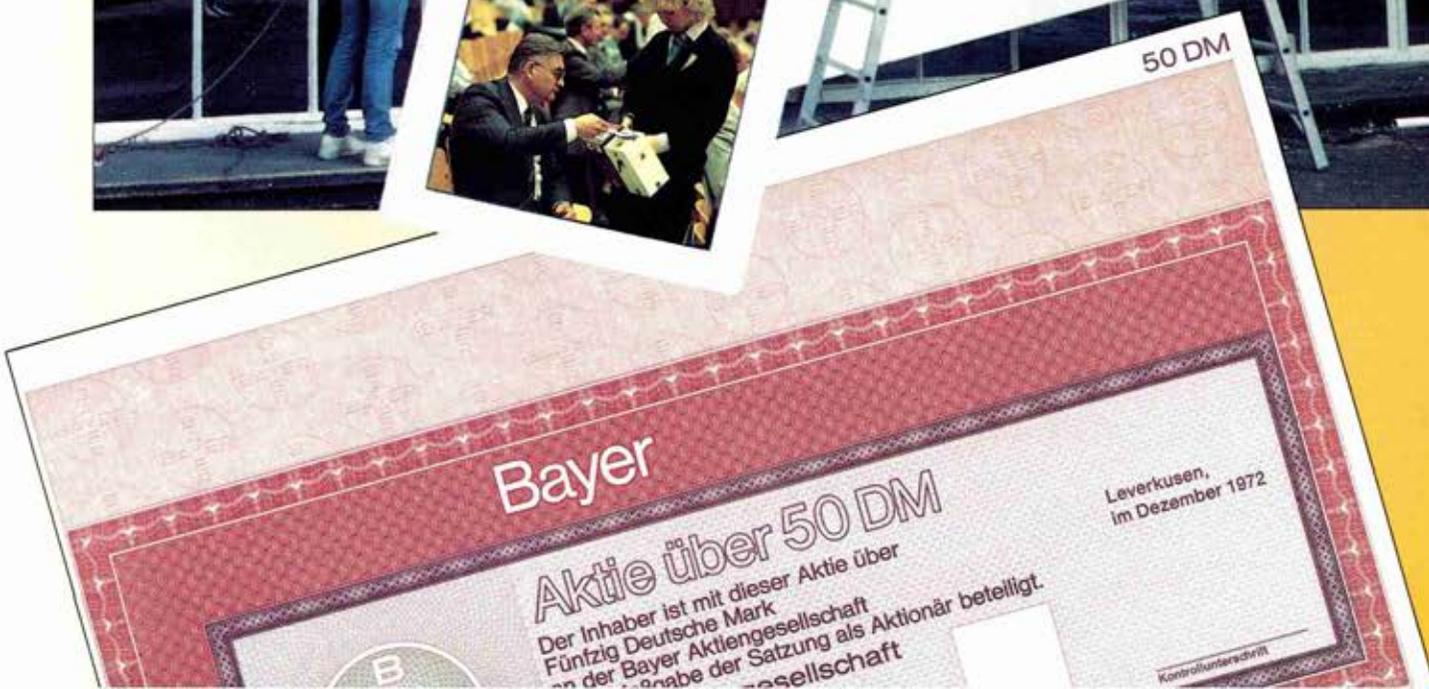
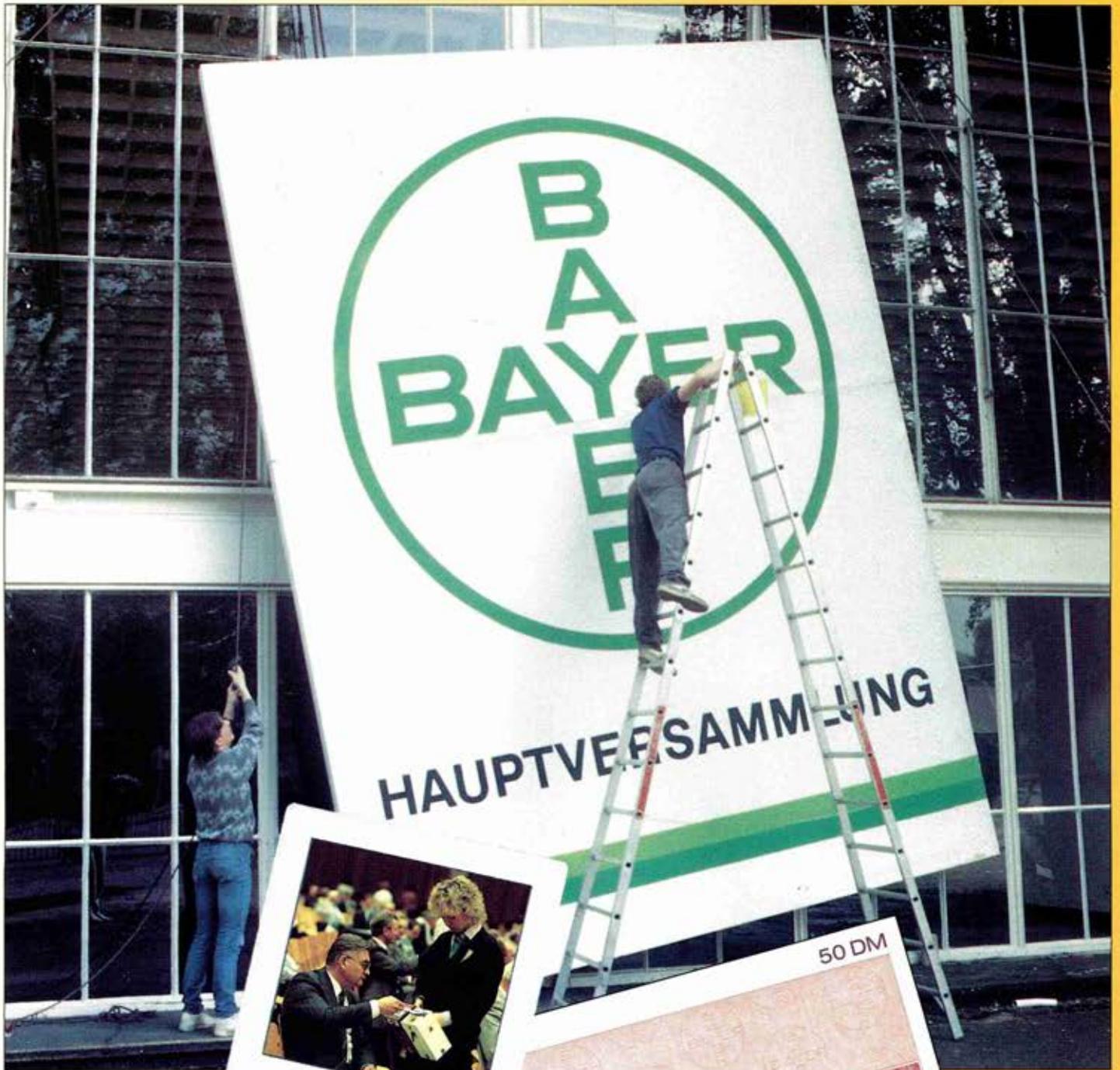
Two steps were taken in order to help the Bayer Employee Funds get off the ground. First of all, if employees were willing to buy

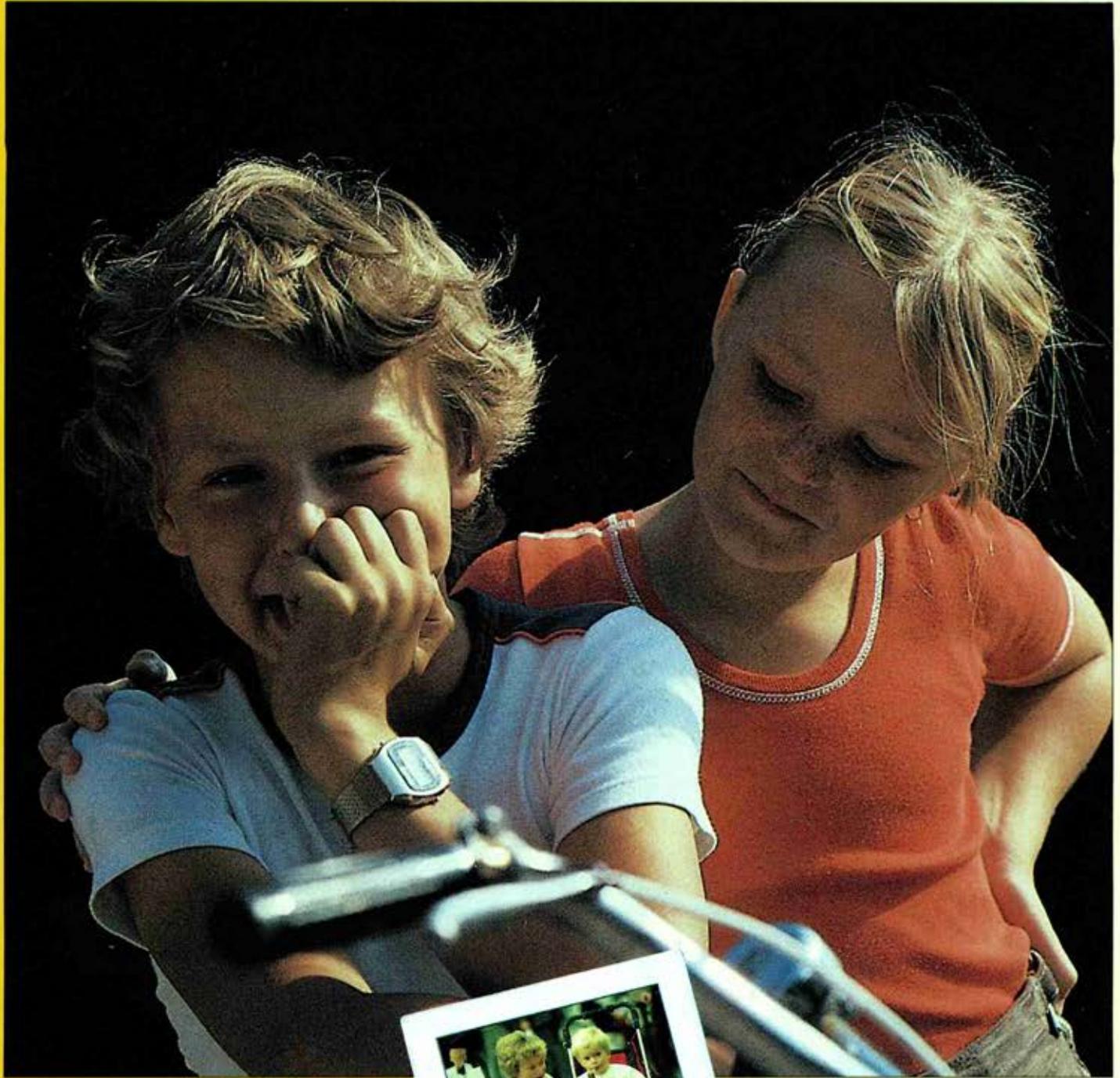
fund certificates and not to sell them for at least three years, the company gave them an incentive payment equal to five percent of an average monthly salary. This payment was tax-free and offered in addition to the regular 1973 bonus agreement. The rate was subsequently increased to 10 percent in 1974. Since then, each employee may also purchase any number of shares from his or her own money, and these shares are not subject to a retention period.

One certificate cost DM 10 when the fund was first formed. Some 90 percent of the payroll supported

As early as 1953, Bayer introduced employee shares as a contribution to individual "Vermögensbildung" (wealth formation). By 1987, over 80 percent of the employees had taken advantage of this scheme. Today, many employees make use of their right to vote at

shareholders' meetings. The brochure shown on this page is intended to explain the various services encompassed in Bayer's overall welfare program.





A special agreement entitled "family and job" was reached in April 1987. It gives families the opportunity for one parent to take a limited amount of time off work. Subsequent reinstatement in a job commensurate with his or her qualifications is guaranteed by the company.

the project; an initial capital of DM 10 million was raised. The price per certificate rose to over DM 31 by January of 1988, and total assets reached almost DM 134 million in some 63,000 employee-held portfolios.

Apart from traditional welfare services, new social policies are gaining importance at Bayer. One of these new programs is entitled "family and job," which is based on the company-wide agreement concluded in April 1987. This program allows either fathers or mothers to stop work for a given period—normally three years—to look after the family. As long as the person does not accept any paid employment during this time, and he or she takes advantage of the recommended courses to maintain the professional qualifications, Bayer pledges to rehire the parent in question and to provide a job in line with his or her qualifications.

The examples given from the company's programs for pensions, housing, capital formation and overall social services show how much attention Bayer pays to the needs and problems of its employees, even at a time of the so-called "cradle-to-grave" government welfare system. The more welfare-oriented system of the company's early history is now being replaced to an increasing extent by services and programs to supplement other benefits already available to the individual. For example, in-house social services today include attempts to help solve the personal problems of the employee—from alcohol abuse and handling stress to dealing with worries arising from the introduction of new workplace technologies. Every employee can take advantage of this service on a voluntary and confidential basis. The main focus is to help the employees help themselves and thus to promote their own feeling of responsibility.

Bayer chronicle 1983

Mycospor is introduced to the market. This new broad-spectrum fungicide combines the advantages of very easy application with lasting effects and a reduction of the length of therapy.

Bayer researchers succeed in synthesizing compounds analogous to the natural vegetable insecticide pyrethrum. Two synthetic pyrethroids are introduced: Baythroid as an insecticide for crop protection and Bayticol against ticks for the animal health program.

Philips starts producing compact discs made from Bayer's Makrolon polycarbonate.

The U.S. subsidiary Cutter Laboratories is merged into the Miles organization.

Bayer acquires the German company Faserwerke Lingen GmbH, a producer of acrylic fibers.

Bayer completely ceases production of polychlorinated biphenyl (PCB).

At an international trade fair for large-scale photographic laboratories in Birmingham, England, Agfa-Gevaert introduces its multi-scanning printer, which is able to develop 18,000 pictures per hour. During the process of developing films, each single negative is analyzed so that mistakes in exposure and color variations can be corrected, and blurred negatives are rejected.

World events 1983

On April 28, the German magazine "Stern" begins publication of what are claimed to have been Hitler's diaries. The "Stern" has paid DM 9.3 million for what turns out to be a forgery.

Soviet fighters shoot down a Korean airliner over the island of Sakhalin, which results in the death of all 269 passengers. The plane had been flying some 370 miles off-course on a journey from Anchorage to Seoul.

Protests against the stationing of U.S. nuclear missiles in Europe reach their peak. A total of 1.3 million people take part in demonstrations in the Federal Republic. Elsewhere in Europe, 500,000 take to the streets in Rome, 250,000 in London and 200,000 in Brussels. On November 22, the Parliament of the Federal Republic of Germany approves the installation of the missiles.

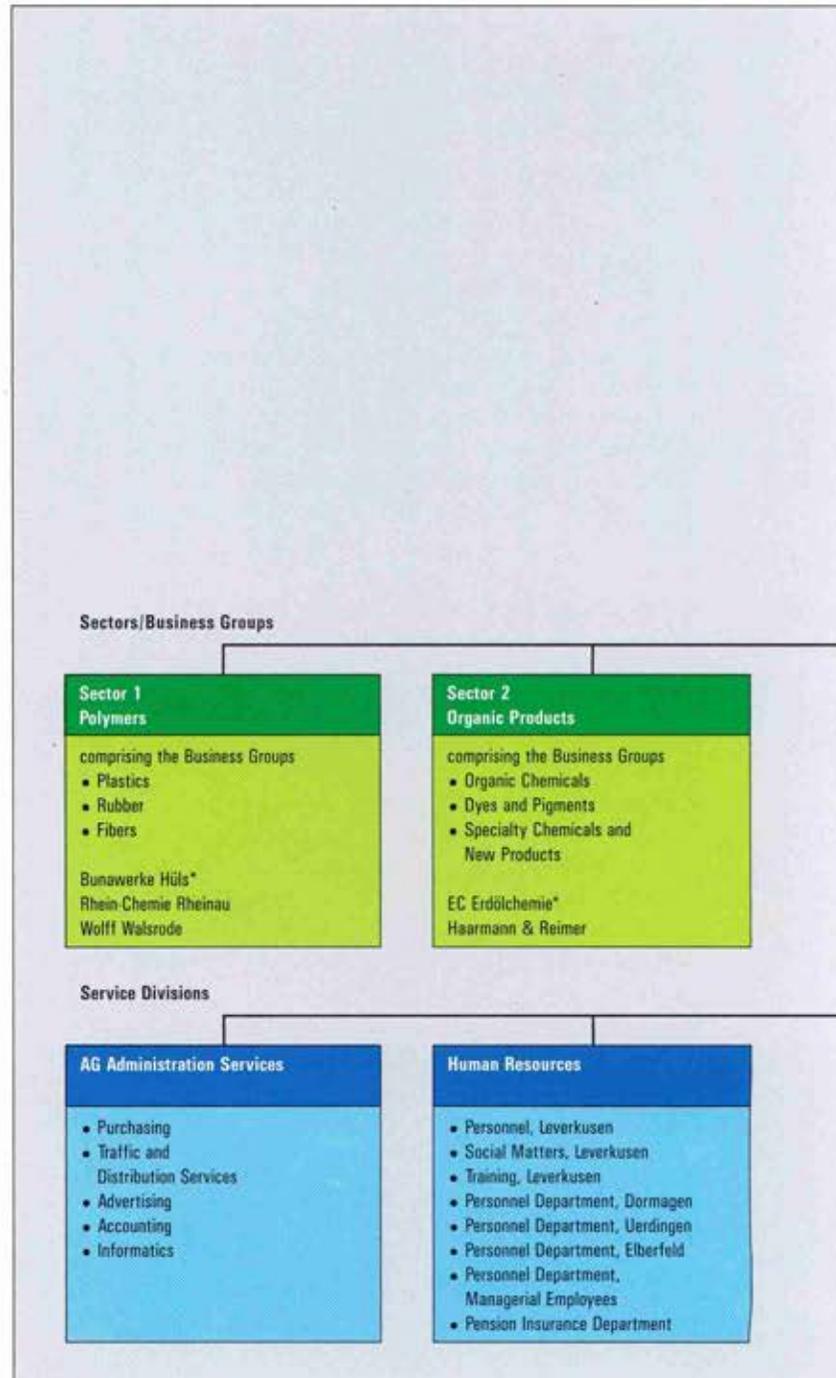
Polish union leader Lech Walesa is awarded the Nobel Peace Prize on December 10.

On June 9, the Conservative Party under Margaret Thatcher wins the general election in the United Kingdom.

On October 25, the United States intervenes on the Caribbean island of Grenada in order to reestablish the democratic government.

Corporate structure of the company

An efficient organizational structure is of utmost importance in order to be able to manage and control a large international company. Unfortunately, there is no magic formula that provides the "right" organization for all times. Structures have to be reviewed and revised on a regular basis.



After the reorganizations of 1912 and 1971, a further restructuring based on experience gained in the seventies and early eighties became necessary in 1984. The above diagram, valid as of February 1, 1989, shows the new distribution of responsibilities.

Board of Management

Corporate Staff Division

- Corporate Planning
- Corporate Finance
- Regional Coordination and Controlling
- Law, Patents and Insurance
- Corporate Auditing
- Public Relations
- Management Development and International Personnel Coordination

**Sector 3
Industrial Products**

comprising the Business Groups

- Inorganic Chemicals
- Pigments and Ceramics
- Polyurethanes
- Coating Raw Materials and Specialty Products

H.C. Starck

**Sector 4
Health Care**

comprising the Business Groups

- Ethical Products
- Self-Medication
- Diagnostics**
- Biotechnology Products**

**Sector 5
Agrochemicals**

comprising the Business Groups

- Crop Protection
- Consumer Products
- Animal Health

**Sector 6
Information Technologies**

Agfa-Gevaert Group
comprising the Business Groups

- Amateur Products
- Technical Products

Plant Administrations, Environmental Protection and Occupational Safety

- Plant Administration, Leverkusen
- Plant Administration, Dormagen
- Plant Administration, Uerdingen
- Plant Administration, Eiberfeld
- Plant Administration, Brunsbüttel

Central Research and Development

- Chemical Research
- Technical Development and Applied Physics
- Research and Development Services

Central Engineering

- Project Engineering
- Plant Safety and Technical Inspection
- Utilities
- Process Control Systems
- Central Workshops

* Bayer's interest: 50%
**headquartered at Miles Inc., U.S.A.

Hermann J. Strenger

Chairman of the Board of Management since 1984

On June 27, 1984, Hermann J. Strenger succeeded Professor Herbert Grunewald as Chairman of Bayer AG's Board of Management. More than a hundred years after Friedrich Bayer and Carl Rumpff, the company once again had a commercial man at its helm.

Hermann J. Strenger was born in Cologne on September 26, 1928. After leaving high school, he joined Farbenfabriken Bayer as a commercial apprentice on April 1, 1949. He worked in various sales departments involved in the chemicals business after completing his professional training. In 1954, he was transferred to São Paulo, the center of Brazilian industry, where Bayer was still in a pioneering stage. He returned to Leverkusen in 1957 and after further training in plastics and tanning agents, he was put in charge of the marketing of these products in Sweden in mid 1958. When he returned to Germany, he became head of the Sales Department for Coating Raw Materials. Two years later, the 34-year-old became Bayer's youngest "Prokurist" (a German title representing a middle management position), before moving on to head the Polyurethanes Department in 1965. He was promoted to departmental director in 1969.

From 1970 until he joined the Board of Management on January 1, 1972, Strenger was Commercial Director of the Polyurethanes Division. His career on the board started as spokesman for

the Polyurethanes and Dye-stuffs Divisions, for purchasing and for the Latin American region. He subsequently took over responsibility for Agrochemicals and Western Europe, and headed the Regional Conference. For six years before taking over as Chairman of the Board, he was Vice-Chairman and chaired the Central Committee for Sales.

At the 1988 shareholders' meeting, Strenger was able to



Hermann J. Strenger

report on the fifth successive year of gratifying business results. This continuing success encouraged the board to launch new strategies for the future under his leadership. Research activities were further expanded and concentrated on important fields of innovation. Major priorities are the development of new high-performance polymers, engineering ceramics, active agents for crop protection and new types of principles

in pharmaceutical therapy. R&D activities were also made more of an international effort with the opening of the pharmaceutical research center at West Haven, Connecticut, and the agrochemicals research facility in Yuki, Japan.

Bayer also supplemented existing businesses with a policy of carefully selected acquisitions. An example of this strategic diversification was the takeover of Hermann

structure was substantially improved; in five years, the equity ratio was increased from 26.6 percent in 1982 to over 43 percent in 1987. Over the same period, debt was reduced from DM 13.5 billion to DM 5.2 billion; net indebtedness even dropped to about DM 100 million.

These positive developments formed the basis for further expansion of capacities at home and abroad and a progressive program of environmental protection and safety measures. Strenger explained the corporate philosophy behind all this at a media forum on Bayer's ecological policy in Cologne in 1987:

"It is our belief that a company can only survive today and in the future if it gives equal priority to the goals of high product quality and optimum profitability on the one hand, and environmental protection and safety on the other."

This statement is the essence of the principles laid down by the company in the form of mandatory "Policy guidelines for environmental protection and safety," which were distributed in 1986.

Bayer enjoys a worldwide reputation thanks to its technological strength and business performance. Hermann J. Strenger has taken up the entrepreneurial challenge to consolidate and expand this position by innovative action. For him, this task includes the commitment to openness and communication, which are absolutely essential to gain the public acceptance that every company needs if it is to remain successful.



Bayer's structure was reorganized for the first time in 1912. The divisional structure was introduced in 1971; details of this organizational form are described in a previous chapter. The organization that became effective in 1984 reflected the changes within the company and in the business environment of the seventies and the early eighties.

In the 1970s, Bayer had further expanded its activities in foreign markets, and the company had grown enormously. It was felt that planning for the future of the company against the background of increasingly complex international competition should be in the hands of a Board of Management that is relieved of sectorial responsibilities.

Bayer basically retained the principle of divisional structure. Management of the business was made the responsibility of 25 Business Groups, which are integrated into six Sectors of approximately the same size. The Sectors act as a link between the Board of Management and the Business Groups.

The Corporate Staff Division assumes management functions for the whole Group and thus acts as a kind of general staff for the board. In 1988, this division consisted of Corporate Planning; Corporate Finance; Regional Coordination and Controlling; Law, Patents and Insurance; Corporate Auditing; Management Development and International Personnel Coordination; and Public Relations.

Bayer AG, the parent company, has five Service Divisions. These are as follows: AG Administration Services; Human Resources; Plant Administrations, Environmental Protection and Occupational Safety; Central Research and Development; and Central Engineering.

Important duties of the Board of Management are reflected in its Committees, whose main functions involve counseling and preparatory work for decision making. Three members of the Board of Management belong to each of the following seven Committees: Corporate Coordination, Finance, Research and Development, Environmental Protection and Occupational Safety, Logistics and Services, Personnel, and Investment and Technology.

Over and above these responsibilities, each member of the Board of Management acts as a spokesman for one of the Group's main market regions. They are: Western Europe, North America, Latin America, Eastern Europe and other state-trading countries, as well as the Middle and Far East and Africa.

Since its introduction only a few years ago, this new organization has proved its worth as an aid to management. It is structured to allow adaptation to new demands, and the organization also fulfills its purpose as an instrument in the hands of those people who shape the future of the company.

The Board of Management of Bayer AG before the shareholders' meeting of June 1988: from left to right: Hermann Wunderlich, Helmut Loehr, Vice-Chairman Gerhard Fritz, Chairman Hermann J. Strenger, Ernst-Heinrich Rohe, Karl Heinz Büchel, Helmut Piechota, Manfred Schneider, Eberhard Weise.

Product ranges geared to the needs of the consumer

Bayer's Consumer Products Group was set up in 1984. Two years later, the original Business Group was expanded to take in a wide range of finished products for the end-user.

The sales program of the new Business Group ranges from cosmetics, sun cream, calorie-free sweeteners and diet foods to household cleaners and pesticides. What is now a broad-based consumer products organization began with Drugofa.

When his Himalayan expedition scaled the peak of the Lhotse in 1977, Gerhard Schmatz became the first person to reach an altitude of over 8,500 meters (about 27,900 feet) without an oxygen mask. The entire party, Germans and Sherpas, came back without sunburns. They had used "delial" with a protection factor of 10 to ward off the dangerous rays. "delial" is a Bayer product that is marketed by Drugofa in Germany.

Drugofa stands for "Drugs of America." This sales organization had been established in Berlin by I.G. Farben in 1933 to market popular consumer goods from the United States in Germany. But the political situation made it difficult for Drugofa to achieve the success that was hoped for. The only American product in its program to establish a name for itself was Kolynos, the first toothpaste that foamed.

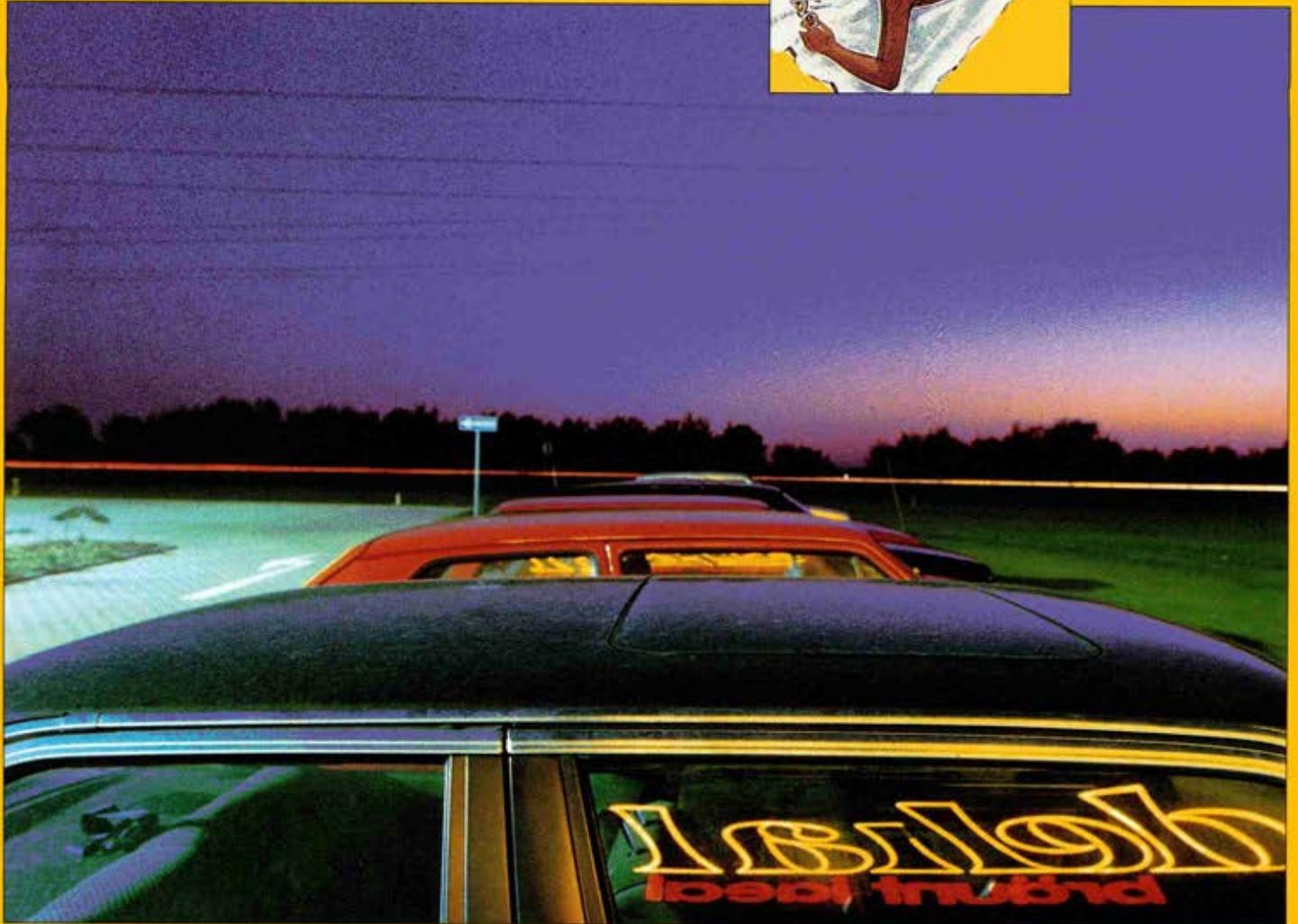
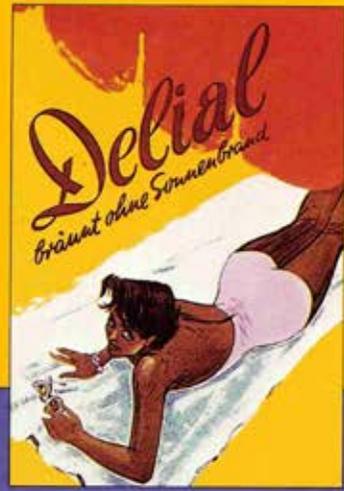
The other articles were all made by I.G. Farben itself: Ortizon breath-freshening lozenges, Coryfin cough drops, the first sun cream containing a filter, "delial," the lighter fluid Bonalin, the adhesive Cohesan and the moth repellent in detergent form Movin. With this broad assortment, which was distributed in both drugstores and pharmacies, Drugofa reached annual sales of 2.3 million Reichsmark by 1942.

The end of the first chapter of the company's history came with the destruction of its headquarters on Berlin's famous avenue, Kurfürstendamm. What was left over of the operations was moved to an old mill in the Eifel hills and then later to an inn in the southern German town of Memmingen. The warehouse was transferred to Diemitz near Halle, where it was subsequently confiscated by Soviet occupation troops.

On April 21, 1951, the British Controller informed Ulrich Haberland, then Chairman of Bayer's Board of Management, that Drugofa would not be liquidated.

The "delial" range of sun lotions are products developed by Bayer and distributed by Drugofa. The name of this marketing operation is, in fact, an acronym of "Drugs of America." The organization was first set up in Berlin in 1933 to distribute popular consumer goods made

in the United States. The company was acquired by Bayer in 1951.



Central Committee Marketing

Thousands of Bayer sales staff serve almost every country in the world. Working as specialists in their own markets, they are the men and women who are sent to the front lines. They know their customers inside and out, as well as all the local details on prices, costs, currency exchange rates, customs regulations, modes of payment and everything else which could affect business. They work in close cooperation with the individual Business Groups for what they see as "their countries" and "their products."

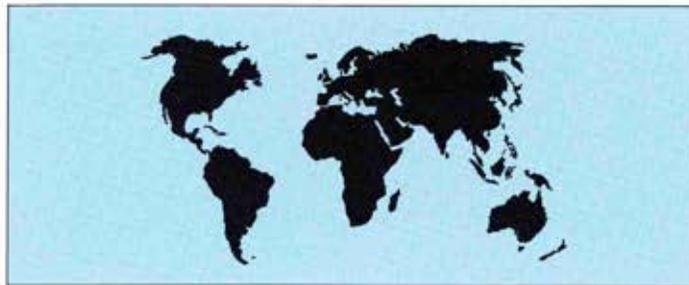
The parent company naturally has to be able to rely on the ability and know-how of the marketing specialists in the field; sales activities cannot be steered from some distant headquarters without the necessary help of the on-the-spot support system.

On the other hand, it is often necessary to coordinate the interests of the Bayer Group as a whole, which may entail more than just putting all of the separate activities together. Systematic cooperation, the exchange of knowledge and experience, and the dissemination of information over and above day-to-day business details are important factors in making such a highly diversified corporation as Bayer an international success.

In its Central Committee (CC) Marketing, management is able to present the overall view of the Group's situation to the top sales executives

of the individual Business Groups; these managers for their part pass on information based on experience from their market. Basic problems of the world economy and economic policy belong to the agenda just as much as current business results, market developments and questions dealing with the organization.

In 1949, management decided to create an instrument that would be concerned with sales representation at home and in foreign countries,



CC Marketing's responsibilities cover Bayer's worldwide operations.

as well as topics affecting sales of more than just one individual product group.

Even though nobody could have guessed back then how substantial international business would become in the following years, the company felt the need to form a permanent conference of top sales personnel against the background of the postwar growth in domestic business and the gradual return to world markets. Consequently, the Central Commercial Office (KZB) was created, and executives were called to the

first meeting in February 1950.

Although a small unit to start with, the Central Commercial Office grew with the company as a whole. On February 16, 1950, it had eight members; today, it has more than 30.

In 1950, sales totaled about DM 500 million. When the Central Commercial Office became the CC Marketing as part of the corporate restructuring in 1971, sales had reached DM 11 billion, and in 1987, the Bayer Group

improving the coordination of its new subsidiaries and affiliated companies and at combining the often numerous operations of its various subsidiaries in the individual countries into an effective corporate organization.

The oil crises of the 1970s forced industry worldwide to undertake radical adjustments in structure and production. The era of rapid growth seemed to have come to an end. As growth rates fell, the marketing organization was restructured and consolidated.

Another new development arose in the seventies and has picked up speed in more recent years. The company was suddenly confronted with new technologies affecting marketing logistics and its organization. Computerization and faster communication channels permit not only a better and prompter flow of information, but also a concentrated organization of domestic and foreign inventory systems. This new situation has consequently led to savings and made local sales organizations able to supply customers in their markets more quickly and with more flexibility.

As a supplement to the Business Groups, which bear worldwide responsibility for their business, the CC Marketing discusses and coordinates measures where joint action promises better results for the firm as a whole. Consequently, this committee plays a key role in Bayer's international sales network.

recorded sales of DM 37.1 billion.

In the fifties, the Central Commercial Office had primarily been concerned with problems of reconstruction. The foreign marketing system had to be reestablished, staff had to be hired and trained and new agencies had to be set up. Foreign currency was still scarce at first and financing problems were a common headache.

Bayer concentrated its efforts on becoming an international concern in the 1960s. The company also worked at

If Bayer were willing to assume responsibility for all outstanding liabilities, it could take over the company as a sales organization. The new Drugofa thus became a 100-percent subsidiary of Bayer. Hans Hebgen, who had started his career at Bayer in 1933 as an apprentice in the Sales Department for pharmaceuticals, became head of the firm, a position which he held until his retirement in 1978.

The first move was to relocate Drugofa's headquarters to Cologne, where the company resumed its activities on May 1, 1951. The sales program included the earlier brands Coryfin, delial and Ortizon, as well as newer products from Bayer's pharmaceutical operations, such as an artificial sweetener and the Sionon sugar-substitute for diabetics.

Production of sweeteners had been launched in 1945 on the recommendation of Walter Hochapfel, Chairman of the Works Council. He reasoned that they would be a good way of giving employees a "fringe benefit" in the era of the so-called "sweetener currency." They were soon selling very well, particularly to the soft drink industry. Since all transactions were carried out in cash, the sweetener helped Bayer's liquid reserves situation in the first months following the currency reform.

In the years to come, a wide range of consumer products were added to Drugofa's assortment.

In the artificial sweetener program, "natreen" was introduced in 1963, further Sionon products for diabetics in 1964 and the fructose product Fructusan in 1967. Autan insect repellent and the effervescent analgesic Sinpro were put on the market in 1958. In 1961, the multivitamin candies Panvitan were introduced, and the self-tanning lotion Maxibraun in 1971. Three years later, the

"natreen" is another Bayer product marketed by Drugofa. The Drugofa product range also includes such well-known brands as Quenty and Baygon. The sales organization forms part of the Consumer Products Business Group.

Quenty cosmetic line came on to the market. The once-modest Drugofa had become an impressive organization. Sales skyrocketed from DM 2.5 million in 1951 to DM 275 million by 1980; alone DM 125 million were achieved by foreign sales.

Up until the mid seventies, the Drugofa range had gradually expanded without any apparent need for an organizational adjustment to adapt to the over-all Bayer corporate structure. This situation changed with the acquisitions of the American companies Miles and Cutter in the 1970s resulting in the gain of a considerable number of new consumer specialties. The logical consequence of these new circumstances was the creation of a Consumer Products Group.

At the beginning of 1986, Bayer management decided to consolidate all of its products sold to end-users into one major Business Group. On July 1 of that year, the existing Consumer Products Group and the former Household Products Unit, with its domestic pesticides, were merged to form today's CP or Consumer Products Business Group.

A major portion of the products sold by the chemical industry leaves the production facilities in drums, tank wagons or containers. It is then the customer industries which subsequently process these materials into products that the consumer

would recognize. This is true for the greater part of Bayer's sales program, but the products of the CP Group are directed toward the end-user. With its wide assortment of well-known brand names, such as delial, Quenty, natreen and Baygon, today's Consumer Products Business Group is an important element of the company's diversified international activities.



Biotechnology enters a new era with genetic engineering

Genetic engineering permits targeted modifications of the genetic information in living cells. With this technology, new possibilities have been opened up for the chemical industry, and more specifically for the development of pharmaceuticals. Bayer began forming research teams to study this field back in the mid 1970s.

The basic substance of all life is deoxyribonucleic acid or, as it is commonly known, DNA. Deoxyribonucleic acid was first discovered as long ago as 1869, but it took 75 years before Oswald T. Avery and his research assistants at New York's Rockefeller University identified DNA as the carrier of genetic information in 1944. Nine years later, in 1953, James D. Watson and Francis H.C. Crick deciphered the actual structure of DNA. They discovered that it consists of a complex, threadlike molecule composed of two strands that are twisted into a coil, forming a double helix. Each of the single parallel strands is made up of four different components, the deoxyribonucleotides. They form, as it were, letters of a simple alphabet. Their varying succession in the DNA determines the specific information content of a gene.

For the discovery of the double helix structure of the DNA molecule and the relationship of the twin strands, Watson, Crick and Maurice H.F. Wilkins were awarded the Nobel Prize in 1962. Shortly afterwards, the genetic code was deciphered, which permitted an insight into the biosynthesis mechanism of proteins.

DNA's "four-letter-alphabet" applies in the same way to the *Escherichia coli* bacterium as it does to soybeans or humans. The difference is only of a quantitative nature; a microorganism requires far fewer "instructions" for its existence and reproduction than a multicelled organism such as a large mammal or a human being. The amount of information contained in a human genome, the total of all genes of an individual, is absolutely enormous. If the genome of a bacterial cell is imagined as a thousand-page book, a human genome would be comparable to a library of a thousand such books.

The molecular biological principles of genetics, in other words of heredity, are relatively simple. Human characteristics are programmed onto the DNA double helix in the chromosomes. In some elementary cases, a lot of this information can be "read" today. But the question of whether someone will have blue or gray eyes, blonde or black hair, white or yellow skin, or be ambitious or phlegmatic

Deoxyribonucleic acid, better known simply as DNA, is the basic component of all life. It takes the form of a double helix and contains all of the genetic information. Each of the spiral strands is made up of only four different building blocks, and their varying sequence in the

DNA chain determines the kind of organism involved. Exact information on the detailed structure of DNA is naturally of prime importance for genetic engineering.

is extremely complex, and scientists are far from understanding the corresponding genetic code down to the last detail.

A single "printing error" at a decisive point in the DNA can lead to serious hereditary diseases or, under certain circumstances, early death. The chance that genetic errors of this kind can be determined in time is an important prerequisite for possible treatment.

Another promising application of this new know-how was soon recognized in the field of biotechnology. A large number of very interesting active protein substances can only be obtained with great difficulty and in small quantities from natural material such as, for example, animal organs or human blood plasma. If a "production instruction" for an agent of this kind—human insulin, for example—can be introduced into the genetic program of a simple and uncomplicated bacterium or fungus, scientists reckon that it may be feasible to produce such valuable substances economically and in any quantity desired.

Intensive, time-consuming and expensive research work all over the world in this field has demonstrated that it is far more easily said than done. Scientists have known since 1973, however, that it is possible in principle. In that year, researchers at Stanford University in California reported the first successful construction of a recombinant plasmid with the help of a restriction enzyme and DNA ligase. It was also possible to implant this recombinant plasmid in a host bacterium.

This process, which has since been repeated in the most varied fields and with all kinds of modifications, has come to be known as genetic engineering. The methodology is not identical with biotechnology, though the latter could be significantly expanded with the aid of genetic engineering techniques. Initial successes have already demonstrated that this is possible.

One of the first problems to be solved with the help of genetic engineering was the production of human insulin using bacteria or yeast. Diabetics, who depend on regular doses of



DNA, RNA, plasmids and genetic engineering

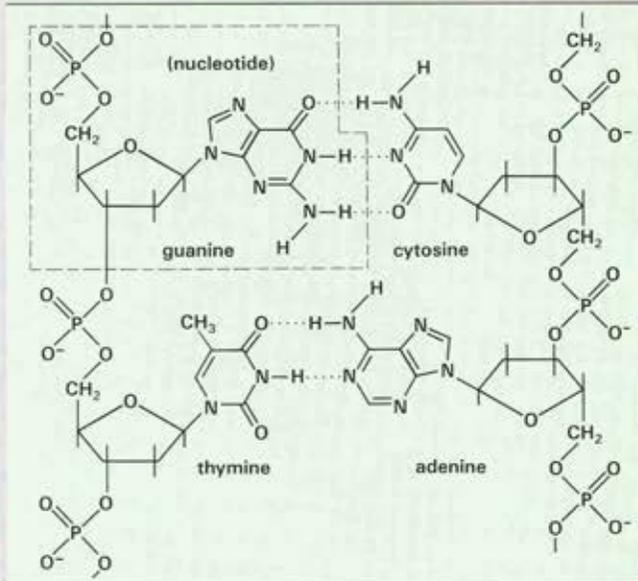
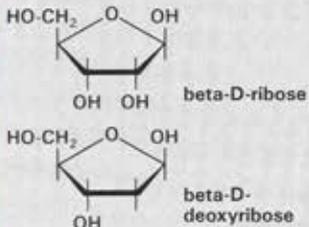
The basis of modern molecular biology and genetic engineering is deoxyribonucleic acid (DNA). It is the essential constituent of the nucleus of a cell and the carrier of hereditary information. DNA is itself based on three components:

- deoxyribose, a pentose (sugar with five C atoms) bearing one hydroxyl group fewer than ribose

— the four nucleobases on which DNA's biological func-

tion depends. They are the heterocyclic compounds adenine (A), thymine (T), guanine (G) and cytosine (C) — and the phosphate group.

All three components are linked to the nucleotides, as shown in the diagram below. Many thousands of these nucleotides in the DNA are linked by the phosphate group and the deoxyribose to form a very long chain, whereby the bases are situated laterally. This chain is paired with a second chain to form a double helix, which stems from the Greek word for "spiral." The second chain is not identical to the first, but instead has a relationship to it similar to that of a negative to a positive. The bases of both chains face toward the inside.

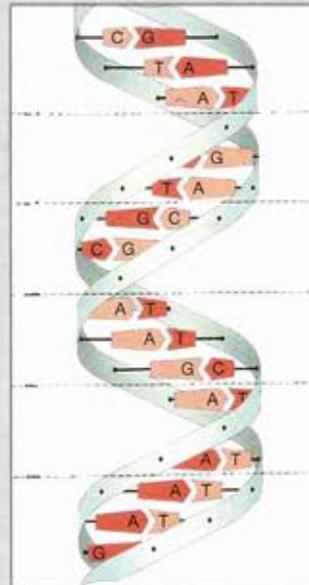


Adenine and thymine, and guanine and cytosine are always paired to one another, whereby their positions are stabilized by hydrogen bridge bonds. The diagrams below demonstrate this relationship in a formula (left) and in an illustration in perspective (right).

To make use of the information contained in the genetic code for the production of proteins, the double helix has to be opened up. When the strands separate, the free bases of one of the strands, the so-called "codogenes," indicate the type and sequence of the alpha-amino acids for one of the many proteins that are needed by the organism. A sort of "dictionary" exists for the 20 different amino acids on which the protein

substances are based, whereby every three nucleotides form a triplet that represents the code for a particular amino acid. DNA is itself not a "working copy"; its instructions are followed only after they have been copied. This process is called transcription, and it leads to the formation of the corresponding ribonucleic acid (RNA) as a single-strand chain, which contains ribose instead of deoxyribose and in which uracil (U) replaces thymine, whereby uracil lacks the latter's methyl group.

The RNA detaches itself from the DNA, leaves the nucleus and settles on the ribosomes present in the cytoplasm; these are tiny bodies which can hardly be detected under the microscope. It is here that the protein synthesis takes place. Since the RNA acts as a messenger between the "archives" of DNA information and the "factory" of the ribosomes, they are also known as messenger RNA, or mRNA for short. In their base sequence, every three adjacent bases create a codon for a specific amino acid. The whole of the codon for the protein to be formed is known as a structural gene. Signal sequences occurring in front of and behind this gene permit the biosynthesis system to "know" with which amino acids the polypeptide chain should start and end.



(continued on page 572)

this vital substance, have hitherto relied on products gained from the bovine or porcine pancreas. This substance is very similar to the insulin that humans normally produce themselves, but slight differences of structure can lead to immunological defense reactions in some patients.

After genetically engineered insulin production succeeded in the United States, it became possible to manufacture large quantities of insulin which is absolutely identical to that produced in the human body and from which a maximum of tolerability can be expected.

In addition to human insulin, human growth hormones produced by genetic engineering methods are now available on the market. They were formerly obtained from the pituitary glands of corpses, which meant that supplies were limited and product quality could not be guaranteed.

With the help of yeast, a vaccine has been developed by means of genetic engineering which is used in the fight against hepatitis B, better known as jaundice. In addition, genetic engineering can be used to produce the human tissue plasminogen activator (TPA), which, among other things, helps to dissolve blood clots in the case of cardiac infarction.

At first, great hopes were placed in interferon therapy against viral diseases or cancer. These expectations have, however, not yet been fulfilled. Up until now, interferons have only been put to therapeutic use in the case of a few special forms of viral infections and cancer.

With the help of genetic engineering methods, it was indeed possible to identify the HIV virus that causes the acquired immune deficiency syndrome AIDS and to determine how this virus works. This technology will most certainly also play an important role in the development of a therapy for the treatment of AIDS.

As the example of AIDS shows, it is impossible to exaggerate the importance of genetic engineering for basic medical research. The knowledge gained by this technology can be expected to provide a

completely new basis for the development of pharmaceuticals. Potential applications in the field of agricultural chemicals and crop protection products have already been mentioned in the chapter describing the research activities in Monheim. In the long term, other sectors of the chemical industry and certainly environmental protection techniques can expect help from these processes.

In the United States, where genetic engineering research is most highly developed, the trend observed in the second half of the 1970s was typical of the American entrepreneurial spirit. By specializing in genetic engineering, companies, some of which had university professors among their founders, have been able to apply the results of molecular biological research in the search for marketable products and processes.

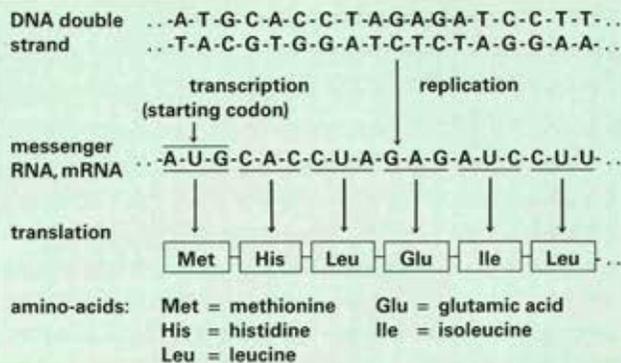
Today, there are over 300 such firms with a total of more than 15,000 employees. They finance their research with venture capital and by entering into contracts with partners in the industry. If taken altogether, they represent a considerable research potential, particularly because they frequently employ highly qualified experts and are capable of a great deal of flexibility.

The first company of this kind was Genentech Inc. of San Francisco, which was set up in 1976 and is still one of the biggest and most successful firms in this branch today. In 1982, the U.S. pharmaceutical company Eli Lilly introduced a human insulin product to the market that had been developed in cooperation with Genentech. Genentech also managed to produce a human growth hormone and human TPA by means of mammal-cell cultures.

In April 1984, scientists at Genentech succeeded in cloning and expressing the complete gene of the human blood coagulation Factor VIII in mammal cells; a few months later the Boston firm Genetics Institute was able to do the same thing. This process makes it possible to produce Factor VIII from a culture taken from the kidney cells of a hamster. The otherwise commonly used cells of such bacteria as *Escherichia coli* could not be employed in this case

Biotechnology is not the same thing as genetic engineering, although this is frequently assumed. Genetic engineering examines hereditary structures which can, for example, determine alterations in the outer form of a plant. Organisms that have been genetically engi-

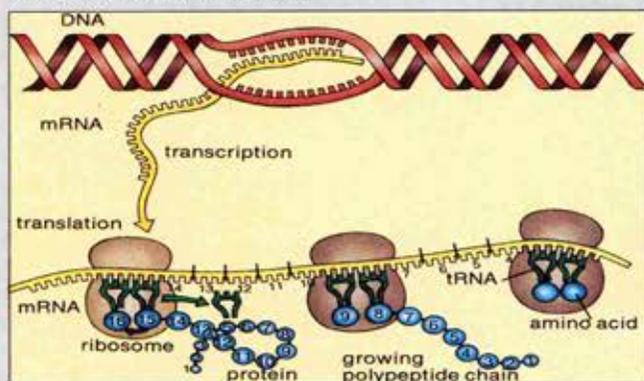
neered, such as bacteria, can be used in biotechnological processes for the production of substances which would otherwise be hard to obtain.



The example of leucine shown above demonstrates that the same amino acid can also be expressed by two different codons. Apart from the replacement of thymine by uracil, RNA is completely identical to the upper strand of the DNA chain. It has, however, resulted from base pairing on the exposed lower complementary strand. The mRNA alone is unable to bring about the protein synthesis on the ribosome; it needs the help of the much smaller transfer RNA (tRNA)

molecules. Each of them is specific for one of the 20 possible amino acids. In a manner of speaking, they "pass on" the acids to the ribosome as the actual center of protein synthesis.

When the cell divides, the DNA has to duplicate itself. For this to happen, the DNA splits itself from one end down to the other like a zipper opening up. The corresponding complementary strands then polymerize onto the two free base chains.

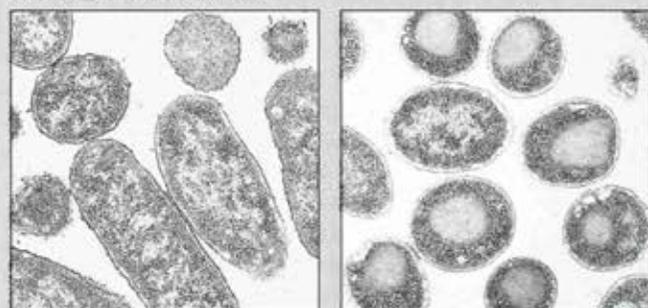


The principle of genetic technology is best illustrated by the plasmids. They are found, together with the very long DNA chain, in a large number of lower bacteria such as *Escherichia coli* K 12. These bacteria belong to an easily obtainable, unobjectionable strain, which poses no handling problems. Plasmids are relatively short DNA strands which often feature very interesting properties; for instance, the resistance to a particular antibiotic.

Using what have today become classic biotechnological methods, the plasmids can be produced from the bacteria. When suitable enzymes, the restriction endonucleases, are added, these DNA rings can be opened at certain points. A synthetic gene or DNA fragments which are extracted from the genome of a different organism with the aid of the same enzyme are then applied. A corresponding ligase, an enzyme able to connect DNA strands at certain points, allows the

reformation of closed plasmid rings. At least in a majority of the statistically possible combinations, the new gene or the foreign DNA fragment will be integrated into the *Escherichia coli* plasmid.

There are a number of successful microscopic methods with whose help the new "recombinant" plasmids can be reintroduced to the cells of *coli* bacteria. These plasmids bring with them the new property, can reproduce under suitable conditions and produce the protein whose genetic data have been introduced. The illustration below shows that the creation of the desired substance within the bacterial cell can be observed with the help of an electron microscope.



Coli bacteria before and after genetic manipulation. The light-gray patches in the right-hand picture are concentrations of the newly produced protein.



because they are unable to produce glycoproteins like Factor VIII or TPA.

Genentech is located only a half-an-hour drive from Miles' Berkeley plant. Miles—or rather Cutter Laboratories, which was incorporated into the Miles organization some years ago—has been manufacturing a Factor VIII product from human blood plasma for a long time.

The important blood coagulation function of Factor VIII is missing in a large group of hemophiliacs due to a genetic defect in their X chromosomes. This so-called hemophilia A is found almost exclusively in males; some 20,000 people suffer from this deficiency in the United States and about 6,000 in the Federal Republic. These patients are, in fact, dependent on Factor VIII products.

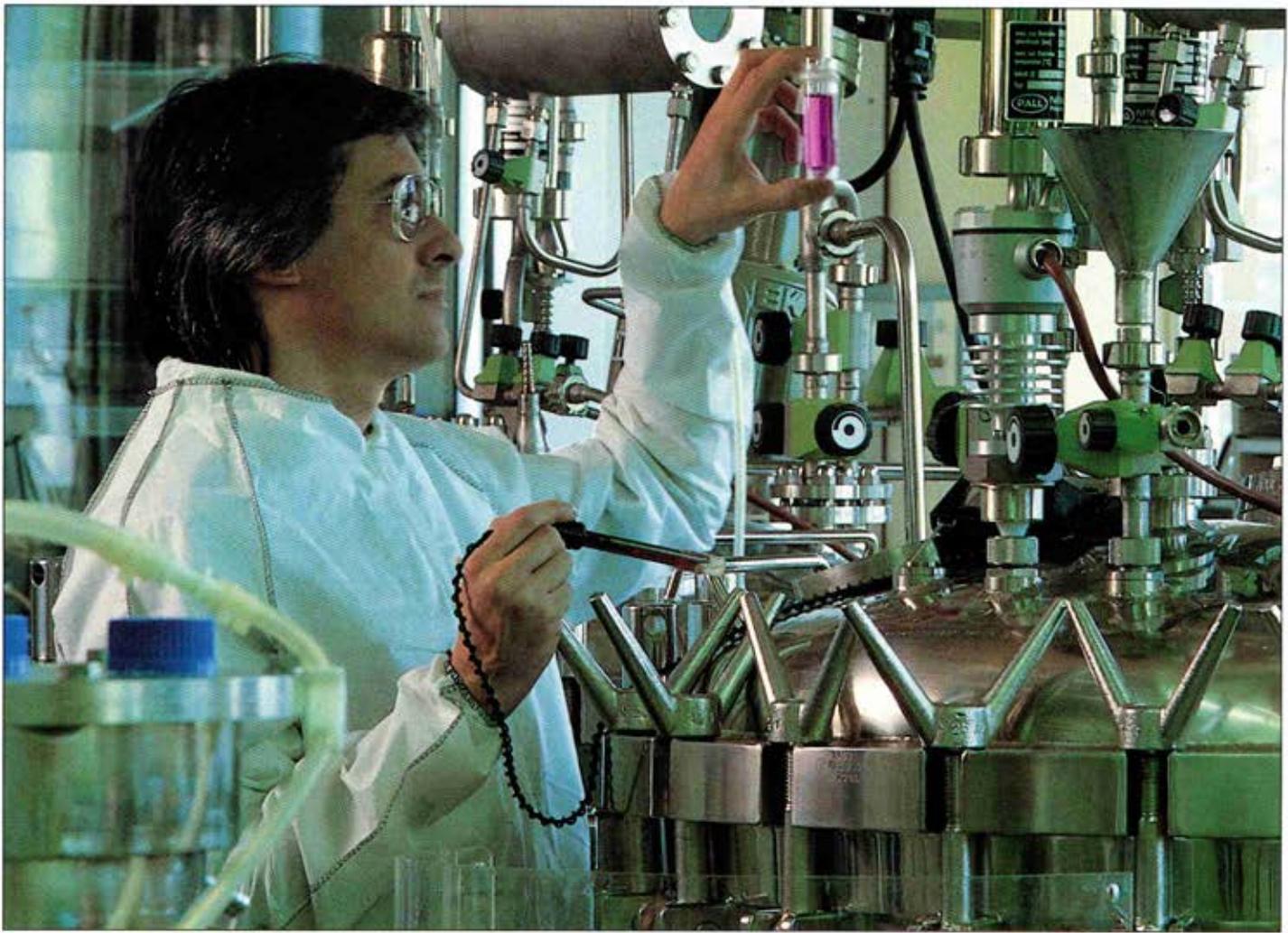
Bayer was extremely interested in a process that would make production possible without using human blood plasma. Working through Miles, the company bought the worldwide production and marketing rights to the Genentech process at the

end of 1984. Since then Bayer researchers at the company's laboratories in the United States and Germany have been working on the development of an industrial-scale production process. The main goals are to increase the as yet low yields and to obtain a high-purity product.

The American and German scientists are diligently trying to perfect an economically viable manufacturing process as soon as possible. The production of Factor VIII by genetic engineering methods would indeed go a long way toward making this important health care product safer and thus would contribute toward the effort to lengthen the life expectancy of hemophiliacs.

Bayer's activities in this promising field are not only concentrated on cooperations with specialized firms of this kind; the company is also working on genetic engineering research projects of its own. Corresponding plans were discussed during the second half of the 1970s in the pharmaceutical research center in Elberfeld, and the result was

The above picture demonstrates how, with the help of a micro-pipette thinner than a human hair, foreign genes are implanted into the nucleus of a cell. This photomicrograph shows how the DNA substance, colored yellow for better visibility, hits the nucleus exactly on target.



the establishment of a work group of experts to concentrate on genetic engineering and a second team to work on cell biology.

Another very important genetic engineering project that is now being handled by Bayer's scientists in Elberfeld is concerned with protein engineering in the field of protease inhibitors. Their work can be described in simplified terms as follows: an immense number of different enzymes in the human body are engaged in the various single steps of the metabolic functions, and each one of these substances is responsible for regulating a certain reaction in this complicated process. For example, there are enzymes for the degradation of proteins. These so-called proteases are in a dynamic equilibrium with other substances that inhibit their activity. In the case of shock, for instance after accidents or operations, certain proteases are released in large quantities so that the body's own inhibitors are not able to keep a sufficient balance in the degradation of proteins. Serious damage can result, which in some cases can even be fatal; for example, the so-called "shock lung"

is characterized by partial destruction of supporting tissue.

Even though it was actually developed for other forms of therapy, the Bayer product Aprotinin has subsequently proved to be a valuable aid for the treatment of shock. It is produced from bovine lungs as a relatively low-molecular protein composed of 58 amino acids whose constitution and sequence are known.

The hope that, with the help of genetic engineering, a drug could be developed that has the specific effect of supporting inhibitors in the case of shock arose from the following consideration: since the sequence of amino acids in Aprotinin has already been identified, the structure of a synthetic gene that would be able to trigger off the synthesis of this protein could be deduced. It is also known which parts of the molecule are responsible for the interaction of Aprotinin with certain proteases. Therefore, one should be able to test whether a particularly effective inhibition of those proteases which are responsible for such clinical conditions

Under carefully controlled conditions, bacterial strains are grown in a nutrient in fermenters to obtain the desired substances. The above picture shows the optical and technical determination of the pH value of a fermentation product.

as shock is possible by systematically modifying the corresponding amino acids.

Effective variants of this kind have already been produced because it is now possible to synthesize DNA segments and, as a result, genes themselves can also be formed. Researchers have succeeded in implanting this new gene for a modified form of Aprotinin into the existing genes of a microorganism, such as *Escherichia coli*, and thus a modified form of the drug could be extracted from the cultures of this genetically altered microorganism. There is, however, still a long way to go before this knowledge will lead to the development of an effective pharmaceutical for the treatment of shock.

The Elberfeld research teams have been cooperating closely with their American colleagues at Miles, who also participated in the investigations into the modification of Aprotinin. In another field of research there has been similarly fruitful cooperation with a group of cell biology experts from the Miles operation in Berkeley, California. They are working on the development of monoclonal antibodies for, among other things, the treatment of infectious diseases.

A further step taken by Bayer in the field of genetic engineering has been its participation in the founding of two joint venture companies in the United States: Molecular Diagnostics, Inc. and Molecular Therapeutics, Inc., both of which are located on the Miles Pharmaceuticals site in West Haven, Connecticut, on the coast between New York and Boston.

The Miles Pharmaceuticals facility in West Haven plays an important role in the development of a center for genetic engineering and molecular biological research. In January 1988, a new pharmaceuticals research unit was also opened there; the first phase of its construction cost the equivalent of some DM 100 million. A particular advantage of this specific location is the proximity of the Miles unit to Yale University in New Haven, which has a renowned research capacity in the field of molecular biology.

Thus, three research groups now form the core of activities in West Haven. In addition to the research-oriented firms specializing in genetic engineering already mentioned, a new group for the research of auto-immune diseases, which include inflammatory and rheumatic conditions, has also been established.

Yale University has played a key role in the evolution of this cooperation. Initially, three Yale professors had the idea of forming a diagnostics firm. Together with an entrepreneur, they founded Molecular Diagnostics in 1982 with the aim of harnessing new technologies for actual product development. After negotiations with Bayer, the company became a 60-percent subsidiary of the German concern in October 1982. Scientific projects are chosen by a so-called Scientific Policy Committee, which comprises the three professors, the entrepreneur and members of the management of Molecular Diagnostics itself, Miles and Bayer.

In the field of diabetes, scientists at Molecular Diagnostics are working on the development of a quick diagnostic test to measure blood sugar. Conventional methods of determining the blood sugar level give only a momentary picture as to the current status of the diabetic. Some years ago, however, it was already recognized that it would be preferable to aim for an "integrated" reading. In other words, if the glycolysis products of blood plasma proteins are determined, the value can provide information on the blood sugar level over the past month. This measurement is an important aid to therapy control.

Test methods currently available generally take over 24 hours to provide results and are technically very complicated to follow. Scientists at Molecular Diagnostics succeeded in using a highly specific monoclonal antibody against the glycolyzed hemoglobin to develop a test whose results are available within a few minutes.

The encouraging experience gained with Molecular Diagnostics led to the founding of a second genetic engineering company in West Haven in 1984: Molecular Therapeutics, Inc. But in this case, the firm is a fully owned Bayer subsidiary. On the basis of the

Biotechnology enters a new era with genetic engineering

know-how acquired by Molecular Diagnostics, the company's scientists intend to apply the newest scientific knowledge in the field of molecular biology to develop therapeutic techniques in medicine.

Biotechnology has definitely been given high priority at Bayer; the company is currently engaged in biotechnological research and development projects at nine different locations around the world. In 1985, more than DM 200 million was spent on this field of research and development; over DM 50 million was allotted to such new areas as genetic engineering and cell biology. All together, these expenditures account for about 10 percent of Bayer's total worldwide research spending. At the same time, the company employed more than 700 people in the field of biotechnology research, some 200 of whom were working in the Federal Republic itself.

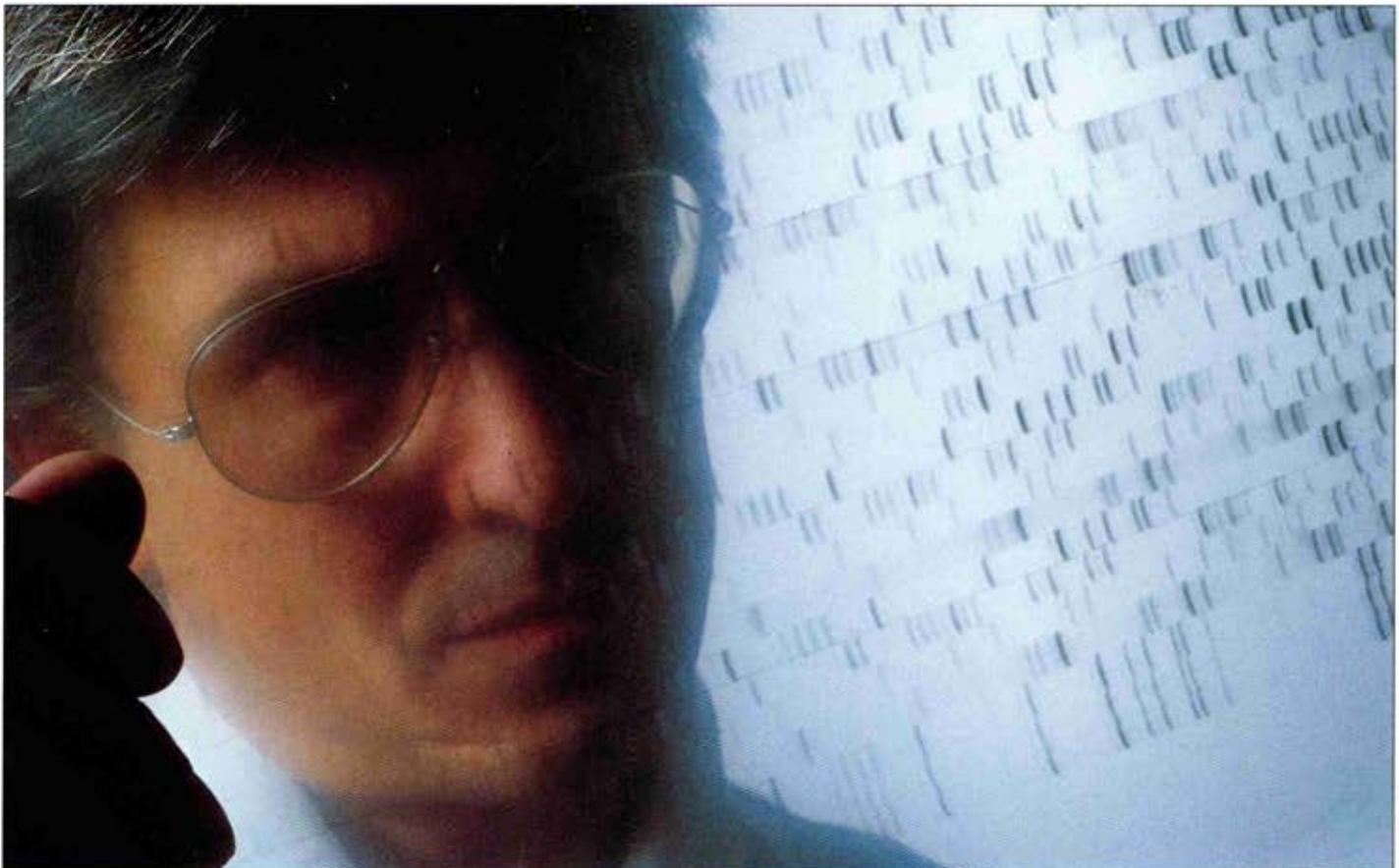
Genetic engineering methods are already used in many areas of biological and medical research. Today, tens of thousands of scientists at universities and colleges, in public and private research institutes and in industry are working worldwide on experiments to clone genes and to express them in corresponding host cells, and no one has been harmed

in the process. In the hands of experts and with proper safety precautions, genetic engineering is a safe technology.

Nevertheless, genetic engineering is viewed with many misgivings in the public. Horror stories are often conjured up and incalculable risks suspected. Most of these fears have proved to be totally without foundation after objective analysis.

Shortly after the first successful genetic modifications of bacteria, the scientists who were themselves involved demanded a critical review of potential dangers. In February 1975, some 140 scientists involved in the field of molecular biology and representing 17 countries met at the now historic Asilomar Conference in California. They strongly recommended that strict guidelines be introduced and that certain kinds of experiments be stopped altogether. The consensus was that not everything should be done that is possible with genetic engineering. In the meantime, most of the scientists who participated in the conference have admitted that the potential risks were vastly exaggerated in those days.

In a report commissioned by the German government on the potential problems of biotechnology, it is stated categorically that *"according to the infor-*



mation currently available, dangers exceeding those of the base organisms used have not become apparent in any laboratory in the world that is working with recombinant DNA."

As far as the Federal Republic of Germany is concerned, questions about supposed safety risks in the field of genetic engineering have been handled by the Central Commission for Biological Safety of the Federal Bureau of Health in Berlin since 1978, and corresponding guidelines have been issued to guard against "dangers from in vitro recombinant nucleic acid." By 1986, these guidelines on safety measures had been revised five times to meet the most advanced level of scientific standards, partly because new findings indicated that the safety precautions could be relaxed.

Like other companies of the chemical and pharmaceutical industry, Bayer has committed itself to respect and comply with these safety guidelines. Above and beyond this commitment, the company has spoken out clearly against experiments with human germ cells. Such experiments are irreconcilable with the principle of human dignity and therefore should be universally stopped.

Bayer chronicle 1984

Scientists at an international symposium in Munich confirm the effects of Bayer's new calcium antagonist, Nimotop, for the treatment of brain conditions and express the hope that this drug will lead to a reduction in the death rate in specific cases of brain damage.

Bayer introduces the anti-hypertension drug based on the substance nitrendipine.

Toyohashi distribution center is opened in Japan.

At the Hanover Fair, Bayer presents Levasint, a new product for surface coating treatment, and a special fluidized-bed coating process for its application.

After a two-year trial period, a new waste water oxidation plant goes into full operation in Leverkusen. The thousandth exhaust air purification unit is also installed in Leverkusen.

World events 1984

On February 7, American astronaut Bruce McCandless performs the first "space walk."

Labor unions in the Federal Republic of Germany call for the introduction of the 35-hour working week as a means to reduce unemployment.

Second Trans-Siberian Railroad (Baikal-Amur-Magistrale), which extends over 1,950 miles, is opened on October 29.

India's President Indira Gandhi is shot by two members of her personal body guard; both of them belong to the Sikh religious sect. The country's Sikh community of 12 million calls for political autonomy.

On November 6, Ronald Reagan is reelected president of the United States. With a share of 59 percent of the votes, he achieves the second-best result ever recorded after Richard Nixon, who received 62 percent of the votes in 1972.

Some 452 people are killed in a gas explosion in Mexico City on November 19.

Worst chemical disaster in history occurs in the Indian town of Bhopal. Over 2,000 people die when toxic methyl isocyanate gas escapes from a storage tank.

An autoradiogram enables researchers to determine the genetic structure of cells. The various radioactively tagged components appear as black bars of greater or lesser intensity on the film. No autoradiogram is like any other—unless the samples under

investigation are taken from the same sources, as for example from the same genetic substance.

Pharmaceutical research : the never-ending story

The cost of pharmaceutical research and development is second only to that of aerospace. But the effort will not be given up as long as there are still incurable diseases.

For Bayer, 1988 is not only the 125th anniversary of the company's founding but also the centennial of its "Pharmaceutical Department." It was in 1887 that Bayer chemists first developed the antipyretic Phenacetin from by-products of its dyestuffs production. Its introduction prompted the formation of the department. The subsequent years were marked with other milestones: Aspirin, Germanin, the various antimalarial remedies from Atebrin to Resochin, the sulfonamides, Neoteben, remedies for schistosomiasis, Canesten, Adalat, the acylureido penicillins and many more. And the list will certainly not end here.

It is a long road from the idea of a new drug to its registration and ultimate introduction to the market. A good example of this painstaking effort is the diabetes medicine Glucobay, which was first registered in Switzerland in 1986.

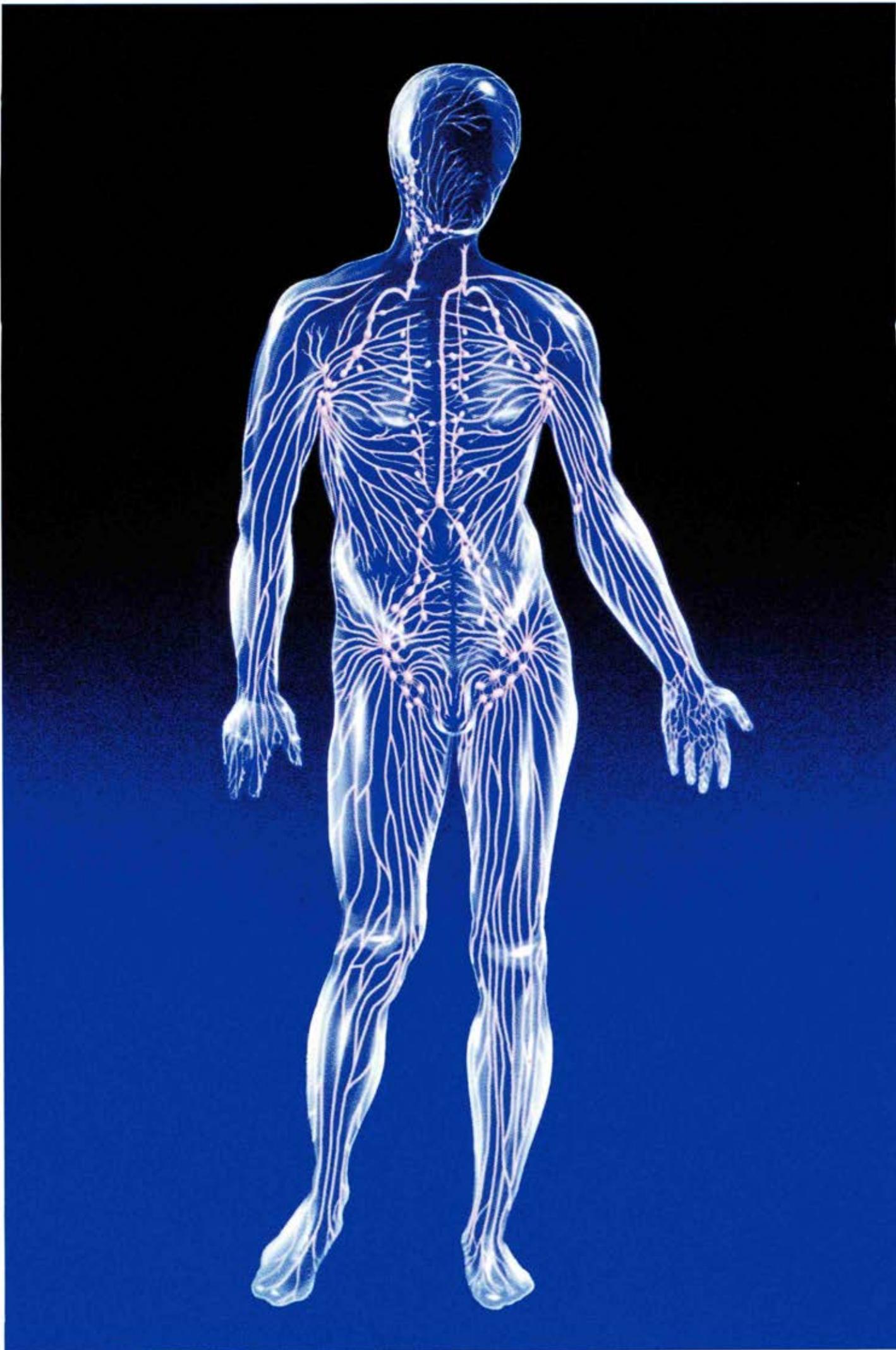
Metabolism experts at Bayer had been working on possible diabetes therapies since the mid sixties. Millions of people suffer from this disease, which is officially called diabetes mellitus and arises from a lack of the vital hormone insulin. Patients sometimes suffer from serious long-term complications as a result of this disease.

Insulin drugs from various manufacturers had already been on the market before the introduction of Glucobay. These products kept the blood-sugar level down as long as they were taken regularly and according to exact instructions—and the patient did not consume too many carbohydrates. This strict adherence to a low-carbohydrate diet cannot always be kept, however, and therein lies the risk for the patients.

Bayer researchers came to the conclusion that if it would be possible to slow down the assimilation of sugar into the blood, it would be a valuable supplement to diabetes therapy. This slowing down effect should take place before the introduction of insulin and should counter blood-sugar peaks in the patient's blood. The aim was to find a product that inhibits the absorption of sugar. In 1970, an active agent with this effect was found in the form of acarbose, a natural substance created by microorganisms.

The human organism is so complex that models can only attempt to illustrate it in highly simplified forms. For example, the model on the right shows the lymph system. The search for new and better medicines is the most cost-intensive field of research next to aerospace.

But no price can be put on health. The effort to discover new drugs and new forms of therapy must and will continue.



When the green light is given for work to begin on a promising project in pharmaceutical research, the chemists start their task by synthesizing a large number of new substances in the laboratory. The hope is that on the basis of theoretical deduction, these synthesized substances might have the desired pharmacological effect. This step is followed by the screening process, in which the new substances are put to the test. By developing new working methods, such as those involving cell cultures, it has been possible to simplify experiments and to reduce costs. At the same time, the number of animal tests could be cut down enormously with the help of these new methods. This trend toward fewer animal experiments will continue, but some tests will remain indispensable, particularly if the aim is to examine the reaction of the organism as a whole.

The results of the screening are channeled back into the synthesis work for further analysis. Before a few substances have been identified as effective, it generally takes years, during which tens of thousands of substances have been investigated. Their pharmacological effects are not the only criterion; tests have to be passed for tolerability, side effects, carcinogenic, teratogenic and mutagenic properties and many more properties. This is a field where researchers of different disciplines work together and have to rely on a constant exchange of information. The so-called "Aprather Weg" research center in Wuppertal is particularly suitable for this work because of its concentration of disciplines.

The opening of the Institute for Clinical Pharmacology in May 1985 closed the final gap in the development procedure from laboratory and animal experiments to human use. The first dose of an active agent that is on its way to becoming a new pharmaceutical product can only be given to a healthy person. Often enough, the scientists actually working on a project are among the people who volunteer to participate in tests, and in fact almost all of the test "patients" are Bayer staff.

The tests begin with fractional amounts of the dose that had shown no effect on laboratory animals. To obtain all of the exact measurements for analysis, such as the distribution of the active substance in the body, its secretion and possible alteration or degradation in the body and side effects, the Institute is fitted out with technical equipment far more advanced than the average modern hospital. These clinical tests themselves, however, only mark the beginning of a time-consuming registration process.

The pharmaceutical industry today considers it fast work if approval is obtained for an active substance a full decade after patent application. The period in which a pharmaceutical company has exclusive rights to a substance that it has discovered is thus normally less than half the 20-year patent life. Therefore, a large amount of money must be earned in a relatively short time in order to be able to finance further projects. For this reason, adequate patent protection periods are of vital importance for research-intensive pharmaceutical companies.





And yet it is not possible to dispense with research into new drugs and therapies since most diseases still cannot be cured by combating their causes. The latest scientific advances in such fields as biotechnology and genetic engineering will therefore be extremely valuable in opening up new and promising means of treatment.

In the coming decades, the proportion of people in the total population that are 60 years old and over will noticeably increase in the industrialized countries of the world. Consequently, these coun-

tries will see a corresponding rise in the number of chronic, primarily age-related diseases to be treated. In addition to this change in the age structure, the shift in the frequency of individual illnesses is going to play an increasingly important role.

A hundred years ago, infectious diseases were the number one cause of death. Thanks to the development of highly effective pharmaceuticals, this is no longer the case today. The most frequent causes of death are now the cardiovascular diseases. In recent years, new epidemic diseases have also appeared,

The picture on the left was taken in the institute for Clinical Pharmacology at Bayer's Pharmaceutical Research Center in Wuppertal-Elberfeld. It is here that the effects of minute doses of new drugs are investigated on healthy people. The results will help to cure the sick.

All pharmaceuticals are subjected to careful and constant investigation to keep up the company's high standards.



such as, legionnaires' disease, Lyme's disease or the worldwide scourge AIDS. And other viral diseases, though they have long been identified and analyzed, are still frequently hard or impossible to combat with the use of pharmaceuticals. It is for these diseases that new therapeutical principles must be sought.

The most important tasks facing the pharmaceutical industry, and thus its research departments, over the coming decades will be in three main sectors: immunology, virology and treatment of tumors.

In the immunological field, physicians are now better able to counter the body's defense mechanisms against foreign proteins in the case of organ or bone marrow transplants, but problems nevertheless remain with regard to tolerability. A similar situation exists in the treatment of disorders of the auto-immune system; certain types of rheumatism also belong to this category of illnesses. Furthermore, there is still no adequate treatment for allergies. This widespread condition continues to pose many diagnostic and therapeutic problems.

One of the greatest challenges to today's—and most certainly tomorrow's—generation of scientists is the scourge of AIDS. The above picture shows an HIV virus entering a human cell. Bayer is one of the companies engaged in intensive AIDS research.

Since 1987, it has been cooperating with Hoechst in the search for a solution to this very serious problem.

While chemotherapy of bacterial infections can fall back on a broad range of highly efficacious and time-tested drugs, the causes of a majority of acute viral diseases of the respiratory and digestive tracts still cannot be successfully treated. Vaccines exist to provide prophylactic treatment against only a few viral diseases, among them polio and the typical childhood illnesses like measles, German measles and mumps. Another problem here is the lack of a rapid and direct viral recognition system, although genetic engineering is opening up new diagnostic possibilities in this area by making use of monoclonal antibodies. AIDS research is a good example to illustrate that the resources of even the biggest companies are simply not sufficient to solve the problems. This is why in 1987, Bayer and Hoechst decided to cooperate in the field of AIDS research.

Another important area of Bayer's pharmaceutical research is concerned with tumorous diseases. Here, too, major progress can only be obtained with the help of biotechnological knowledge and developments. The discovery of factors responsible for the growth of tumors will, for example, probably be furthered significantly by using the appropriate monoclonal antibodies.

It is simply not enough to develop pharmaceuticals for these important fields. The question of investigating the causes of diseases and then creating new methods of treatment based on these results is becoming a bigger issue. This approach calls for a thorough understanding of the mechanism of the illness in question.

Bayer feels it can meet these diverse and complex challenges. Its competence has been gained in one hundred years of research tradition, which is based on the experience and mutual cooperation of all disciplines involved, whether chemistry, medicine, pharmacology or biology.

Bayer chronicle 1985

New products hit the market: specialty rubber Therban, developed specifically for use in offshore oil drilling; Makrolon CD 2000 for compact discs and Perizin for the protection of beehives against the Varroa mite that was brought in from Asia in 1977.

On July 1, the new Business Group Specialty Chemicals and New Products is established.

Ciba-Geigy leaves the Schelde Chemie joint venture in Brunsbüttel; Bayer takes over plant and employees.

Bayer Philippines opens an agrochemicals unit which, as far as environmental protection technology and occupational health considerations are concerned, is one of the most modern installations in Asia.

World events 1985

On March 11, Mikhail Gorbachev becomes head of the Soviet Communist Party. He meets President Reagan in Geneva on November 19, for the ninth summit between the two superpowers since 1959.

The wreck of the "Titanic," which sank in 1912, is located at a depth of over 13,000 feet some 350 miles off the coast of Newfoundland in October.

In the biggest takeovers to date, Philip Morris buys General Foods for \$5.75 billion and General Electric acquires the Radio Corporation of America (RCA) for more than \$6 billion.

For the first time ever, Germans win the Master golf championship and the Wimbledon tennis championship: Bernhard Langer on April 14, and Boris Becker on July 7, respectively.

Bayer faces the Japanese challenge

Both as a supplier and as a market, Japan has enjoyed unparalleled success in recent times. Bayer has been doing business with this country for over a century and in 1986 celebrated the 75th anniversary of the founding of its Japanese subsidiary.

International economic structures are subject to constant change. The history of Japan is an excellent example. Up until World War II, Japan was an agricultural country that imported more than it exported. The country still had a substantial trade deficit up to the mid 1960s and was the world's seventh biggest exporter, ranking below the Soviet Union and Canada. Just twenty years later, it counted among the world's biggest exporters after the Federal Republic and the United States and recorded a large surplus balance of trade.

Like Germany's "economic miracle," the rapid growth of the Japanese economy resulted from an export boom. In comparison, the domestic market developed much more slowly. This is now starting to change. The Japanese have recognized that they can only remain successful on world markets if they are prepared to open up their own market to imports from abroad more than has been the case in the past. Thus, Japan is experiencing the third major "opening" in its history, after the reforms of the 19th century and the turn towards the West after the Second World War.

"Japan attracts the attention of all those who are in any way involved in the development of East Asia. The small island nation has responded to the trust invested in her with an astonishing openness. The empire that was still slumbering in the darkest Oriental night scarcely 30 years ago has thus been transformed into the leading power of East Asia."

This commentary, published in the journal "Die chemische Industrie" in November 1912, shows that the economic miracle of Japan has a long tradition. It was not fully recognized in the West, however, until the country's industries began large-scale exporting in the years following 1960 and caused a furor in the world's steel, shipbuilding, automotive and electronics markets. In fact, this "miracle" was the result of a long process of development which has been fascinating observers of the Japanese scene for decades.

After centuries of self-imposed isolation, Japan started to open up foreign trade business in the

Japan.

vom 17. 4. - 3. 5. 1926.

Fujisan (Tokyo) 21. - 24. 4. 1926.



Mt. Fuji From Kawabashi Suruga.

▲ 望ヲ岳富リヨ橋合河河駿

1850s by signing a series of agreements with leading Western powers. It was a gigantic challenge for the Japanese, who tackled the situation with a great deal of energy and hard work in the decades which followed.

The Meiji Restoration began in 1868; the Imperial House regained its former rights when the rule of the shoguns came to an end. In fact, the word "restoration" is misleading because the nation certainly did not return to its earlier condition. It was more of a revolution, in many ways similar to the political and social upheavals in Europe of the 18th and 19th centuries. On the other hand, there were considerable differences which left their mark on later development. First and foremost, it was a revolution "from the top," but one which freed energies

for the building of a modern economy. The class of samurais was abolished and the farmers were able to become free citizens after centuries of dependence. Equality and liberality were introduced, and the industrialization typical of Europe and America was viewed as a model for an unprecedented modernization program. With absolute determination, Japan set about learning from the West, without giving up its own national identity in the process.

Among the industries which grew particularly fast in the initial phase of Japanese industrialization was the textiles branch and especially the producers of silk and cotton. As a result, there was a steadily increasing demand for dyestuffs. Japan did have natural dye production of its own, but it was not at

As in many other countries, Bayer first established purely commercial links with Japan before opening a branch of its own in Yokohama in 1911. Carl Duisberg brought home the above postcard from a journey he made there in 1926.

all sufficient to meet rising needs. This shortage of products provided an opportunity for the German dyestuff industry, and thus for Bayer.

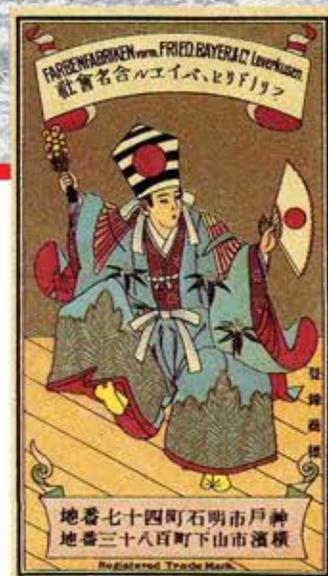
The company's first business links to Japan are documented by a bill for dyestuffs dated 1886. After the initial marketing business was established by agencies and local traders, Bayer subsequently set up a branch of its own in Yokohama in 1911. Two years later, Japan was Bayer's eighth biggest foreign customer, and the company had 48 people on its payroll there.

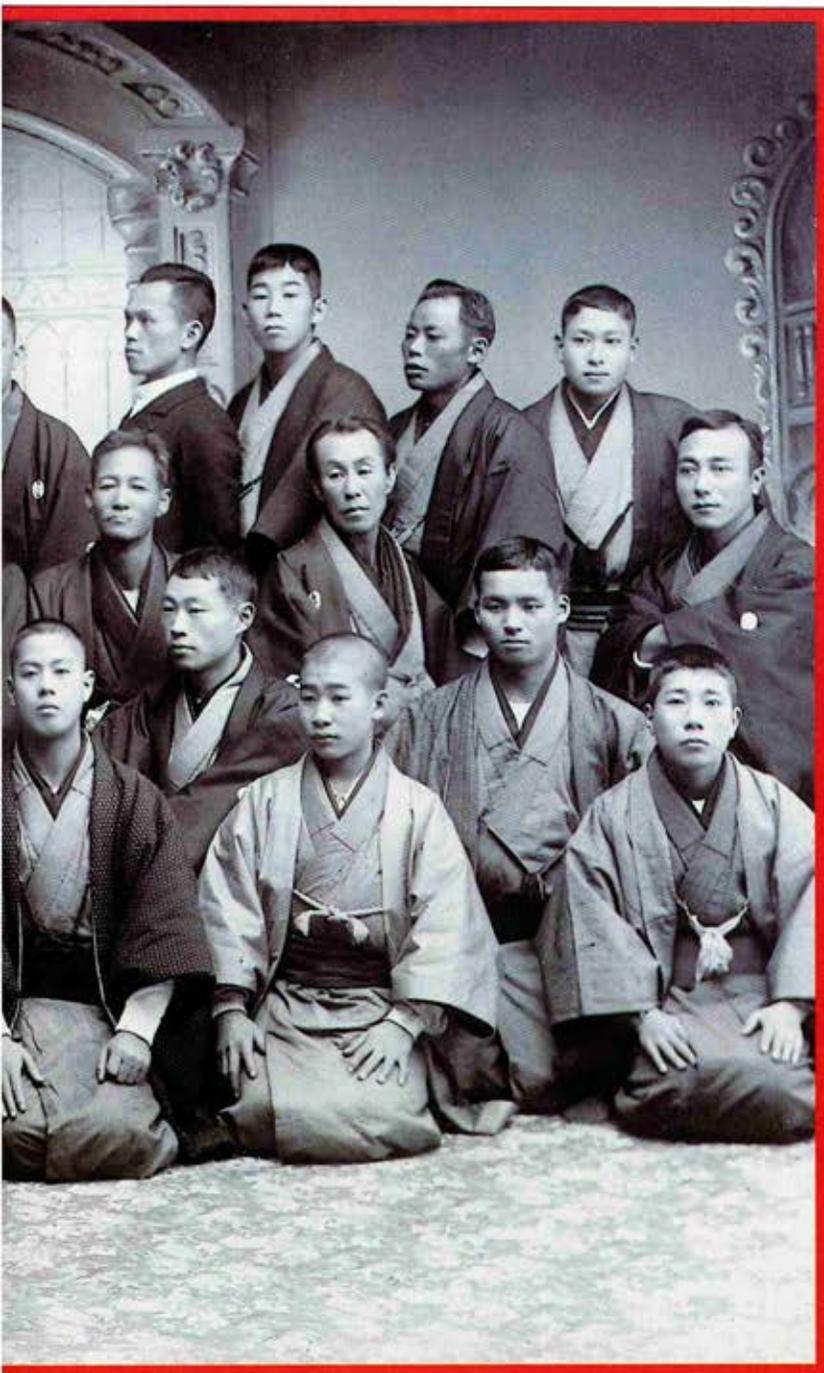
During World War I, when imports from industrialized countries were lacking, Japan's own industry took a big step forward. On the one hand, imports from industrialized countries were replaced by Japanese production, but this boom also provided new markets for outside suppliers. In the immediate postwar period, Japan and China were in fact Bayer's biggest single foreign customers. But a major setback came in 1924 when Japan banned imports of German dyestuffs to protect its own manufacturers.

In the meantime, however, Bayer had become much more than just a dyestuffs producer and the Japanese market offered a whole range of new opportunities. In the early twenties, Bayer's sales of pharmaceuticals in Japan were surpassed only by those in Germany itself. At the same time, Japan was also the second most important export market for the company's organic intermediates and the biggest foreign client for its photographic products. Bayer's agrochemical products also sold well in Japan; the density of the country's population called and still calls for intensive farming, which would be impossible without crop protection efforts.

Working through its sales organization "Pharma und Pflanzenschutz Bayer," I.G. Farben took up a stake in Nihon Tokushu Noyaku, a company active in the manufacture and marketing of agrochemicals, as early as 1941. Japan had, in fact, become one of the trust's major export markets.

In spite of this good position, Bayer practically had to start all over again after World War II. There were no business transactions at all between 1945 and 1948.





The above photograph shows employees of Bayer's Yokohama branch, most of them in traditional Japanese dress. By 1913, only two years after the branch was set up, Japan had become the company's eighth most important export market. Going along with Bayer tradition,

dyestuff labels to be used for the Japanese customers of the day featured subjects typical for the national market.

Pharmaceuticals worth a grand total of DM 7,000 were the first postwar sales at the end of 1949. When Farbenfabriken Bayer AG was reestablished two years later, business with Japan covered the whole range of products from dyestuffs, chemicals and pharmaceuticals to crop protection products and fibers worth a total of DM 6.5 million. In retrospect, these sales were not more than a very modest beginning in this interesting market.

Many Bayer products enjoyed a good reputation in Japan. Although the Japanese have a strong sense of tradition, a good name alone could not guarantee success. And in any case, Bayer does not only live from its longstanding products, but also from its ability to adapt constantly to meet the specific requirements of its customers.

Japanese industry is among the most innovative in the world, and for that reason it demands top performance from its suppliers. The Japanese themselves have demonstrated to the rest of the world in the last decades how successful a policy of innovation and excellence is as a means to conquer international markets.

In the 1950s, dyestuffs accounted for the lion's share of Bayer's business in Japan. These products were shipped from Germany and marketed by the company Ott Shokai. In 1955, Bayer set up Chemdyes as a trading company based in Hong Kong, whose Japanese subsidiary subsequently acquired Ott Shokai.

The business in Japan proved too big to be run out of Hong Kong. For this reason, Bayer set up Chemdyes Doitsu Senryo in Tokyo in 1960 as an independent sales firm. Four years later, this company changed its name to Bayer Japan Ltd. The Bayer subsidiary does not restrict its activities just to trading in dyestuffs but rather handles a broad assortment of other Bayer products from organic and inorganic chemicals to fibers.

Bayer Japan is not synonymous with Bayer in Japan—in fact, it is not even the biggest subsidiary there. Bayer Yakuhin, Ltd., which coordinates its activities from Osaka and Kobe, achieves the

highest sales volume of all Bayer's Japanese subsidiaries.

Yakuhin is the Japanese word for pharmaceuticals, and this business was far from easy to build up again after the war. Japan was oriented much more toward the United States, and it was nearly impossible to obtain import licenses. But longstanding relationships helped in this case, too. When contacts were resumed with former business acquaintances, the partners soon discovered their mutual interests.

In the fall of 1950, Yoshizo Takeda, Chairman of Yoshitomi Pharmaceutical Industries in Osaka, visited Leverkusen. The Japanese company had been formed in 1940 by Mitsubishi and the well-known firm Takeda Pharmaceuticals, which had long been headed by Yoshizo Takeda. When the major Japanese concerns were broken up after the war, Yoshitomi became independent. In 1951, Bayer entered into a cooperation agreement with Takeda Pharmaceuticals and Yoshitomi. The same partners subsequently established Bayer Yakuhin in 1973, which began its own production in 1979. Bayer Yakuhin was not only supposed to take over the marketing, but also establish production and research operations. The success of this company and its top position in terms of sales among the Bayer companies in Japan are certainly partially due to Bayer's pharmaceutical research. It has turned out excellent products for the treatment of heart and circulatory disorders, bacterial and fungal infections and many other diseases. Bayer AG has held a majority stake in Bayer Yakuhin since 1984.

In other sectors, too, Bayer managed to build up its presence in the Japanese market by establishing joint ventures with Japanese partners. After the war, for example, cooperation was resumed and subsequently expanded with Nitokuno. Bayer's agrochemicals, and especially the pesticides to fight against insects and parasites, have a strong position in Japan today.

Nitokuno not only sells Bayer's agrochemicals from Germany, it also carries out R&D of its own and operates plants in Hachioji and Hofu.

For its research and development activities, Nitokuno is building a sort of "Japanese Monheim" at Yuki in the Kanto plains to the north of Tokyo. The first phase of this modern agrochemicals research center has now been inaugurated. In addition to the biological laboratory in Yuki, an agricultural chemicals institute is in operation at Toyada. Equipped with these facilities, Nitokuno will be able to secure its position in this increasingly difficult market.

Today, Japan is one of the world's leading car producers. Of the approximately 46 million motor vehicles manufactured worldwide in 1985, almost 27 percent were made in Japan. Both Toyota and Nissan belong to the world's top twenty industrial concerns.

The automobile industry is the largest customer for polyurethanes. The diverse opportunities of the Japanese market could not be fully exploited working from the Federal Republic alone, particularly since international demand was already high and capacities were for the most part well utilized. Bayer found the right partner in Sumitomo Chemical Co. Ltd.; with its help, Bayer could build up this promising business in Japan. In 1969, the two companies formed the joint venture Sumitomo Bayer Urethane (SBU) for the manufacture and sale of polyurethane raw materials. With Bayer's know-how, a plant was built at Sumitomo's works in Niihama on the island of Shikoku. Besides products from this unit, SBU markets materials imported from Bayer's German plants.

A peculiarity of Japanese industry is the distribution system, with trading firms acting as middlemen between producers and customers. These traders were somewhat suspicious when SBU sales and technical staff sought direct access to users. Moreover, the customers themselves, and particularly the leading car manufacturers, also had misgivings at first because they felt that SBU could see too much of what went on in their factories.

The success of Bayer's polyurethanes was, however, spurred by the ability of the application experts to offer solutions to the problems of the customers.



Thus, a facility was installed at SBU's Osaka headquarters to serve customers under conditions of strict confidentiality. Today, SBU is one of the biggest polyurethane suppliers to the Japanese auto industry and has plans to expand its capacities.

It would go too far to describe the activities of all 13 of Bayer's Japanese subsidiaries, which include such "sister" companies as Miles-Sankyo, H.C. Starck, Haarmann & Reimer and Agfa-Gevaert. In 1986, the Bayer Group recorded sales in Japan equal to some DM 2 billion, and employed a total of 2,800 people there. Japan is certainly one of Bayer's major export markets. It has a market for chemicals second only to that of the United States and an extremely innovative industrial sector in

general. Expansion in Japan is a top priority for Bayer. This strategy includes the listing of Bayer shares on the Stock Exchange in Tokyo.

Bayer's activities in Japan have been shaped by the diversity inherent in the country's historical development. Without forcing the issue, and only where it is in the general interest of the Group, Bayer Japan acts as a kind of "centralized coordinator," offering the various Japanese subsidiaries and affiliates its services, which range from planning and administrative assistance to finances and help with the harmonization of common interests. Bayer Japan is the representative of the parent company in Japan—a land which has once again opened its doors to the world.

The automotive industry is the biggest single customer of polyurethanes. Since Bayer could not make use of all the opportunities offered by the Japanese market by working out of Germany, it sought a local partner—and found it in Sumitomo Chemical.

In 1969, Sumitomo Bayer Urethane (SBU) was established as a joint venture. The above picture shows its headquarters in a suburb of Osaka.

A glass that supports bridges, and other specialties

The world première took place in Düsseldorf on July 11, 1986. A two-lane prestressed concrete bridge whose load-carrying capacity was not based on steel was opened to traffic. A development of Bayer's Specialty Chemicals and New Products Business Group known as Polystal holds the bridge.

The name "Specialty Chemicals and New Products" shows how this Business Group differs from others at Bayer. Created in 1985, it does not limit its activities to specific fields of production, such as fibers, plastics or pharmaceuticals. Instead, the "SN" Group concerns itself with promising new ideas and sees whether they can be developed to provide new products or business units. If the work proves successful and develops into an interesting business, the products are passed on to the respective Business Groups and the SN team turns its attention to new projects.

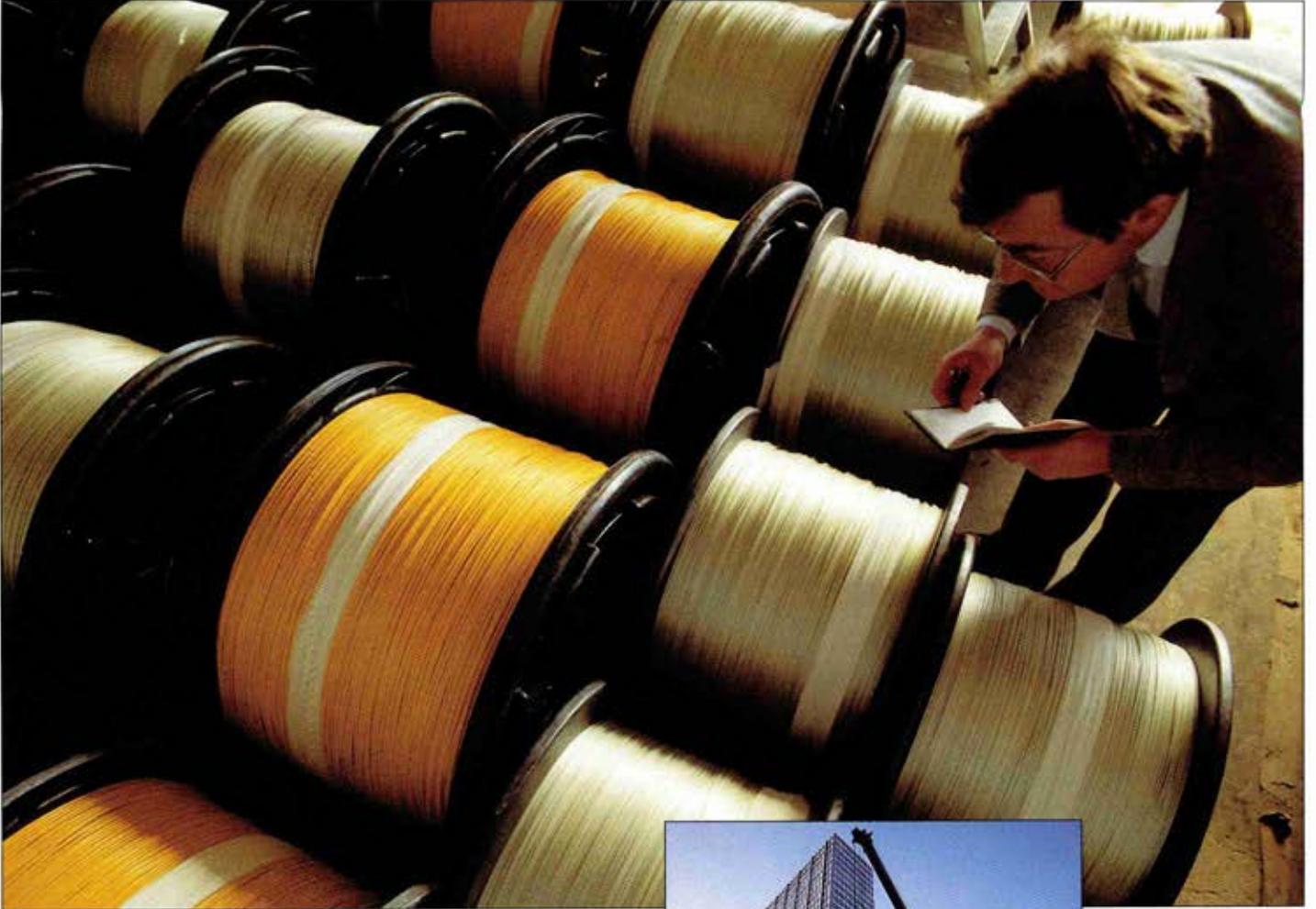
For example, Polystal—the glass that can support bridges—is a result of the SN program. Originally, the intention was to find an improved material for skis. This search led to the development of new composite materials whose tensile strength is comparable with that of steel.

Composite materials consist of two or more different substances whose various properties are combined either to offset any inherent weakness or to enhance the advantages. As a matter of fact, this principle was known to the ancient Egyptians, who used a mixture of Nile mud and chopped-up reeds as a building material. European half-timbered frame houses with a composite material made from clay and straw are based on the same idea. In both these examples, the strength of the actual building material is significantly increased by the addition of fibers.

Glass-fiber-reinforced plastics have been in use, particularly in boat and aircraft construction, for several decades. Polystal belongs to this group of composites; its special feature is the combination of a maximum of individual glass fibers with a synthetic resin to create a material with enormous tensile strength. This property results from the fact that the glass fibers, which account for 80 percent of the weight, run parallel lengthwise along the profile; the cross section of a rod of 7.5 millimeters in diameter reveals some 65,000 individual fibers. To demonstrate just how strong a rod of this kind is, Bayer technicians used it to hold a 4-ton truck.

Polystal is a new, plastic-based composite material whose tensile strength is comparable with that of steel. In a 7.5-mm cross section of a Polystal rod, some 65,000 individual fibers run parallel to one another. To demonstrate the performance of Polystal, Bayer suspended

a 4-ton Unimog vehicle from a single rod. Polystal elements have already been used successfully—instead of steel elements—for the entire suspension of two bridges.



Bayer in China

The joint venture of Bayer and the Shanghai Dental Materials Factory, Bayer-Shanghai Dental Ltd., began producing dentures in Shanghai on March 30, 1988. The company had actually already been set up in August of 1986.

One of the major goals of the Chinese reform policy is to modernize the trade and industry of the country. In order to obtain state-of-the-art Western technology, the Chinese government today permits the establishment

of jointly owned companies; one of the first of these cooperations to be formed in the chemical industry was Bayer-Shanghai Dental. In addition to this joint venture, Bayer has branch offices to represent its business interests in both Shanghai and Peking.

As is the case with most countries, Bayer's connections to China go back a long way. At the beginning of this century, when the company was still primarily a dyestuffs manufacturer, China was one



This label adorned the dyestuff cans that were designated for export to the Chinese market.

of its leading export markets, along with the United States, Russia and the United Kingdom. The important role of the Chinese market did not change until the 1930s and after the Civil War ending in 1949, when China lost most of its significance as a business partner for a considerable length of time. China tried to achieve self-sufficiency and thus substantially limited business relations to the West.

Things took a turn for the better in the wake of the

political change following the death of Mao Tse-tung. The Chinese authorities realized that isolation from the advanced technologies and markets of the West had apparently contributed to the country's economic stagnation.

Setting up Bayer-Shanghai Dental is thus more than just another landmark in the company's history. It is also a symbol of economic change in a modern China—a China which is working hard to catch up with the times.

The scientists in the SN Group immediately realized that Polystal could be quite interesting for the construction industry. Experience had shown that moisture can penetrate concrete and attack the supporting steel bars used in such constructions as bridges and roofs. The new glass-fiber composite from Bayer offered a range of properties that made it equal to steel in prestressed concrete and even included a number of additional advantages. Polystal is light, has excellent resistance to corrosion and weathering and provides outstanding electrical and thermal insulation properties.

After completion of the fundamental development program and the necessary tests, Bayer got together with the Düsseldorf building firm Strabag and in 1980, they erected a small bridge that is able to withstand a load of some 30 tons. It was the first prestressed concrete bridge in the world in which Polystal was used instead of steel.

This "test object" lived up to its expectations so a major project was launched together with the Federal Ministry of Research and Technology in the form of the two-lane road bridge that is supported by Polystal beams.

Polystal proved to be interesting for use in another important application: as a support for the highly sensitive glass fiber that is beginning to replace copper cables in the telecommunications sector. Since Polystal had now become a product in its own right, it was taken over by the Plastics Business Group in early 1988.

Bayer was able to enter a totally different field of activity thanks to the pioneering work of the SN team: microencapsulation technology. For some time now, sets of forms have been available that dispense with carbon paper between the individual pieces of paper. And not only that—if a sheet of white paper is laid between the forms, it remains white, while the text is transferred to the intended copy. All this is made possible by microcapsules, tiny drops which are encased in a plastic skin. The capsules are so small that 1,500 of them put end to end measure just one centimeter. When used in

Carbon paper is gradually disappearing from the office scene. To an increasing extent, copypaper is used in which developer and coloring agents have been applied to the back of the sheets by the manufacturer. The invisible microcapsules burst under pressure to repro-

duce the typescript—as in the top left-hand corner of this page. Another new development helps the oil industry to increase its yields. Xanthan, shown in laboratory tests on the right, "shoves" the remaining oil in a deposit along to the end of the drilling hole.

form paper, these capsules are filled with a coloring agent and cover the back of the paper. The front of the paper is coated with a developer. The capsules burst during writing and color shows up where their contents come in contact with the developer, thus making the text visible.

Years of experience in polyurethane chemistry enabled Bayer to develop a new type of process for the continuous production of these microcapsules, which are now marketed under the trade name of Baymicron. On the basis of Bayer's technology, microcapsules for duplicating paper are now being produced in various parts of the world.

SN is also working on a number of other projects, including basic liquids for high-quality lubricants, products and processes for environmental protection and chemicals for oil producers. In the latter sector, products that will help increase oil yields are in the course of development. As it is, only 15 percent of the oil deposits in the ground come up "voluntarily" through the drill hole. There has been no shortage of attempts to increase this amount to make oil drilling profitable in inaccessible areas, such as jungles and deserts or on the sea bed. In one example, water is injected or superheated steam is pressed into the drill holes to push the oil upward. SN has developed a polymer with which the injected water can be made just as viscous as the oil. This product, known as Xanthan, is made by biotechnological means with the help of natural bacteria. Dissolved in the injection water, it pushes up the oil from its deposit like a liquid buffer to the rig. In cooperation with Preussag AG, a pilot project is currently being carried out at a German oilfield near Peine to the east of Hanover. It has already shown that Xanthan allows a substantial improvement in yields.



Rare metals and high-performance ceramic materials

As part of the corporate strategy to supplement existing fields of business and open up new technologies, Bayer bought the Berlin-based Starck group, a leading producer of rare metals, in 1986. Bayer then acquired the Cremer Forschungsinstitut in Coburg, a pioneering research organization in the field of engineering ceramics.

Hermann C. Starck Berlin GmbH & Co. KG, in which Bayer has a stake of more than 90 percent, has its headquarters in Berlin and plants in Goslar of Lower Saxony and in the southern German town of Laufenburg. It also has operations in Castres, France, and Newton, Massachusetts. In 1987, the company employed a total of 3,000 people and attained sales of DM 551 million, some 70 percent of which stemmed from business outside of Germany.

HCST, as the company name is generally abbreviated, is among the major producers of special metals. Production is concentrated in particular on metals with a high melting point such as tungsten, molybdenum, niobium/tantalum, rhenium and their compounds. Cobalt, nickel and the salts of these two metals play a secondary role, as do a range of specialty products.

Many people are not aware of the practical use of such rare materials; in fact, they are much more common in their applications than might be thought. Some of the metals are used as additives to steel, but a more important application is their utilization as refractory metals for such products as metal-cutting tools or as contact materials in the electrical and electronic industries.

The range of customers is thus very diverse: the refractory metal industry, powder metallurgical processors, manufacturers of electronic components, producers of catalysts for the chemical industry and the high-grade steel sector together with its foundries.

Production facilities and processes based on the latest technology provide the foundation for extensive research and development work, which in its turn has led to a succession of new fields of business. Recent examples of these innovations can be found in the surface coating sector with powders for applications using flame and plasma spraying.

Hermann C. Starck founded his firm in 1920 at a time when the first refractory metal was just making its appearance in Germany. The initial product to emerge was a sintered alloy based on tungsten and cobalt known as "Widia," which is an acronym for

Smelting furnaces are an important part of the processing work done at Bayer's subsidiary Hermann C. Starck. This company is a specialist in such high-melting metals as tungsten, molybdenum and tantalum, together with their alloys, as well as cobalt and nickel

compounds and corresponding salts. Other specialties are included in Starck's sales program, which serves the needs of customers in the processing industry worldwide.

ADM
JENOS A TRES



MOLYBDATE
EN GARE DE
PARIS LA
CHAPELLE

WC-HC-100
HCST 4172
OSAKA

Special metals and engineering ceramics

The most important metals in H.C. Starck's production program belong to the 5th, 6th and 7th subgroups of the Periodic Table of the Elements. Besides cobalt and

nickel salts, a certain role is also played by zirconium and hafnium from the 4th subgroup.

Subgroups (transition elements)

IV	V	VI	VII
22 Ti titanium	23 V vanadium	24 Cr chromium	25 Mn manganese
40 Zr zirconium	41 Nb niobium	42 Mo molybdenum	43 Tc (technetium)
72 Hf hafnium	73 Ta tantalum	74 W tungsten	75 Re rhenium

Most of these metals are characterized by great hardness, high specific weight

and high to extremely high melting points.

Metal	Zr	Hf	Nb	Ta	Mo	W	Re
spec. weight	6.52	13.31	8.58	16.69	10.2	19.1	21.2
melting points	1860°C	2210°C	1950°C	2800°C	2500°C	3370°C	3167°C

Because of their high melting points, they cannot normally be extracted from their ores as liquid metal in a kind of blast furnace process, which is possible for example with iron. One method is to use mixed ores in the process. In this case, chromite produces an alloy made from chromium and iron, the so-called ferro-chrome, which can be employed for the production of further chrome alloys. However, if one wants to obtain the pure metal, special and frequently very complicated processes are required. For instance, a tungstate solution is produced from calcinated and ground wolframite ore by extraction with sodium hydroxide. Impurities and by-products

are subsequently removed from this solution by precipitation and filtering. The tungstate is then extracted by a solvent containing amine and converted with the help of ammonia into aqueous ammonium paratungstate solution. This salt, which is easily obtainable in solid form and also easy to standardize, is then either marketed or goes on for further processing. It can also be converted into the oxide WO₃, which can itself be reduced to tungsten metal powder when treated with hydrogen at high temperatures. With boron, carbon, nitrogen and silicon, the transition metals react at higher temperatures to form the corresponding borides, carbides, nitrides and silicides,

most of which exist in various stoichiometric compositions. Among these products, some of which are more similar to metals and others closer in character to ceramic materials, are substances with extremely high melting points and great hardness. Combinations of these materials with metals are known as "cermets," short for "ceramic metallics." For example, "Widia," which has been known for a long time now, is composed of tungsten carbide and cobalt.

The most important raw materials for engineering

ceramics are compounds of the elements boron, carbon, nitrogen and silicon—with one another or with such light metals as aluminum or titanium. The major prerequisites for the manufacture of serviceable ceramic powders are the very high chemical purity of the components and the highly homogeneous and extremely fine pulverization. The following table gives a series of examples of applications for high-performance ceramic products and their corresponding raw materials:

Possibilities and applications for high-performance ceramics made from non-oxidizing materials

Applications	Materials
1. Engineering ceramics Cutting and molding devices in metal-working: e. g. cutting discs, wire drawing jets, wire feeding rollers, rollers	silicon nitride, titanium carbide, titanium nitride, titanium boride
Ceramics in engines: e. g. heater plugs in diesel engines, diesel precombustion chambers, turbosuperchargers, rocker discs, valves	silicon nitride, silicon carbide
Wearing parts: e. g. pump seals used in the chemical industry, sandblast jets, bulletproof vests	silicon carbide, silicon nitride, borium carbide, titanium boride, titanium carbide
Parts of equipment in metallurgy and process engineering: e. g. crucibles, evaporation boats, ball-bearing mills, heat exchangers	silicon nitride, silicon carbide
Components of precision machines: e. g. ball-bearings, tool machine spindles, gauges (measuring instruments)	silicon nitride, silicon carbide
2. Electrical ceramics Substrate for integrated circuits	aluminium nitride, silicon carbide
Magnetic recording heads	silicon nitride, titanium carbide
Resistors	titanium nitride, chromium nitride, aluminium nitride, lanthanum hexaboride

the German words "like diamonds." Starck first bought the Laufenburg works on the Upper Rhine and later acquired Gebr. Borchers AG in Goslar. Founded in 1807 in Germany's traditional mining area of the Harz Mountains, Borchers had developed from a factory for refining zinc and copper vitriol into a versatile metal works, which began processing cobalt and tungsten ore as early as the 1890s. This pioneering tradition lives on in the work of today's employees of **HCST**.

The raw materials for the family of special metals are not found so close together as those for iron ore and coal. The mostly small deposits are strewn all over the world. For example, tantalum is only found in very small deposits in Thailand, Australia, Brazil, Canada and southern Africa, but it can also be obtained from the slag produced by tin smelters, for example in Thailand and Malaysia.

HCST is one of the world's leading tantalum processors. Some 50 percent of all the processing of this metal takes place at its three plants in Germany and the United States. Tantalum is used as a metal powder for the manufacture of condensers, but it also serves as the basis for heavy-duty metal sheets, pipes and other building elements. It is also used as a carbide for hard-metal, and its oxides find applications in the optical and electronic industries.

Using niobium, which occurs abundantly in the world and especially in Brazil, **HCST** makes such specialties as high-purity oxides for the optical industry. The high refractive index of niobium permits its use in the manufacture of eyeglass lenses which can be made considerably thinner than those of conventional glass.

The deposits of tungsten used for production are found on all continents, whereby imports from Chinese mines have been preferred in the past few years. On the other hand, **HCST** obtains a significant part of the raw materials required for its tungsten production from the recycling of processing-waste. Tungsten yields resulting from this kind of production cover about 15 percent of the total demand worldwide. Tungsten is the most important component of

refractory metal used for products in metal-cutting machines and other special parts. The best-known use of the metal, however, is for the filaments of electric light bulbs.

Molybdenum ore is found primarily in larger deposits in western areas of both North and South America. Its most common application is in the high-grade steel industry. For many years now, **HCST** has been concentrating its efforts on the production of highly pure molybdenum compounds destined, in particular, for use as catalysts in powder metallurgy and solid lubricants.

Chemical history was made when **HCST** extracted rhenium from certain molybdenum concentrates. Rhenium was one of the last naturally occurring elements to be discovered. German physicists Walter and Ida Noddack identified this element back in 1925, and until recently it was just relegated to the fine print in textbooks on inorganic chemistry. Today the extremely rare and expensive metal is used in X-ray tubes and in catalysts for the treatment of oil and as an additive for super-alloys.

This list, which is far from being complete, explains why Starck's advertising describes the company as a "specialist for specialties." Actually, the company Hermann C. Starck Berlin has something even more "special." For more than 20 years, its research staff has been working on the development and manufacture of specialty ceramics. Their time was well invested because in the past five to ten years, this class of materials has opened up interesting industrial applications and promising perspectives for ceramics. The market needed this much time before it was ready for these high-performance ceramic materials.

A demonstration at a trade fair in the Japanese city of Nagoya in March of 1985 showed just how promising this sector of business is: as is a common custom everywhere, the exhibition was opened by cutting a ribbon—but it was made of steel and the scissors used were made of the new ceramic material zirconium oxide.

Some ceramics are indeed harder than steel; they are already being used in tools designed to form and

Hermann C. Starck Berlin is one of the world's leading companies in the field of special metals. Some 70 percent of its total sales are achieved by business outside Germany.

Rare metals and high-performance ceramic materials

shape metals. However, this application is certainly less spectacular in the public eye than the ceramic heat shield of the American space shuttle, a fully ceramic engine or a gas turbine with ceramic parts used as a transmission for a motor. Without the protection of its 30,000 tiles made of heat-resistant, porous and thus insulating ceramic materials, the space shuttle would burn up on reentry into the Earth's atmosphere.

Ceramic components are also gradually making their way into car engines. This application demonstrates that ceramics have sufficient stability and heat-shock resistance to replace metal parts.

High-performance ceramic materials have little in common with conventional ceramics other than that they are also powder-based; the classic ceramics are made from natural compounds and the new ones from synthetic materials, which are then crafted and sintered into the desired forms. The feedstocks and the manufacturing and processing technologies are, however, quite different, as are the properties of the finished products.

The know-how involved in the production of special ceramic materials is very complex, but even the most careful adherence to processing procedures is of no use if the ceramic powder base materials are not absolutely pure and otherwise unobjectionable. This is where **HCST** comes in; it supplies the processing industry with such raw materials as nitrides—nitrogen compounds of silicon, aluminum, boron or titanium—as well as carbides and borides of such elements. **HCST** synthesizes these primary products and sells

them as powders of exactly specified fineness and purity.

Today, development work is following a number of different directions. There are now, for example, high-performance ceramics that can challenge metals because of their light weight, extreme hardness, resistance to abrasion, attrition and corrosion as well as their stability and resistance to heat. Some of them can, unlike most metals, withstand continuous high temperatures of up to over 1,400° C.

Other types of high-performance ceramics have particularly good thermal conductivity, which can even exceed that of many metals, and at the same time, they can act as electrical insulators. In contrast to these products, there are also ceramic materials that can function as conductors of electrical current in much the same way as metals.

Normal, i.e. hexagonal, boron nitride is soft. Under high pressure, however, it can be converted into cubic boron nitride, which is second only to the diamond in its hardness and is an excellent ceramic cutting material.

Their special properties make this kind of high-performance ceramic material suitable for a wide range of uses, and their potential is far from being exhausted. Unfortunately, there is one major snag: the classic and the high-performance ceramic materials are brittle. When they reach their pressure limits, they break without warning.

A great deal of research is going into attempts to counter this disadvantage. Considerable progress has been made here by the use of preprogrammed microfissures and the intercalation of highly resistant



ceramic whiskers. There is now reason to hope that these fascinating materials will find wider use in the foreseeable future.

With the acquisition of Hermann C. Starck, Bayer has found a partner which is among the world's leading manufacturers in this future-oriented field. Its research is a perfect complement to the development work in ceramic powders which has been going on for years at Bayer's Uerdingen plant.

Activities in the field of high-performance ceramic materials were significantly supplemented when Bayer acquired a majority holding in Cremer-Forschungs-Institut (CFI) in Rödental near the southern German town of Coburg in 1986. This research unit had been one of six operations forming the Cremer Group, which is involved in various branches of the classical ceramics industry and numbers among the top three European producers. The Cremer Group had set up a research institute of its own in 1959, which soon earned a reputation for itself after the development of non-oxidic high-performance ceramic materials.

As a research unit, CFI has no marketing activities of its own. Its major task consists of testing ceramic powders which have been developed or produced by Bayer or **HCST**. CFI also continues to probe for components based on "matured" powders that lend themselves to mass production. Working in cooperation with the experts of Bayer's research and the **HCST** production and development departments, CFI has thus taken over the role of a major applications technology unit.

It can be said today that high-performance ceramic materials already play an important role, and it will increase even more in significance in the future, whether in applications for engine and machine building, microelectronics and computer construction, electrical and energy technology, nuclear power and space travel, medicine or environmental control.

Ceramic materials are rapidly gaining in importance for a wide range of industrial uses. The Starck Group was quick to realize their potential. Without its shield of 30,000 ceramic tiles, the space shuttle would burn up on reentry into the atmosphere. The return

to earth was made possible by these heat-resistant, porous and consequently heat-insulating components made of silicon oxide and silicon nitride.

Bayer chronicle 1986

Bayer USA Inc. is established in Pittsburgh, Pennsylvania, as the management holding company for Bayer's subsidiaries in the United States.

Bayer-Shanghai Dental Ltd. is set up as a joint venture in China. Bayer subsidiary Miles takes over Columbus Dental, of St. Louis, Missouri, which is one of the best-known firms in its field in the United States.

Pirelli Société Générale of Basel purchases the Munich company Metzeler Kautschuk, which Bayer has owned since 1974.

Bayer AG sponsors a professorship of technical chemistry in the Department of Mathematics and Science at the University of Cologne.

Biltricide, the drug developed jointly by Bayer and the Darmstadt-based firm E. Merck against schistosomiasis, is awarded the Prix Galien, a French prize for pharmaceuticals whose introduction signifies outstanding progress in medicine. Bayer, which received the award in 1980 for its product Adalat, is the first company to obtain it for a second time.

Margret Janke from Bayer's Brunsbüttel plant wins the Pelikan national prize, awarded by the Hanover office-supplies firm to determine the "nicest colleague in the office."

World events 1986

A serious accident takes place on April 26 in one of the four reactors at the nuclear power station in Chernobyl in the Ukraine. A radioactive cloud moves over a large part of Europe.

On January 28, the U.S. space shuttle "Challenger" explodes after its takeoff from Cape Canaveral killing all seven astronauts on board. The space-shuttle program is thus halted after 24 successful flights.

Ernst August Ruska receives the Nobel Prize for distinction in physics in honor of the development of the electron microscope, which he began working on in 1931.

The World Health Organization announces that the Acquired Immune Deficiency Syndrome (AIDS) is spreading at an alarming speed and already affects some ten million people in 110 countries.

Ronald Reagan and Mikhail Gorbachev meet on October 11 and 12 in Reykjavik, the capital of Iceland. Their talks center on the bilateral removal of medium-range missiles.

Looking ahead for the benefit of the environment

An important event took place in Cologne in September of 1987: Bayer staged an international media forum to present its perspectives on environmental control.

Informing the media is a routine matter for major corporations. Bayer's forum for representatives of the press on environmental policy was anything but routine. A total of 150 journalists from German and foreign newspapers, radio and TV stations devoted several days of their time to a tightly packed program. The event drew this much attention because it was the first time that a company had gone all out to present the public with a comprehensive view of the current status and future perspectives of its environmental protection policy. The reasoning behind this move was the opinion of Bayer's management that an active and open information policy should be an intrinsic part of the corporation's responsibility to the community. The basic concept of Bayer's philosophy on environmental issues was summed up by Hermann J. Strenger, Chairman of the Board of Management, in his opening address: *"Environmental protection and safety have the same priority as product quality and profitability."*

In 1986, the German chemical industry published guidelines on environmental protection that constituted a voluntary commitment on the part of producers to take environmental considerations into account in their operations. That same year, Bayer issued its own set of guidelines on environmental protection and safety that are mandatory for all operations of the company. The main objective of the media forum was to give Bayer the opportunity to explain in depth how these principles are applied.

An indication of the overall importance of environmental control to the company was demonstrated by the announcement that over the next five to eight years a total of some DM 3 billion were to be spent in this field. This sum can be broken down into expenditures on three main fields of activity: the prevention of water pollution, the purification of waste air and flue gas and the installation of new canal networks and closed cooling systems. These plans form part of an overall concept in which earlier policies are continued, and at the same time, new perspectives are opened up.

The tenet of Bayer's corporate philosophy concerning environmental protection has been summed up by Management Board Chairman Hermann J. Strenger: *"Environmental protection and safety have the same priority as product quality and profitability."*

The company's efforts to improve its performance in environmental protection even further are directed inward as well as outward. The poster on the right advertises a bonus for every employee who comes up with a promising proposal in this field.

Neu für alle
Mitarbeiter

Umwelt prämie



Entdecken Sie neue Möglichkeiten,
Wasser, Luft und Boden zu schützen



Central Analytics

The research chemist works more or less "in the dark" today. He visualizes molecules and how they can be formed without being able to see them. Some of the resulting substances can be smelled, tasted or recognized by their color. But in order to properly identify them, the chemist has to make use of analytical techniques. The analytical laboratory has thus been an essential element of chemical research from the very start. Large-scale analytical facilities working for the whole company are part of Bayer's Central Research section. With its almost 600 employees, it is one of the biggest single departments for such special assignments in the company.

The basic task of chemical analysis has not changed over the decades. Compounds are first broken down into their constituent parts. Each one of them is then identified and its share in the whole determined, even when a substance accounts for only a thousandth of a percent or less. In these cases, trace analysis is necessary.

The methods of tracing these minute concentrations largely owe their development to discoveries in physics over the last 50 years. As a result of these discoveries, the work of the analytical laboratory has radically changed.

The measurement of physical characteristics peculiar to each molecule has in many cases replaced the reaction-detection method conventionally used as a system of

chemical identification for specific groups of substances. The old-time analytical chemist has become a specialist in the use of sophisticated physical devices. And it often requires years of experience to interpret the constitution of a molecule from the signals that it gives off via such equipment as a nuclear magnetic spectrometer.



Even the tiniest traces of metals in liquids, such as plant effluents, can be detected with the help of an atomic absorption spectrometer. For this photo, the bright color of the flame was intentionally produced by using lithium.

The Analysis Section of Central Research is also responsible for structural research, i.e. identifying the molecular structure of a newly synthesized substance as quickly and as exactly as possible. This work demands the closest imaginable cooperation between researchers because the raw materials and reactions involved in a syn-

thesis both give important clues to the expected analysis results.

Analysis plays a particularly important role in connection with the environmental protection program. Samples of liquid wastes are, for example, subject to continuous examination. They contain a wide range of chemical compounds, most of them in almost immeasurably tiny

interest of safety for the employees.

A broad-based program is also aimed at providing comprehensive information on substances which only occasionally occur in production processes. Because of the extremely small concentrations involved, very little is known of their chemical constitution and possible toxicity.

Quality control is another major responsibility of the analytic experts. High-precision processing methods used by Bayer's customers demand that the chemical composition of a product adheres very closely to specifications.

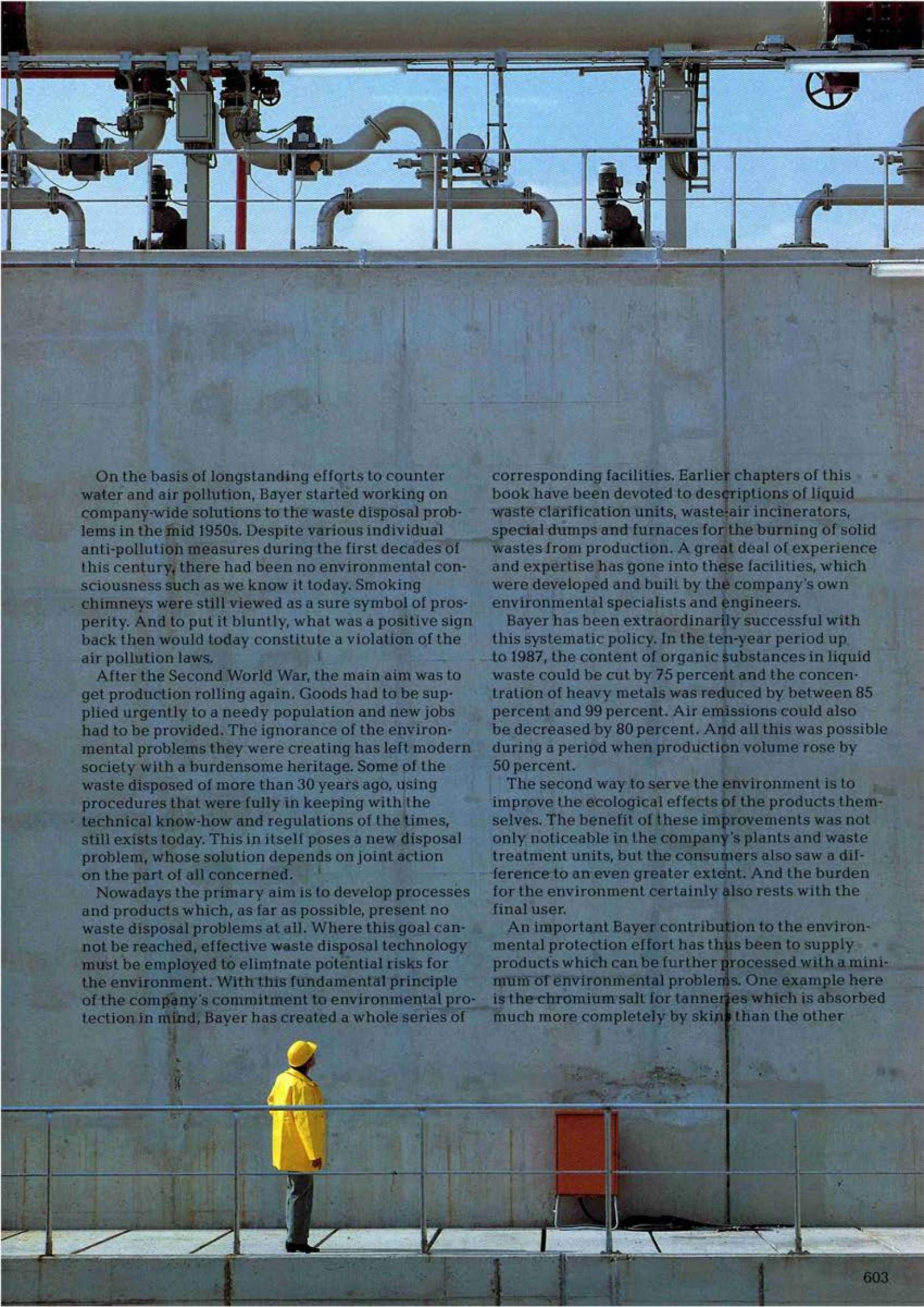
More than 1,500 samples arrive at the central analytical laboratories every day.

Analysis of these samples accounts for the largest part of the experts' work. Many different reaction phases are often required for the manufacture of a product, and analytical confirmation of the chemical conversions is necessary for each of these stages. In order to facilitate the production process, round-the-clock shifts, a rapid service specially developed for sample testing and a high degree of apparatus automation are essential. And yet things are changing in this field, too. Even the most rapid analysis of samples requires a certain waiting time, so it has become preferable to incorporate a major part of the analysis in the process itself. The development of corresponding methods is an important task for Bayer's process analysis.

concentrations. Work of this kind is described today as ecological analysis.

Not only wastes but the products themselves are also constantly under careful investigation by the analytical laboratories. The same applies to the intermediates which never leave the plant. Here, analysis is performed also in the

Bayer has given top priority to the development of processes and products which, as far as possible, present no waste-disposal problems. When this goal cannot be attained, effective environmental facilities are installed, like the liquid waste treatment unit in Dormagen.

A photograph of an industrial facility, likely a wastewater treatment plant. The top portion of the image shows a complex network of pipes, valves, and machinery against a clear blue sky. Below this, a large, light-colored metal wall dominates the middle ground. In the foreground, a worker wearing a bright yellow protective suit and a yellow hard hat stands on a metal walkway, looking towards the right. The walkway has a metal railing. The overall scene is brightly lit, suggesting a sunny day.

On the basis of longstanding efforts to counter water and air pollution, Bayer started working on company-wide solutions to the waste disposal problems in the mid 1950s. Despite various individual anti-pollution measures during the first decades of this century, there had been no environmental consciousness such as we know it today. Smoking chimneys were still viewed as a sure symbol of prosperity. And to put it bluntly, what was a positive sign back then would today constitute a violation of the air pollution laws.

After the Second World War, the main aim was to get production rolling again. Goods had to be supplied urgently to a needy population and new jobs had to be provided. The ignorance of the environmental problems they were creating has left modern society with a burdensome heritage. Some of the waste disposed of more than 30 years ago, using procedures that were fully in keeping with the technical know-how and regulations of the times, still exists today. This in itself poses a new disposal problem, whose solution depends on joint action on the part of all concerned.

Nowadays the primary aim is to develop processes and products which, as far as possible, present no waste disposal problems at all. Where this goal cannot be reached, effective waste disposal technology must be employed to eliminate potential risks for the environment. With this fundamental principle of the company's commitment to environmental protection in mind, Bayer has created a whole series of

corresponding facilities. Earlier chapters of this book have been devoted to descriptions of liquid waste clarification units, waste-air incinerators, special dumps and furnaces for the burning of solid wastes from production. A great deal of experience and expertise has gone into these facilities, which were developed and built by the company's own environmental specialists and engineers.

Bayer has been extraordinarily successful with this systematic policy. In the ten-year period up to 1987, the content of organic substances in liquid waste could be cut by 75 percent and the concentration of heavy metals was reduced by between 85 percent and 99 percent. Air emissions could also be decreased by 80 percent. And all this was possible during a period when production volume rose by 50 percent.

The second way to serve the environment is to improve the ecological effects of the products themselves. The benefit of these improvements was not only noticeable in the company's plants and waste treatment units, but the consumers also saw a difference to an even greater extent. And the burden for the environment certainly also rests with the final user.

An important Bayer contribution to the environmental protection effort has thus been to supply products which can be further processed with a minimum of environmental problems. One example here is the chromium salt for tanneries which is absorbed much more completely by skins than the other

products that have been available on the market up to now. The chromium content of liquid waste leaving the tanneries can thus be reduced. Another example is the development of low-solvent raw materials for coatings.

The policy guidelines outline four main tasks for environmental control and safety procedures. The first concern is the improvement of existing production processes and the development of new methods which place more emphasis on environmental considerations. The second is aimed at the expansion and modernization of waste treatment facilities. The third main field of endeavor comprises research and development work on products and applications that provides ecological advantages to the processor or the consumer. A new consideration in this connection has been the fact that environmental criteria also play a significant role before a product is finally released to the market. Underlining corporate policy at the Cologne forum, Strenger quoted the decisive clause from the guidelines: *"Where health or environmental considerations demand it, the sale of products shall be curtailed or their production halted, regardless of economic interests."*

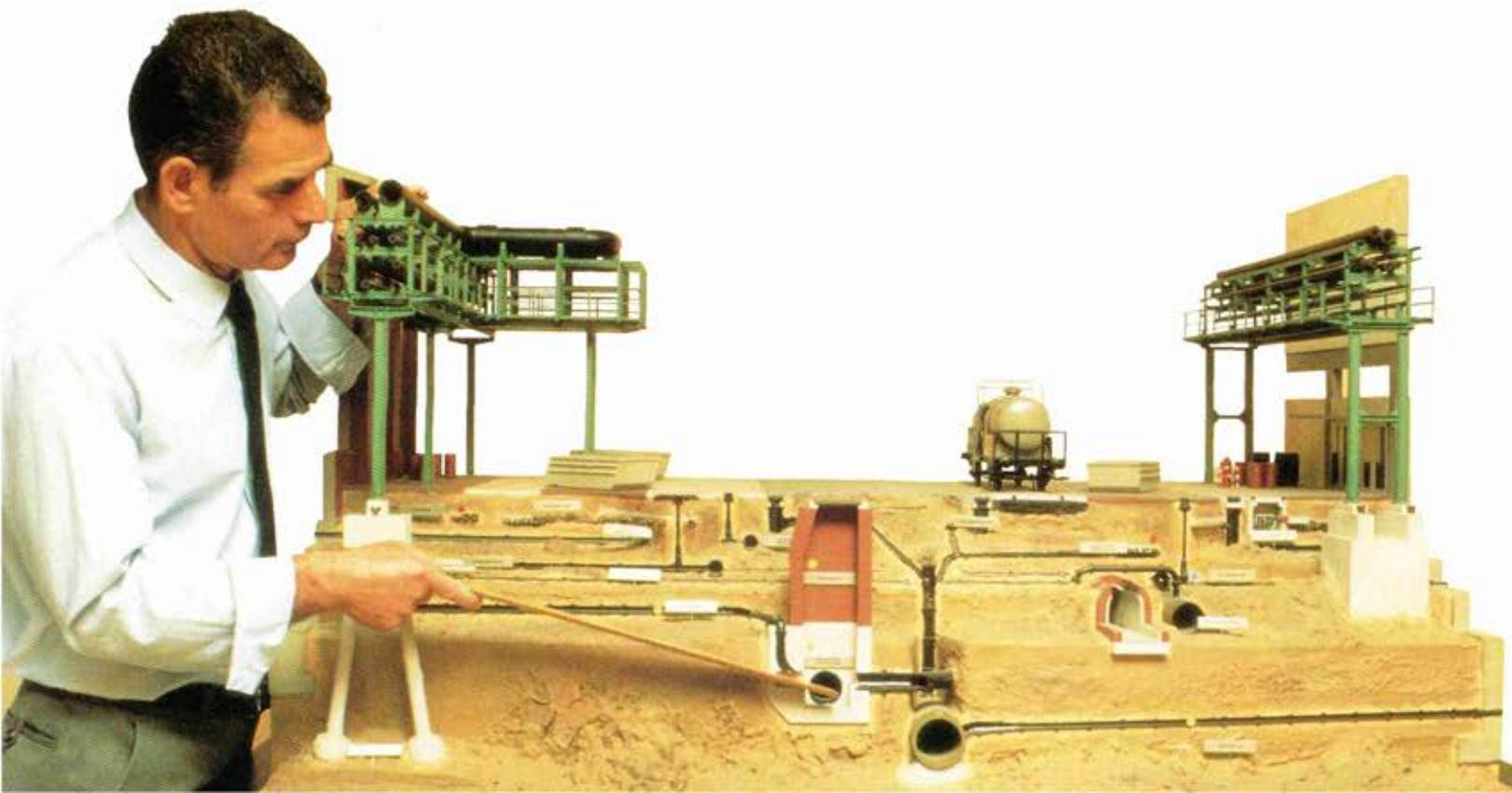
And this is not just an empty promise. For these very reasons Bayer called a complete stop to production of benzidine-based dyestuffs and, in 1984, of polychlorinated biphenyl (PCB). Both of these product groups had been extremely popular with

customers, thanks to their outstanding technical properties, but in both cases, the company itself was able to develop and subsequently market alternatives of at least equal quality.

The fourth of the major tasks explained in the guidelines, but not necessarily the last one in priority, is the call to all employees to pay close attention to even routine matters in the lab or the plant that have a bearing on the environment. This also applies where a high level of practice and operational safety already exists.

The rising cost of environmental protection is a factor of increasing significance. Today, environmental installations account for a good 25 percent of all Bayer AG's investments. In 1987, research in the interest of the environment and product safety reached DM 260 million, i.e. some 22 percent of all research spending. Actual operating costs in this sector added up to DM 969 million in the same year, or more than Bayer AG's profits after tax. And the trend indicates that these costs will rise.

At the Cologne forum, Bayer presented a one billion-mark program for the expansion of its liquid waste treatment system. The first DM 100 million of this amount is designated for the "Kanal 2000" project in Leverkusen, i.e. a collection system for all waste water which is fed into the plant's biological treatment unit. This is, in fact, the third generation of plant sewage installations.



At the turn of the century, Bayer installed its first canal system some 13 feet below the ground; the pipes collected rain and cooling water, as well as liquid waste from the production facilities, and carried these effluents to the Rhine. In 1963, the conduit system was reconstructed so that the old pipes carried only rain and cooling water in addition to unobjectionable waste water. A 19-mile subterranean network of "biocanals" was installed for the polluted liquid waste. The weak point was the danger of leaks, which were difficult to locate and called for large-scale repair work.

The new "Kanal 2000" system will collect organically polluted liquid waste and sanitary sewage in overhead pipelines and feed them into an accessible tunnel leading to the waste water purification unit. Since the system is partly above ground and partly in a tunnel able to be entered by maintenance and repair staff, it will be much easier to control. Further measures include the extension of the warning and reporting system, the elimination of odor nuisance from the open settling basins and improvements in the efficiency of the clarification units.

Important projects are also in process or are in the planning stage in the field of solid-waste disposal. Four waste incineration plants are currently in operation—two each in Leverkusen and in Uerdingen. One of the Leverkusen units will soon be expanded at a cost of DM 60 million. A fifth incinerator, now under construction, will be used primarily for burning sludge and liquid waste but will also be able to dispose of chemical sewage hitherto incinerated at sea. Initially greeted by the public as a progressive means of disposal but recently the subject of criticism, this controversial technology of incineration at sea will be stopped in 1988.

The media forum of September 1987 demonstrated to a broad public that environmental protection not only has a long tradition at Bayer but is also an integral part of corporate policy. Economics and ecology are not conflicting interests as far as Bayer is concerned; they are targets of equal standing within a responsible management concept.

"Kanal 2000" is the latest development in the field of liquid waste management at the Leverkusen plant. All underground collection conduits for waste water are to be taken out of operation. The new system provides for a network of above-ground pipelines leading to

a main feeder, which takes the liquid through a tunnel—with access for inspection—to the clarification unit.

Bayer chronicle 1987

Bayer Italia installs a special research laboratory which is to work on the development of new products for the surface treatment of ceramic materials and other applications. Bayer is a leading manufacturer of ceramic frits, glazes and colors not only in Italy but also in the United States, the United Kingdom, Spain, Belgium and Mexico. The laboratory in Italy serves all of these plants.

Bayer acquires all of the shares of Denka Chemical Corporation in Houston, Texas.

Bayer and Siemens enter into a cooperation for the development and manufacture of catalytic converters for the removal of nitric oxides from the flue gases of large-scale furnaces.

British Vita, of Manchester, takes over Metzeler Schaum GmbH, Memmingen, from Bayer as of January 1, 1988.

Cereal dressing Baytan receives the Gold Medal of East Germany's Fall Trade Fair in Leipzig.

World events 1987

The world population passes the five-billion mark in July.

Matthias Rust, a 19-year-old hobby pilot from the Hamburg suburb of Wedel, flies a Cessna 172 through Soviet air defenses and lands on Red Square on May 28. He is sentenced to prison in the subsequent trial in Moscow.

On October 19, the so-called "Black Monday," a stock-market crash takes place of even greater dimensions than the "Great Crash" of October 1929. The Dow Jones Index plummets by 508 points, or some 22.6 percent. Calculations show an overall loss of assets around the world of some \$2 trillion.

On December 8, U.S. President Ronald Reagan and Soviet Party Secretary Mikhail Gorbachev sign a disarmament agreement in Washington on the bilateral scrapping of medium-range missiles.

Vincent van Gogh's famous "Sunflowers" painting of 1889 is sold for the equivalent of some DM 72 million at a London auction, the highest price ever paid for a work of art.

The United States celebrates the bicentennial of its Constitution on September 17.

Leverkusen works : the face will change but the essence remains

Duisberg's memorandum of 1895 on the planning of the Leverkusen plant restricted itself to fundamental considerations, which is why it remained valid for such a long time. But today's different conditions call for a change. A new design for the Leverkusen works, which is currently being perfected, will lead the plant into the 21st century.

Duisberg's design for the Leverkusen plant was centered around the steps of production; the idea was to keep the distances between interrelated facilities to a minimum. The result was a strip-like pattern which corresponded to the various stages in the production process, with the first step starting at the bank of the Rhine.

The location of factories, service roads, power units and even individual pieces of equipment depended on the different operational requirements and served to provide the greatest possible ease in production. The reasoning behind the design that Duisberg developed was good, and the system could be fully utilized in the new works in Leverkusen, which in time became something of a model for the chemical industry at home and abroad. But the layout of the works reflected the particular needs at the turn of the century. Today, it is much more important to guarantee that a chemical plant fits into its surroundings. Particular attention has to be paid to environmental and safety concerns, which are controlled down to the tiniest detail by a series of laws and regulations.

In addition to these aspects, city planning, traffic flow and quite simply the well-being of both the employees and the neighborhood have to be considered. **The plans of the site must not only make allowances for the exigencies of existing statutory demands, but they must also anticipate developments in the distant future.**

The Leverkusen plant consists of much more than just production units. It also accommodates the corporate administrative headquarters and the central research and development, applications technology and engineering facilities. Many of the departments that are found in other plants are also represented in the main works in Leverkusen, but in a much larger form.

Despite the wide range of activities that go on within the plant, a chemical works does not necessarily have to be considered an island in its environment today. **On the contrary, Bayer is attempting to break down the strict borders between its works and the**

For many years, Carl Duisberg's memorandum was the basis for the planning of the Leverkusen works. Conditions have since changed to the extent that a fundamental adjustment to the design has become necessary. This operational reorganization is the subject of an ambitious

program, whose salient points are marked in yellow in the above text.

"outside world." For this reason, a great deal of attention is being paid to the outskirts of the plant and its immediate surroundings.

For example, the area where the works meets the town to the north is particularly important. Office blocks for administrative departments and service facilities have been set up and will continue to be expanded in such areas. Departments which are frequented by the public have been chosen for this location so that more clientele will be brought in to the neighboring shopping areas. In the past years, the company has been able to make impressive progress, and these changes have been accomplished in cooperation with city officials of Leverkusen.

Examples of this new face are the buildings "Wiesdorfer Arkaden," "Wiesdorfer Treff," and "Wiesdorfer Eck" and the renovated houses on Moskauer Street. This area is, or will eventually be, the home of the company's personnel department, health insurance fund, housing subsidiary, Works Council, pension fund and a number of Bayer clubs and societies.

These ambitious plans do not stop at the construction of attractive buildings but also include improvements to the traffic system and the creation of parking space for the cars of 2,000 employees; these measures are in an advanced stage of planning and have in part already been completed.

Top priority has been given to on-site alterations. The fact that the works has no room left to grow makes the existing area particularly valuable. Planners are therefore examining how the available acreage can best be used and where, if necessary by demolition work, new open spaces can be created. Among other things, storage facilities are being consolidated and, wherever possible, they are going to be moved outside the plant. This applies particularly to the storage of spare parts and technical equipment. The planners feel that a substantial share of available space will thus be able to be put to new uses without having to relocate a single production unit.

The aim to make more open space available is an important part of the overall revised design. Basically,

the site of the Leverkusen works is supposed to be less densely packed than in the past. Enough space around the production units is an important prerequisite for good logistics work. Older factories will continue to be torn down and replaced by modern facilities, which themselves will take up less space and thus further reduce building density.

With these and many other plans being carried out in the course of the coming years, the face of the Leverkusen works will gradually change. Duisberg's strip plan will evolve into a kind of shell structure. The production units will be located in the middle of the site; they will be surrounded in a semicircle by such ancillary facilities as energy supply, pilot plants and workshops.

The outer shell will consist of research laboratories, application technology units and other auxiliary buildings; these will then gradually lead to the new office blocks already mentioned and the surrounding neighborhood.

Despite all of these changes, the essence of the Leverkusen plant will remain—even in the long run. In contrast to the works in Dormagen, Elberfeld, Uerdingen and Brunsbüttel with their large-scale facilities for relatively few products or the specialized research centers for agrochemicals and pharmaceuticals in Monheim and in Wuppertal's "Aprather Weg," Leverkusen's characteristic feature is its diversity.

Almost all of Bayer's Business Groups are represented in Leverkusen, where half of the company's products are manufactured and both specialized application technology units as well as the central research and development installations are housed. This integration of so many different operations is the best basis for developing new ideas and offers good opportunities for their practical testing and realization.

Leverkusen may change its appearance, but its character will stay the same. The new plans are intended to guarantee that it not only remains a Bayer plant with a longstanding tradition, but that it is also given a modern structure.

1988

Innovation is the basis for success

Austrian economist Josef Alois Schumpeter coined the term “innovation.” He understood the word to mean introducing new products, processes and management structures and opening up new markets. According to Schumpeter, an entrepreneur is by definition an innovator.

Carl Rumpff, a businessman with a commercial background, created the basis in the 1880s for Bayer’s evolution into a diversified chemical company. He had recognized that the research and development of new products and processes, and the opening up of new markets were absolutely decisive for the future of the firm. Rumpff may never have heard of the word “innovation,” but his actions were guided by entrepreneurial skill.

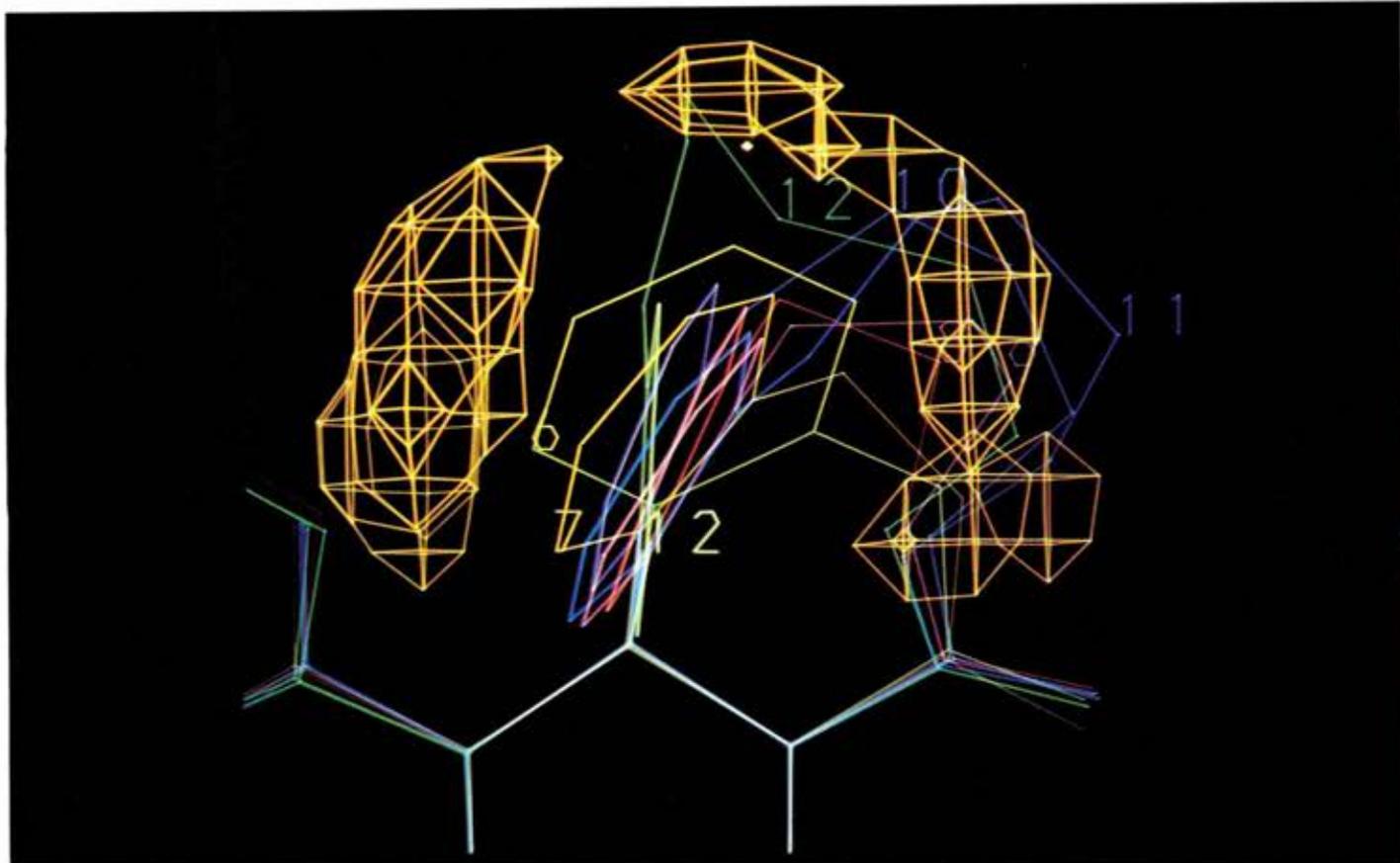
Today, large corporations are sometimes accused of no longer being innovative. The claim is that like all big organizations, corporations of this size are subject to codes of behavior that result in inertia and a tendency to hold on to the status quo.

To direct such a charge at Bayer would certainly not be justified; it is an international corporation with annual sales in the order of DM 37 billion, a work force of over 164,000 people and a business stronghold in virtually every country in the world.

Bayer is far from being the only leading chemical producer; numerous competitors are also active in the same fields. It would thus be a grave mistake for any company to rest on its laurels because only those with a forward-looking approach will be able to survive in today’s markets.

As in the period of rapid industrial growth after Bayer’s founding, the course of the company’s future will be determined by its ability to prepare the way for innovation. Nobody can know for sure what the





future will bring, but a company that wants to succeed on the world's competitive markets today must be able to realize corporate strategies in good time.

Bayer will invest a total of DM 2.5 billion in research and development projects in 1988. The company sees particularly interesting perspectives for innovation in which molecular biology will help to open up new principles of pharmaceutical therapy and crop protection.

Other focal points include high-performance polymers, new engineering ceramics, high-purity products in the special metals sector and technologies based on physics for communications and data processing. All these fields of innovation mean new and immense challenges for the chemical industry.

Modern industry requires products which are both high-performing and custom-made to meet its needs. For example, new information technologies call for materials which can be supplied by inorganic chemistry, and especially by the ceramics industry. The causes of most diseases still cannot be treated, and comprehensive health care would simply be impossible without efficacious pharmaceuticals.

Agrochemicals will also have to face tremendous challenges. In the coming decades, more people will need to be fed than in the whole span of human history to date. Scientists will have the task of

coming up with active agents that combine specifically targeted efficiency with optimum environmental acceptability.

Bayer is not only just striving for profitability and technical quality. The environmental effect of products and processes has long been a major and decisive element in innovative programs and one on which the whole future of the chemical industry depends.

More than anything else, forming the future of the company means preserving the ability to innovate. This challenge will also call for the courage of Bayer's employees to question even the sound, time-tested and successful; the search will continue for still better solutions. The ability to innovate ultimately depends on the willingness of all concerned to learn from experience and to have enough imagination to see where the chances for the future lie.

Bayer has become the company it is today only because of the men and women who have thought and acted with innovation in mind. The company will continue to be successful as long as the employees working in all areas of the organization strive to meet the future challenges with this same spirit of innovation.



At the end of the 19th century, Carl Rumpff, pictured on the left, set the course for Bayer's future development. He quickly recognized that research and development work and the opening up of new markets would decide the fate of the company. The basis for further

success lies with the innovative ability of all concerned. Bayer applies the methods of modern technology to develop new products. Above, the spatial structure of chemical compounds is demonstrated on the screen of a special computer.

Index

- A**
- A Chimica "Bayer" Ltda.
see Bayer do Brazil S.A.
- A plant 248, 419 f., 488
- Aachen 105, 141, 289
- Abbe, Ernst 168
- ABS plastic 333
also see Novodur
- acarbose 578
- accident-prevention seminar 492
- Accounting 193, 560
- acebutolol see Prent
- Aceta GmbH, Berlin 239, 291, 337
- acetanilide 90, 92
- acetate 238, 341
- acetate rayon 165, 169, 238 f.
- acetic acid 77, 108
- acetone 92, 202, 329, 330
- acetophenetidine
see Phenacetin
- acetylene 289, 336, 338, 447
- acetylsalicylic acid 129, 135 f., 216, 465, 515
also see Alka-Seltzer
also see Aspirin
- acid 108
- acid green 49
- A. Cochrane & Co., Boston 47
- Acquired Immune Deficiency Syndrome (AIDS) 571, 582 f., 599
- acridine 264
- acrylic fiber 334, 341, 356, 559
- acrylonitrile 249, 289, 333, 338, 360 f.
- acylureido penicillin 506, 512, 578
also see penicillin
- Adalat 128, 312, 446, 494, 496 f., 498, 519, 535, 578, 599
also see nifedipine
also see Sali-Adalat
- Adam, Dieter 512
- Adelsberger, Udo Eberhard 271
- Adenauer, Konrad 313, 316, 351, 401
- adenine 570
- adhesives 318, 395, 421, 431, 564
also see Cohesan
- adipic acid 286, 336, 368
- Adler, Hans 315
- Adolf Baeyer Society for the Promotion of Chemical Literature 211
- Adolf von Baeyer Memorial Medal 193, 211
- adrenaline 518
- advanced training 450
- advertising 79, 84, 137, 258, 337, 353, 366, 367, 470, 470 f., 515, 565, 567
also see dyestuffs (labels)
- Advertising and Market Research (Corporate Division) 463
- AEG-Telefunken AG, Berlin 201, 277
- aerial advertising 471
- Aerial Sports Clubs, Leverkusen 164, 375
- Aero Lloyd AG 243
also see Deutsche Lufthansa AG
- aeronautics 432
- aerospace 334, 375, 383, 432, 453, 477, 485, 499, 543, 577 f., 598 f.
- Aeschylus 152
- Agfa-Gevaert AG, Leverkusen 280, 282, 313, 356, 408 f., 465, 487 f., 543, 551, 559, 561, 589
also see Gevaert Photo-Producten N.V. Mortsel
also see Perutz Photowerke
- Agfa-Gevaert Inc., Ridgefield Park 487, 489
also see Autographix Inc.
also see Compugraphic Corporation
also see Matrix Corporation
- Afghanistan 177, 523, 535
- Africa 73, 176, 215 f., 220, 267, 277, 365, 442, 445, 482, 563, 597
- African expedition 215, 217, 220 f.
- Afrido Blue 216
- Afrido Violet 216
- AG Administration Services (Service Division) 560, 563
- Agfa AG, Leverkusen 33, 50, 52, 54, 58, 74, 76, 78, 89, 118, 142, 161, 176, 181, 203, 230, 233, 253, 278 f., 309, 315, 408 f., 487 f., 551
also see Agfa-Gevaert AG, Leverkusen
also see Gevaert N.V., Mortsel
- Agfa Australia 401
- Agfa Camerawerk München AG 280, 315, 317, 365, 408, 411 f., 551
- Agfa Copyrapid process 291
- Agfa film 313, 408
see product names
- Agfa Optima 375
- Agfa Products Inc., New York 221
- Agfa rhombus 411
- Agfa "XT" film 282
- Agfachrome film 283
- Agfacolor CT 18 282, 399
- Agfacolor CT copy paper 371
- Agfacolor film 281 f., 289, 399
- Agfacolor New Reversal Film 281
- Agfacolor transparency 281
- Agfa-Gevaert AG, Leverkusen 280, 282, 313, 356, 408 f., 465, 487 f., 543, 551, 559, 561, 589
- Agfa-Gevaert S.p.A., Italy 439
- aging inhibitor see anti-aging agent
- Agricultural Chemicals Division 460, 562
also see agrochemicals
- agricultural chemicals institute, Toyada 588
- Agricultural Department 228
- agriculture 208, 214, 226, 247, 252, 271, 317, 356, 404, 466, 476, 479, 484, 487, 544, 552
- agrochemicals 233, 247, 307, 333, 347, 352, 361, 388, 389, 400, 404 f., 417, 429, 455, 457, 466 f., 516, 532, 546 f., 549, 586 f.
also see product name
- Agrochemicals Center Monheim 129, 229, 457, 468, 488, 513, 519, 523, 544, 545
- Biological Institute 226
- Institute for Biotechnology, Monheim 551
- research 199, 228, 544
- research station 229, 547, 469
- Sector 87, 103, 544, 561
- technical service unit, Munich 215
- Yuki research center 562
- Agrochemicals Sector 88, 544, 549, 561
- Agurin 149
- Ahmadabad 86
- AIDS see Acquired Immune Deficiency Syndrome
- air freight 540
- air ship 145, 245, 253, 289
- air sniffers 403, 426
- air-control van 403
- Akerman, Otto 105
- Akron 251
- Alabama 404
- Alaric 262
- Albany 29, 36, 50, 67, 154 f.
- Albany plant 29, 37, 50, 51, 67, 154
- Albatros-Werke 245
- albumen 256
also see protein
- alcohol 26, 236
- Aldrin, Edwin 334
- Alessandria 436
- Alexander I 271
- Alexander II, emperor of Russia 67
- Alexander III, emperor of Russia 67
- Alexander III the Great, king of Macedonia 262
- Alfa Romeo 435
- alfalfa 466
- Algeria 371, 476
- Algol dyestuffs 89, 170, 173
- Alliança Comercial de Anilinas Ltda.
see Bayer do Brazil S.A.
- Alien Property Custodian 205
- Alinit 129
- alizarin 34, 48, 66
- alizarin blue 97, 142, 144, 172 f.
- alizarin bordeaux 97, 142, 144, 144
- Alizarin Convention 66, 67, 79, 142
- alizarin cyanine 66 f., 144
- Alizarin Department 388
- alizarin dyestuffs 38, 55 f., 142
- alizarin dyestuffs
—department 142 f.
- alizarin plant 36, 37, 38, 45, 51, 64, 110, 149
- alizarin red 35, 552
- alizarin red factory 103, 114
- Alkali Blue 30
- alkane 380
- alkanna plant 16
- Alka-Seltzer 139, 258, 259 f., 514
also see acetylsalicylic acid
- alkyd resin 245 f., 366, 369, 441
- Alkydal 245, 277
- Allende Gousseus, Salvador 459, 485
- allergies
—anti-allergic drugs 439, 582

- Allgemeine Börsenzeitung, Berlin 74, 75, 79
- Allied Chemical & Dye Corp., United States 211, 235
- Allied Control Council 304
- Allied High Commission 307, 313 f., 317
- Alsopp & Sons, Burton-on-Trent 56
- Altenberg Cathedral 151
- aluminum 202, 291, 598
- Amagasaki 588
- ambient monitoring 493
- ambulance service 150
also see polyclinic
- American Chemical Society 289
- American Color & Chemical Co., Rensselaer 156
- American Commercial Company 439
- Ames Company see Miles, Inc., Ames Division
- amino acid 256, 386, 570, 572, 574 f.
- aminoanthraquinone 172
- aminobenzene 19
- ammonia 108 f., 176, 336, 361
—soda process 29
—synthesis 185, 203, 208
- Ammoniakwerk Merseburg GmbH 232
- ammonium sulfate 415
- Ampicillin 355, 493, 508, 512
- Amrhein, Hubert 194
- Amsterdam 24
- Amundsen, Roald 193
- anaesthetic 90, 417
- analgesic 50, 135, 139
- anatase 362, 364
- Anchorage 559
- Andersag, Hans 266, 283
- Andhra Pradesh 457
- André, Salomon August 129
- Andresen, Momme 89
- angina pectoris 141, 177, 494, 497
- Angola 476
- aniline 18 f., 26, 32, 92, 240, 242, 357, 419
- Aniline Blue 32 f., 280
- Aniline de Nuit 26
- aniline dyestuffs 19, 24, 26, 29, 38, 45, 55 f., 216, 242
- aniline factory 29 f., 33, 45, 52, 64
- aniline oil 45
- Aniline Purple 20
- Aniline Violet 26
- aniline warehouse 94
- animal experiments 79, 90, 130, 135, 219, 263, 322, 507, 580
- animal health 365, 400, 445
—Business Group 549, 561
—department 261
- animal health research station 441
- anopheles mosquito 262, 263, 264, 266, 474
- ANS unit 488
- anthracene 35, 36, 51, 173, 176, 254, 358
- Anthracene Blue 144
- anthracene purification 38, 109, 112
- Anthralan wool dyestuffs 267
- anthraquinone 35, 109, 153, 172 f., 228, 254, 419
- anthrax bacilli 51, 506
- antibiotic 218, 324, 355, 505, 506, 513
- Antifebrin 90, 92
- antihypertension drug 496
- Antileprol 181, 219
- Antimosan 445
- antimycotic see fungicide
- Antinonin 103, 547
- antioxidant see anti-aging agent
- antiozone agent 189
- antipyretic 90
- Antipyrine 90
- antiseptics 90, 272
- antituberculosis drug 299, 303
- anti-aging agent 189, 193, 261, 396, 398, 480
- Antweiler 317
- Antwerp 95, 97, 211, 282, 389, 408, 414 f., 417, 459, 480, 499
- Antwerp works 185, 364, 414, 415 f., 459, 499, 518, 540
also see Schelde Chemie
- APEC 329
- apoplexy 494, 499
also see stroke
- Application Technology Department 63, 84, 330, 339, 430, 460
see Colorist Department
- application technology: 63, 84, 88, 242 f., 347, 430, 458, 460, 588
- apprentice 29, 87
- apprenticeship diploma 451
- Aprotinin 575
- Aquacillin 510
- Aranjuez 465
- archives see Bayer archives
- Arequipa 356
- Argentina 257, 351, 356, 389, 413, 477, 485, 505, 535
- Aristophanes 152
- Armstrong, Henry Edward 68, 98
- Armstrong, Neil 334, 453
- Arnhem 199, 401
- arsenic 30, 219
- arsenic acid 26, 30
- arteriosclerosis 123, 177, 494
- artificial silk 73, 126, 233 f., 236, 237, 245, 334
—production 233, 239, 337
- artificial sweetener 308, 399, 564, 567
—Bayer sweetener 308, 309
also see Fructusan
also see Natreen
also see Sionon
- ascorbic acid see vitamin C
- Asia 190, 244, 267, 294, 442, 482, 563, 583
- Asilomar 577
- Asperix 139
- Aspirin 134, 134 f., 140, 156, 207, 258, 312, 361, 389, 439, 465, 469, 470, 475, 519, 578
also see acetylsalicylic acid
- Association for the Protection of the Interests of the Chemical Industry of Germany 60, 158, 200
- Association of German Industry (RDI) 209
- Astrazon dyestuffs 291, 338, 357
- Astrozon Green M 52
- Asuntol 365
- Asypin 219
- Atatürk, (born Mustafa Kemal Pascha) 221
- Atebrin 264, 265, 444, 578
- Athens 123, 493
- athlete's foot 485
- atomic absorption spectrometer 602
- Atomium Corporation, Massachusetts 517
- Atoxyl 219
- Auburn 243
- Audi 100 434
- Audi NSU Auto Union AG, Ingolstadt 434
- Auer von Welsbach, Carl 79
- Auguste Victoria coal mine, Marl (near Recklinghausen) 176
- Augustus 16
- Aureomycin 309
- Auschwitz 297, 306, 448
- Australia 153, 176, 206, 441, 505, 597
- Austria 29, 39, 60, 67, 89, 200, 205 f., 209, 271, 291, 351, 383
- Autan 567
- autoclaves 33, 78
- Autographix Inc., Waltham, Massachusetts 487
- Automatic 66 357
- automobile 70, 83, 105, 126, 137, 149, 190, 192, 193, 199, 202, 229, 247 f., 330, 370, 393 f., 421, 430, 430 f., 433 f., 523, 584
also see automobile manufacturer
—mechanic 430
- automobile industry 247, 382, 394, 465, 588 f., 598 f.
- autoradiogram 576
- Avery, Oswald Theodor 568
- AWALU laboratories 425
- azo blue 80, 82
- azo department 77
- azo dyestuff D 4145 274
- azo dyestuffs 55 f., 56, 59, 73, 77 f., 81 f., 82, 120, 142, 216, 218 f., 274, 552
- azo dyestuffs production facilities 57, 64, 78, 129, 480
- azo orange 58
- azo yellow 58
- Bad Pyrmont 36
- Bad Wörishofen 67
- Baden-Powell, Robert Stephenson Smyth Baaron 181
- Baekeland, Leo Hendrik 177, 326
- Baeyer, Adolf von 29, 72 f., 98, 120, 158, 159, 169 f., 190, 193, 211
- Bakelite 177, 326
- Baker, Josephine 243
- balance sheet 214 f., 315
- Balkan war 197, 199
- Baltic 48, 205, 280
- Baltimore 438
- Banat 211
- Bangkok 413, 454
- Bangladesh 469
- Bangpoo 455
- Banting, Frederick Grant 215
- Barcelona 73, 441, 464 f.
- Bardeen, John 357
- barium maganate 242
- barium sulfate 242
- Barmen plant 28, 30, 33, 59, 64, 146, 150
- Barnard, Christaan Neethling 441, 497
- Barthou, Louis 271
- Basel 28, 33, 105, 148, 236, 340, 407, 539, 599
- BASF AG, Ludwigshafen 28, 35, 50, 58, 66, 106 f., 120, 129, 141 f., 145, 152, 158, 170, 172 f., 175 f., 198, 203, 205, 224, 230, 248, 394, 415, 440, 503
—Oppau plant 160 f., 173 f., 203, 205
- Batista y Zaldivar, Fulgencio 375
- Bauer, Max 202
- Baumann, Eugen 93
- Bayblend 329, 434
- Baycain 383
- Baychem Corporation, New York 467, 469
- Baychrom 255
- Baycillin 399, 508, 510
- Baycor 551
- Baydur 432, 434
- Bayer, Caroline Juliane (Julie), née Hülsenbusch 28, 62, 64
- Bayer 39, 63
- Bayer, Erna, née Schniewind 62
- Bayer, Friedrich Jr. 38, 55, 63 f., 80, 100, 106, 144 f., 156, 158, 182, 194, 210 f.
- Bayer, Friedrich Sr. 14, 24, 25, 26, 28, 30, 36, 38 f., 45, 48, 55, 62 f., 72 f., 562
- Bayer, Otto 102, 284 f., 286 f., 299, 314, 315, 318, 330, 336, 338, 366, 551
- Bayer, Richard 315
- Bayer 04 Leverkusen
see TSV Bayer 04 Leverkusen
- Bayer 205 see Germanin
- Bayer Aerial Sports Club 141
- Bayer Agrochem 458
also see Bayer India Ltd.
- Bayer Antwerpen N.V., Antwerp 414
also see Antwerp works
- Bayer archives 35, 59, 110, 182, 199, 211, 278, 523
- Bayer Belgium S.A.-N.V., Brussels 493
- Bayer Bromitkontrast 215
- Bayer Canada Inc., Pointe Claire 371
- Bayer Chemicals Ltd., United Kingdom 333, 553
- Bayer China Co. Ltd., Hong Kong 371
- Bayer clubs 162, 167, 169, 554
also see club name
also see cultural clubs
also see sports clubs
- Bayer Company, Inc., United States
see Albany plant
- Bayer computing center 441
- Bayer cross (illuminated sign) 5, 268, 269 f., 400 f., 611
- Bayer cross (trademark and logo) 23, 136 f., 162, 163, 165, 207, 233, 283, 296, 367, 400, 407, 436, 470 f., 473, 489, 528, 533, 541, 553, 556 f., 589
- Bayer de Mexico, S.A. de C.V., Mexico City 357
- Bayer department store 117, 167, 168, 169, 213
- Bayer do Brasil S.A., São Paulo 193, 325, 347, 352 f., 485, 523
—Belford Roxo Plant 354, 355, 493
- Bayer Dyestuffs Ltd., United Kingdom 401, 553
- Bayer Employee Funds 556
- Bayer Far East Company, Hong Kong 371
- Bayer Foreign Investments Ltd. (Bayforin), Toronto 365, 439
- Bayer France S.A., Puteaux 310, 499
also see Progil-Bayer-Ugine
also see Fliers plant
- Bayer Hispania Industrial S.A. (BHI), Barcelona 441, 453, 464, 465
—Barcelona plant 465
—Tarragona plant 465
- Bayer India Ltd., Bombay 123, 383, 456 f.
—Thane works 456 f., 528
- Bayer Industrial S.A., Lima 356
- Bayer Italia S.p.A. 436, 437, 605
—Cannara plant 439
—Filago plant 439
—Garbagnate plant 439
- Bayer Japan Ltd., Tokyo 193, 229, 587, 589
- Bayer Kemi AB, Gothenburg see Bayer (Sverige) AB
- Bayer Limitada S.A., Lisbon 277
- Bayer lion (trademark) 38, 97, 117, 160, 163, 199, 270
- Bayer Maroc S.A., Casablanca 383
- Bayer Men's Choir, Brazil 523
- Bayer Men's Choir, Leverkusen 178, 449, 523
- Bayer Nederland B.V. 199, 401
- Bayer Orchestral Society 145, 178
- Bayer Pharma AB, Stockholm
see Bayer (Sverige) AB
- Bayer Pharma Indonesia 453
- Bayer Pharma S.A., Sens 312
also see Bayer Foreign Investment Ltd.
- Bayer Pharmaceuticals (Nigeria) Ltd., Lagos 499
- Bayer Pharmaceuticals, Australia 399
- Bayer Philharmonic Orchestra, Leverkusen 178, 179, 181, 449
- Bayer Philippines, Inc., Manila 399, 583
- Bayer Portugal S.A., Lisbon
see Fredco Bayer & Cia.
- Bayer Reports 127, 129
- Bayer Shanghai Dental Ltd. 592, 599
- Bayer social service benefits 554
- Bayer Thai Company, Ltd. 399, 454
- Bayer UK Limited, Newbury 447, 552, 553
- Bayer USA Inc., Pittsburgh 486, 599
also see Rhinechem Corporation
- Bayer Women's Choir 499
- Bayer Yakuhin Gomei Kaisha, Japan 247, 587 f.
also see Bayer Japan Ltd.
- Bayer (Sverige) AB, Gothenburg 493
- Bayerischen Motorenwerke AG (BMW), Munich 430
- Bayer-Chimie see Bayer France S.A.
- Bayer-Email see enamel
- Bayer-Phytochim see Bayer France S.A.
- Bayer-Shell-Isocyanates N.V., Antwerp 417
- Bayer-Wohnungen GmbH 325, 607
also see employee housing
- Bayferrox 240
- Bayfill 432
- Bayfill 432, 434
- Bayflex 393, 432, 434, 435, 523
- Bayforin see Bayer Foreign Investments Ltd.
- Baygen 347
- Baygon 413, 467, 474 f., 548, 567
- Baykanol 255
- Baykofaden 185
- Bayleton 505, 546
- Bayluscid 444, 445 f., 467, 548
- Baymer 432
- Baymicron 593
- Baynat 432, 434
- Bayonne 487
- Bayotensin 496, 499
- Baypen 508, 512
- Baypren 357, 371, 395
also see Perbunan C
- Bayropharm GmbH, Cologne 447
- Baysical 351
- Baysilone M 50 EL 382
- Baytan 546, 549, 605
- Baytex, United States 469
also see Baychem Corporation
- Baytherm 434
- Baythroid 559
- Baytcol 559
- Baytown 459, 487, 505
- Baywood Chemicals, United Kingdom 553

- Beadle, Clayton 236
 Beardley, Albert Raper 515
 Beardley, Andrew Hubble ("Hub") 258
 Beardley, Charles Sumner 260 f.
 Becker, Theodor Hermann 238 f.
 Becker, Boris 583
 Becquerel, Antoine Henri 123
 Beecham Laboratories, United Kingdom 508, 510
 Beethoven, Ludwig van 178
 Begin, Menachem 513, 519
 Behnisch, Robert 322
 Behring, Emil von 97, 149
 Behringwerke AG, Marburg 233, 253, 441
 Beiersdorf, Paul 67
 Beiersdorf AG, Hamburg 67
 Beijing 592
 Beilstein, Friedrich Konrad 67
 Beirut 551
 Belford Roxo 352, 355 f.
 Belford Roxo plant see Bayer do Brazil S.A.
 Belgium 51, 59, 63, 67, 204 f., 235, 299, 365, 383, 410, 605
 Bell, Alexander Graham 51
 Bell, Johannes 208
 Bell Corporation, United States 229
 Bell Laboratories, United States 351
 Bell Telephone Company, United States 51
 Bemberg silk 239
 benefit payment in case of death 42, 44
 Benz, Carl Friedrich 83, 126
 benzene 29, 124, 176, 358, 361
 benzidine 74, 76, 78, 81, 133
 benzidine dyestuffs 79, 493
 Benzo Blueblack 82, 142
 Benzo Fast Blue 142
 Benzo Fast Scarlet 142
 Benzoazurine G 80, 82, 90
 benzoic acid 245, 344
 benzopurpurine 76, 76, 82, 118, 142
 benzopurpurine 1 B 76, 78
 benzopurpurine 4 B 74, 76
 Bergdoldt, Wilhelm 180
 Berger, Heinz 302
 Bergischer Verein für Gemeinwohl 89
 Bergisch-Märkische Eisenbahn 67
 Bergius, Friedrich 199, 261
 Bergmann, Ernest von 55
 Berichte der Deutschen Chemischen Gesellschaft 54
 Berkeley 573, 575
 Berlin 19, 26, 33, 35, 39 f., 58, 60, 74 f., 79, 89, 97, 117 f., 126, 134, 137, 145, 169 f., 175, 181, 193 f., 197, 199, 201, 203, 207, 209, 220 f., 239, 250, 271, 278, 280 f., 283, 291, 294, 309, 315, 325, 333, 337, 345, 371, 388 f., 401, 407 f., 413, 441, 447, 469, 564, 577, 594
 Berlin Motor Show 250, 283
 Berliner, Emil 89
 Bern 45
 Bernstein, Richard Barry 324
 Berry, Charles A. 141
 Berthelot, Marceline Pierre Eugène 46
 Berufsgenossenschaft (professional association of the chemical industry) 79, 491
 Berzelius, Baron John Jacobs von 46
 Best, Charles Herbert 215
 Betaxin 283
 beta-receptor blocker 499, 513
 Bethmann Hollweg, Theobald von 185
 Bevan, Eduard John 236
 Beyer, Georg Friedrich 24
 Beyer, Johannes 24
 Beyer, Peter Heinrich Friedrich 24
 Bhopal 457, 538, 577
 Bhopal accident 577
 Biebrich 28, 58, 90
 bifonazole see Mycospor
 Bilharz, Maximilian Theodor 442, 443
 bilharzia 253, 442, 476, 535, 578, 599
 Billroth, Theodor 67
 Billy camera 411
 Biltricide 312, 444, 446, 535, 599
 Binotal 399, 508
 Biochemical Laboratory—Elberfeld works 511
 biochemical oxygen demand (B.O.D.) 424 f.
 biological laboratory technician 452
 biological monitoring 132, 493
 biological tolerance levels 493
 biologist 407
 biotechnology 103, 519, 551, 568, 571 f., 576 f., 581
 Birlinghoven 88, 318, 321
 Birmingham 559
 Bismarck, Prince Otto von 29, 39 f., 59, 73, 89, 97
 Bitterfeld 280
 Bizet, Georges 47
 black dyes 142, 153
 black fever 253
 Black Forest 176 f., 365
 black-and-white film 281, 302, 351, 413
 also see Isopan
 Bladafum 405
 Bladan 405
 Blankophor 389
 Blériot 185
 blood plasma 489, 569, 573
 blood poisoning 272, 507 f.
 blood sugar test 575
 Blue Star photo paper 410
 Board Committee 563
 also see Committee name
 Board of Management (Bayer AG) 64, 194, 225, 314, 316, 354, 362, 388, 440, 462, 488, 561, 563 f.
 Bock, Walter 248, 251
 Boeckelmann 105
 Boehringer & Söhne, C.F., Mannheim 141
 Boeing 747, 369, 459
 Bogota 356
 Böhme, Otto 314, 315
 Bohn, René 172 f.
 Bohn-Schmidt reaction 144
 boiler house 348
 boilermaker 502
 Bolivia 59, 356
 boll weevil 404
 Bolstar 468
 Bombay 86, 94, 123, 456 f., 459
 Bonalin 564
 Bonn 20, 124, 210
 Bonrath, Wilhelm 228
 book binder shop 79
 Booth, William 59
 borax 438
 Borgwardt, Helmuth 314, 315
 boric acid 144 f., 145
 boride 598
 Borneo 192
 Borrell, André Amédée 157
 Bosch, Carl 208, 222, 223, 224 f., 230, 253, 261, 294 f.
 Bosch, Robert 153, 168
 Bossert, Friedrich 497
 Boston 35, 47, 154, 155, 573, 575, 594
 Böttiger, Paul 77
 Böttiger, Heinrich 56
 Böttiger, Henry Theodor 48, 59, 63, 66, 73 f., 86, 93, 100, 104, 106, 145, 168, 194, 201, 210 f.
 Böttiger convalescent home see Grosse Leder
 Böttiger Festschrift see History and Development of Farbenfabriken vorm. Friedr. Bayer & Co. in its First 50 Years
 Bottrop 403
 Box camera 411
 BP Benzin und Petroleum AG, Hamburg 163, 338, 358, 361
 Bradford 24, 552
 Brandt, Willy 413, 453, 459, 469, 477, 493
 Brattain, Walter Houser 357
 Brauer, Heribert 79
 Braun, Karl Ferdinand 129
 Braun, Baron Werner von 459
 Braun tube 129
 Brazil 103, 190, 257, 325, 346 f., 352, 364, 447, 493, 518, 562, 697
 Brecht, Gustav 315
 Bree, Johann Friedrich 93
 Bremen 95
 Breslau (today Wrocław) 19, 193
 Brest-Litovsk 205
 Bretton Woods 469, 763
 Bretton Woods Conference 469
 Breuer, Josef 117
 Brezhnev, Leonid 413, 523, 551
 Briand, Aristide 235
 British Alizarine Company 66, 145
 British Dyes Ltd. 209
 British Dyestuffs Corporation Ltd. 209, 235
 British Leyland 434
 British Petroleum Company PLC, London 361
 also see Deutsche BP Benzin und Petroleum AG Hamburg
 British Vita, Manchester 605
 Brockmann, Hans Heinrich 289
 Brookhaven Laboratory, United States 429
 Brönner's acid 76 f., 82
 Brugge 438
 Brugsch, Heinrich 442
 Brunck, Heinrich von 144, 158, 160, 173
 Brunner, Mond & Co., United Kingdom 235
 Brunsbüttel 459, 478 f., 513, 583, 599, 607
 Brunsbüttel works 185, 459, 478 f., 479, 481, 513, 528, 551, 599, 607
 Brüning, Gustav von 158, 160
 Brussels 24, 493, 559
 Bryce & Rumpff, Glasgow 552
 BSI plant 416, 417
 Büback, Siegfried 513
 Büchel, Karl Heinz 563
 Buchenhofen 427
 Buchloh, Adolf 93
 Buenos Aires 347, 356, 477, 596
 Buff, H. 45
 Buffalo 149
 Buick Skyhawk 435
 building department 64
 building inspector 501
 Bulgaria 197, 205
 Bülow, Bernhard Heinrich Martin 145, 185
 Buna 193, 248, 249 f., 283, 289, 295, 394, 397
 Buna CB 396, 397
 Buna N 249, 271
 also see Perbunan
 Buna S 250, 277, 289
 Bunawerke Hüls GmbH (BWH), Marl 351, 394, 397, 560
 Bunsen, Robert 46, 98
 Burg 481
 Burton-on-Trent 56, 74
 Busbach, Adolf 374
 Busch, Wilhelm 153
 Bushy Park 346, 447, 469, 519
 Bushy Park Plant
 see Mobay Corporation
 see Verona Dyestuffs
 business assistant 452, 477
 Business Groups (Bayer AG) 88, 102 f., 127, 356, 418, 532, 560 f., 563, 607
 also see name of Business Group
 Busse, A. 289
 butadiene 189, 248 f., 333, 361, 395, 499
 Butenandt, Adolf Friedrich Johann 315
-
- C**
 cadmium pigment 242
 cadmium selenide 242
 Cairo 413, 442, 446
 Calais 185
 calcinosis 494
 California 129, 285, 543, 575, 576
 camera 278, 289, 409, 411, 432
 also see product name
 Camp David 519
 Campbell, Malcolm 267
 Campolon 261
 Canada 33, 154, 158, 294, 347, 459, 519, 553, 584, 597
 cancer 157, 169, 494, 505, 571
 Canesten 458, 482, 519, 546, 578
 also see Empecid
 also see Mycellex
 Cannara 439
 Cannara plant see Bayer Italia S.p.A.
 Cannstatt 126
 Canton (Kuang-chou) 86
 capital stock 66, 317
 caprolactam 330, 337, 415, 499
 car and truck facilities 96
 carbamate 475
 carbamic acid 287
 carbolic acid 272
 carbon 124, 380
 carbon disulfide 236, 238
 carbon fiber 432
 carbon paper 592
 carbonate 243
 cardiac infarction 133, 141, 495, 571
 cardiovascular medicine 494
 Carl Duisberg Foundation 211
 Carl Duisberg House, Marburg 211
 Carl Duisberg Park 70, 167
 Carl Duisberg Society 488
 Carl I of Hohenzollern-Sigmaringen 67
 Carl Rohde & Co., Japan 587
 Caro, Heinrich 35, 58, 120, 160, 170
 Carothers, Wallace Hume 277, 287, 336 f.
 carpenter 45
 Carter, Howard 215
 Carter, James Earl 513, 519, 523
 Cartwright, Edmund 17
 Caruso, Enrico 137
 Casablanca 299
 Caspari, Hugo 177, 180
 Cassella AG, Frankfurt 142, 161, 224, 230, 232 f.
 Castres 594
 Castro Ruz, Fidel 375
 Castrop-Rauxel 403
 CAT scanning 413
 catalytic process see contact process
 Cebion 271
 Celebes 445
 cell biology 573, 575
 Cellidor 239, 330
 Cellit 169, 201, 239, 245, 246, 308, 330
 Cellit coating 245
 Cellit film 239
 Cellon 201, 239
 celluloid 239, 326
 cellulose 169, 188, 202, 236, 238 f., 239, 295, 344, 386
 —cellulose fiber 340, 384
 —cellulose film 83
 cellulose acetate 169, 238 f., 330
 Central Analytics (Department) 602
 Central Application Technology (Corporate Division) 462, 463
 Central Association of German Industrialists 51
 Central Commercial Office 566
 Central Committee Marketing (CC) 566
 Central Engineering (Division) 354, 420, 535, 561, 563
 Central Information and Documentation Center 129
 Central Office for Educational Programs 448
 see Cultural Department
 Central Pilot Plant for Organic Chemicals (ZeTO) 418, 418, 419, 421
 Central Research and Development (Corporate Division) 102 f., 462, 532, 561, 602
 Central Rubber Laboratory 86, 249
 central telephone system 185
 Central Workshops 354, 502, 502, 561
 Centro Sviluppo Ceramica, Italy 439
 ceramics 243, 436, 439, 489, 596, 605, 609
 —ceramic materials 596, 597 f.
 —engineering ceramics 562, 594
 Ceresan 253
 cermet 596
 Certan 209, 229
 Cesano 505
 Ceylon see Sri Lanka
 Chagas, Carlos 474
 Chagas' disease 459, 474
 Chain, Ernst Boris 507, 509
 Chamberlain, Joseph Austen 291
 Chaotee temple 454
 Chardonnet, Count Hilaire Bernigaude de 73, 97, 126, 236
 Charité Hospital, Berlin 507
 Charles Goodyear Medal 288, 289
 Charleston 487
 Chemagro Corporation, United States 333, 347, 466, 469, 487
 also see Baychem Corporation
 also see Mobay Corporation
 Chemdyes Doitsu Senryo see Bayer Japan Ltd.
 Chemical Abstracts Service (CAS-Online), United States 126, 129
 chemical oxygen demand (C.O.D.) 424
 chemical technician 69, 429, 450

- chemical technician 452
chemical weapons 203, 405
Chemische Fabrik Griesheim-Elektron 28, 115, 203, 224, 230
also see Uerdingen works
Chemische Fabrik Kalk GmbH, Cologne 115
Chemische Fabriken vorm. Weiler-ter Meer AG, Uerdingen 42, 50, 55, 107, 123, 145, 181, 203, 230, 240
Chemische Produkten-Fabrik zu Oranienburg 17
Chemische Werke Hüls AG, Marl 371, 394, 422, 429, 503, 519
Chemists' Conference 103, 105, 109, 124
also see reading circle
chemotherapy 175, 216, 218, 272, 322, 583
Chernobyl 599
Chevrolet Monza 435
Chiang Ching 543
Chiang Kai-shek (born Chiang Chung-chen) 505
Chicago 105, 199, 260, 466, 516
chicken pox 139
Chika Ltd., India 459
also see Bayer India Ltd.
childbed fever 272, 275
children's home 317
Chile 59, 347, 356, 459, 485
Chile saltpeter 108
China 58, 67, 84, 86, 87, 109, 145, 193, 198 f., 230, 243 f., 267, 289, 313, 388, 429, 445, 455, 477, 505, 543, 586, 592, 597, 599
China Blue 30
Cinchon 262
chloramphenicol 509, 511
chlorinated rubber see Pergut
chlorine 108, 197, 202, 246, 302, 419
chlorine gas 203, 205
chloroprene 499
chloroprene rubber 357
chloro-quinoline see Resochin
cholera 73, 109, 422
cholesterol 188, 494
Chou En-lai 505
Christians, F. Wilhelm 374
chrome tanning 254 f., 256
chromium oxide pigments 242
chromogen developing 281
chromosomes 79, 568, 573
Chrysamine G 77
Church, Arthur Herbert 20
Churchill, Winston Leonard 206, 207, 303, 417
Ciba-Geigy AG, Basel 28, 407, 480, 513, 583
cinchona bark 90
cinchonati 471
Ciprobay 506, 509, 512, 513, 519
ciprofloxacin see Ciprobay
citric acid 67, 105, 514, 518 f., 549
City of London School 20
Clack 1900 camera 411
clerk assistant 452
Cleveland 229, 289
Clifton 518
clinical testing 92, 141, 275, 322, 477, 497
Clinostat 518
Climistix 517
Clinitek 517
Clinitest 516 f.
clotrimazole see Canesten
clove oil 344
coal 14, 15, 95, 151, 176 f., 202, 207, 229, 298, 317, 358, 395, 500, 553, 597
coal hydrogenation process 103, 229, 243, 247
coal tar 17 f., 35, 51, 93, 176, 192, 358
coal (anthracite) 15, 199, 349
coal-tar dyestuffs 14, 26
coating raw materials 86, 88, 238, 244, 318, 366, 382, 439, 465, 562
—Coating Raw Materials and Specialty Products 561
coatings 86, 243 f., 246, 296, 362, 366, 368, 371, 382, 387, 389, 431, 435, 439 f.
—coatings and plastics testing unit 86, 283
—pilot plant 247, 370
cobalt 246, 594, 596
Coburg 594, 599
Coca-Cola 83, 137, 337
cochineal scarlet 16
cod liver oil 209, 289
Cohedur 429
Cohesan 564
Cohévult 307
Cohnheim, Julius 55
Colfarit 141
collagen 256
collodion 236
Cologne 63, 115, 123, 129, 161 f., 181, 199, 202, 227, 247, 250, 282, 296 f., 302, 315, 327, 331, 338, 351, 357, 361, 383, 400, 425, 448, 450, 453, 521, 538, 543, 551, 554, 562, 567, 599, 600, 604
Cologne Cathedral 63, 296, 298
Colombe, Cesare Joe 340
Colombia 157, 356, 383, 518
colophonium 244
Colorado beetle 309, 333
colorimetry 87
colorist 63, 84, 86, 109, 199
also see Application Technology
also see dye-testing unit
—colorist conference 109
—Colorist Department 63, 84, 86, 199
Colour Chemicals Ltd., Bombay 459
also see Bayer India Ltd.
Columbia Black 142
Columbia (space shuttle) 543, 598
Columba 127
Columbus, Christopher 464
Columbus Dental, St. Louis 599
Combistix 517
commercial clerk 452, 477
Commerzbank AG, Frankfurt 38
Committee for Clean Factory Air 148, 149, 199, 422
Committee for the Promotion of Educational Endeavors 180
Committee for Worker Affairs 165
Community of Interests of the German Coal-Tar Dyestuffs Industry see Interessengemeinschaft der deutschen Teerfarbenindustrie
compact disc 331, 332, 333, 559, 583
Compagnia Farmaceutica S.A. (Cofa) see Bayer Italia S.p.A.
Compagnie Nationale des Matières Colorantes et Produits Chimiques 208, 215
Companhia de Acidos see Bayer do Brazil S.A.
company anniversary
—75th anniversary (1938) 291
—50th anniversary (1913) 197, 198
—centennial (1963) 102, 316, 400
—125th anniversary (1988) 94, 374, 544, 578
company housing 89, 116, 117, 166 f., 167, 201, 271, 325, 373
also see Gemeinnützige Wohnungsgesellschaft mbH
—model apartment 117, 167
company journal 193, 277, 309
—Die Erholung 193, 277
—From Plant to Plant 277
Compiègne 205
Compton, George E. 515
Compton, Walter Ames 516 f.
Compugraphic Corporation, Wilmington, Massachusetts 413, 487, 489, 551
computer see electronic data processing
computerized warehouse 542
computer-aided design (CAD) 100, 101, 354
computer-aided engineering (CAE) 354
computer-aided synthesis planning 128
concentration camp 292, 297 f.
Congo 220, 445
Congo red 118
also see patent trial
Congo red 74, 76, 76, 118, 142
coniferin 344
Constantinople 73, 97
also see Istanbul
Consumer Products (Business Group) 516, 549, 561, 564
contact process 107 f., 145
Conteben 276, 322, 324
Continental Caoutchouc und Guttapercha Compagnie, Hanover 190
"Contributions to One Hundred Years of Company History" 400
controlled dump 422 f., 426, 426, 428, 429, 505, 603
cook 223, 452
Cooley, Denton Arthur 453
cooling water 350, 415, 427, 525
cooper 45
—cooper's workshop 502
Copenhagen 338
copper 202, 226, 417
copper oxide ammonia process see cuprammonium process
copper vitriol 226
Corifin lozenges (Coryfinchen) 455, 564
corn 455, 466
coronary sclerosis see angina pectoris
coronary vessels 497, 499
corporate administration
—high-rise office building (W1) 140, 376, 383, 400, 401, 594, 601
—Q 26 building, Leverkusen 23, 195, 197, 207, 214, 314 f.
Corporate Auditing (Corporate Staff Division) 561, 563
Corporate Coordination (Board Committee) 563
Corporate Division 460
also see Corporate Division name
also see Service Division
also see Service Division name
Corporate Law and Taxes (Corporate Division) 462, 463
Corporate Planning (Corporate Staff Division) 561, 563
Corporate Staff 462, 488
Corporate Staff Division 561, 563
Correcta Werke GmbH, Bad Wildungen 493
corrosion 247, 366, 382, 431, 434
cortisone 277
Corvinus, Jakob see Wilhelm Raabe
cosmetics 564
cotton 17, 30 f., 31 f., 52, 58 f., 69, 74 f., 78, 173, 219, 238 f., 294, 334, 337, 341, 384, 386, 404, 405, 407, 455, 457, 466, 476, 585
Cotton Album 123
Coubertin, Baron Pierre de 109
Council of the Gods 223
coupling of power and heat 349
co-determination 372
Co-Fa see Bayer Italia S.p.A.
cracker 358, 360 f.
Craftsmen Department 45
also see Engineering Department
crane 96, 113, 541
Cremer, Gustav 315
Cremer-Forschungs-Institut GmbH & Co. KG (CFI), Coburg 594, 599
Crick, Francis Harry Compton 333, 568
croceic acid 58, 77 f.
Crocein Orange 49, 58
Crocein Scarlet 49, 58, 61, 77
Crocein Yellow 61
crop protection 226, 287, 325, 347, 355, 357, 404, 413, 439, 487, 488, 544, 549, 551, 559, 583, 609
—Business Group 549, 561
—research station 228, 413, 467 f., 469
Cross, Charles Frederick 236
crystal violet 54
cultural clubs 178, 449
also see club name
Cultural Department 178, 448, 462
Cultural Revolution 388, 429
Cuprama 239, 271, 308, 341
cuprammonium process 238 f., 271
cuprammonium rayon 236
Cupresma 237, 238, 239, 341
Curie, Marie 133, 193
Curie, Pierre 133, 193
currency reform 308, 371
customer file 153
customs 17, 48, 50, 94, 215, 290, 341, 358, 540, 566
Cutter, Edward A. 129, 175
Cutter Laboratories Inc., Emeryville 129, 488 f., 519, 559, 567, 571
Cydsa-Bayer S.A., Mexico 493
cytoplasm 570
cytosine 570
- D**
Daguerre, Louis Jacques Mandé 278
Daimler, Gottlieb 83, 126
Daimler-Benz AG, Stuttgart 109, 126, 243, 434
Dallas 401, 466
Dalton, John 46
Daphnia pulex 147
Darmstadt 271, 444, 446, 599
Darwin, Charles Robert 67, 71
Davy, Humphry 46
Dawes, Charles Gates 214
Dayton 518
DD coating 299, 312, 366, 369 f., 389, 434 f.
DDT 167, 407, 549
De Gaulle, Charles see Gaulle, Charles de
Deerfield Urethane, Inc., United States 489
DEGESCH GmbH, Frankfurt 306
Degeyer, Pierre Ch. 39
Degussa, Frankfurt 439
Delhi 55
delial 564, 565
Delplace, Gustav 106 f.
Demeler, Karl 145
Dencker, Paul 314, 315
Denka Chemical Corporation, Houston 605
Denmark 299, 383, 477
Dental Department 271, 383, 400
dentures 44, 382, 592
Denver 466
deoxyribonucleic acid (DNA) 333, 568, 569, 570, 572, 573, 577
deoxyribose 570
Department of War 201, 203
Derivados del Fluor S.A., Bilbao 465
Descat 49
Desgrange, Henri 157
Desio 505
Desmodur 366, 368, 369, 389, 417, 480
Desmopan 394, 397
Deterding, Henri 177
detergent 177, 253, 389
Detroit 105, 229, 260, 435
Deutsche Bank AG, Frankfurt 38, 556
Deutsche Gesellschaft für Fondsverwaltung m.b.H. (DEGEF) 556
Deutsche Grammophon Gesellschaft 89
Deutsche Lufthansa AG, Cologne 243, 513
Deutsche Pferde-Eisenbahn-Gesellschaft 39
Deutsche Shell AG, Hamburg 417
Deutsche Solvay Werke GmbH, Solingen 66, 198, 415
Deutsche Titangesellschaft see Kronos Titan GmbH
Dhünn river 427, 525
diabetes 516, 575, 578
diagnostics 489, 514, 517 f.
diameter 287
diaminotoluene 108, 286
Diamond Black 109, 142, 153
diaminidine 81 f., 94
Diabene 325
dibromo-indigo 18
Dichlor Stapenor 508, 511
Die Erholung see company journal
Dieckmann, Max 229
Diemitz 564
diethylene glycol 286, 368
digitalis 495
diisocyanate 287, 318, 330
Dillinger, John 271
diluted sulfuric acid 363 f., 551
dimethylbutadiene 189, 192
dimethylformamide (DMF) 336, 338
dinitrotoluene 108, 286
diphenylcarbonate 329
diphenylmethane-4,4'-diisocyanate (MDI) 287, 355, 357
diphtheria 97, 175, 253, 441, 506
Dipterex 406, 467
Direct Deep Black E 142, 153
disinfectant 177, 274, 302, 421
Disney, Walter Elias 243
Disraeli, Benjamin, Earl of Beaconsfield 47
DISTR I (Distribution des Colorants) see Bayer France S.A.
Dittmar, Gerhard 374
dividend 74, 79, 198
Division 460
also see Business Group name
also see Division name
also see Sector name
Dix, Otto 272
DNS gyrase 509
Dollfuss, Engelbert 271
Domagk, Gerhard 267, 272, 273, 276, 299, 303, 322, 324 f., 507

- Dome Chemicals, Inc., New York
see Miles Pharmaceuticals
domestic subsidiary
see company
see headquarters
Donauwörth 430
dopa 496
Dorix 417
Dormagen 44, 205, 315, 358, 397, 419,
425, 427, 469, 485, 505, 519, 607
Dormagen works 107, 205, 236, 295,
302, 308, 313 f., 330, 333, 338, 349,
358, 361, 397, 413, 425, 429, 450, 490,
499, 505, 519, 522, 536 f., 607
Dornier GmbH, Friedrichshafen 261
Dorvivan 429
Double Alliance 161
also see Interessengemeinschaft der
deutschen Teerfarbenindustrie
double-contact process 107 f., 402
Douglas-Home, Sir Alexander
Friedrick 413
Dover 185
Dow Corning Corporation, Midland,
Michigan 378
drafting office 83
Dragoco, Gerberding & Co. GmbH,
Holzminden 342
Dralon 239, 291, 311, 313, 328, 333,
334, 341, 357, 361, 389, 453
Dralon plant 339, 441
Dramatic Association 178
Drathen, Hans 374
Dresden 211
Dresdner Bank AG, Frankfurt
38, 513
Dreser, Heinrich 135
Dressel, Oscar 219
Dreyfus, Alfred 109, 129
Drucker, Julius 314, 315
drug design 102
Drugofa GmbH, Cologne 271, 399,
455, 564
drugs see pharmaceutical
Drummond, Jack Cecil 209
dry-spinning process 165, 238 f.
Dr. Carl Leverkus & Söhne 66, 103,
114, 149,
Dr. E. ter Meer & Cie see Chemische
Fabriken vorm. Weiler-ter Meer AG
Dr. Miles Laboratories, Inc.
see Miles Inc.
Dr. Miles Restorative Nervine 515
Dr. Petro Misto see Bayer Italia S.p.A.
Du Bois-Reymond, Emil 63, 278
Du Pont (E.I.) de Nemours & Co.,
Wilmington, Delaware 235, 287,
291, 337, 395, 467 f.
dual-component coatings 366
Duggar, Benjamin Minge 309
Duisberg, Curt Friedrich Eduard
Hans 225
Duisberg, Johann Carl Friedrich
69
Duisberg, Sophie Wilhelmine,
née Weskott 69
Duisberg, Johann Carl 69
Duisberg, Johanna, née Seebohm
70, 73
Duisberg, Friedrich Carl 46, 56, 59,
66, 68, 68 f., 71 f., 74, 77 f., 80 f.,
92 f., 96, 98, 100, 102 f., 106 f.,
109 f., 113 f., 117 f., 120, 123 f., 133,
142, 144 f., 149, 151, 155 f., 158,
159 f., 166, 182, 190 f., 197, 200 f.,
204, 207, 210, 211, 212, 221 f., 223,
224 f., 230, 233, 253, 268, 277, 376,
585, 606
Duisberg villa 197, 207, 224 f., 376
Duisberg-Achaz, Carl-Ludwig
70, 110
Duisburg 212
Duisburger Kupferhütte AG,
Duisburg 519
Dulles, John Foster 347
Dunant, Henri 149
Dunlop, John Boyd 190
Dunova 340, 519
Durethan 330, 434
Dureya, Charles 105
Dürrield, Walther 298
Düsseldorf 29, 97, 105, 157, 162, 177,
181, 197, 212, 267, 318, 430, 448, 470,
554, 590, 592
duties see customs
Dutschke, Rudolph 447
dye 24, 63, 77, 83 f., 86 f.
Dyes and Pigments (Business Group)
88, 560
dyestuffs see name of dyestuff
—dyestuffs can 52, 75, 86
—Dyestuffs Division 460, 463
—dyestuffs for fur 145
—dyestuffs sample card 32, 76, 79,
82, 85, 123, 173, 237
—labels 33, 35, 52, 58, 75, 79, 89, 165,
280, 456, 457, 586
dye-testing unit 84
also see Application Technology
Department
also see Colorist Department
Dynamit Nobel AG, Troisdorf 243
- E**
E 600 405
E 605 307, 311, 404, 407, 467
Ebert, Friedrich 209, 235
EC Erdölchemie GmbH, Cologne
336, 338, 358, 359, 361, 371, 419, 425,
469, 560
Ecker-Rosendahl, Heidemarie 477
Ecuador 356
Edinol 145, 365
Edison, Thomas Alva 55, 59, 89
education see training
education and training center
401, 450
Education Department 177, 180
Egypt 14, 70, 244, 253, 347, 429,
441 f., 446, 476, 497, 543
Ehrlich, Paul 175, 216, 218
Eichengrün, Arthur 145, 169, 238 f.
Eiffel, Alexandre Gustave 97
Einsler, Otto 315
Einstein, Albert 169, 267
Eisenhower, Dwight David 333, 365
Elberfeld technical college 69
Elberfeld works 29 f., 33, 37, 39, 50,
52, 59, 64, 67, 74 f., 79, 83 f., 86,
89 f., 91, 94, 95 f., 106, 109, 113, 115,
123, 129 f., 133, 135, 138 f., 144,
146 f., 156, 158, 185, 193 f., 199, 209,
216, 228, 254, 272, 295, 303, 315, 325,
329, 347, 352, 356, 388, 401, 427, 450,
464, 511, 519, 522, 536, 607
electricity 348 f., 415, 598
electrocardiogram 497
electronic data processing 87, 122,
127 f., 291, 354, 346, 383 f., 401, 403,
413, 441, 452, 477, 530, 531, 532 f.,
540, 542, 551, 566, 599, 609
electronics technician for power
stations 452
electrophotography 413
Eli Lilly & Co., Indianapolis, Indiana
571,
Elisabeth, empress of Austria 133
Elisabeth II, queen of Great Britain
and England 333
Elkhart 67, 73, 258, 489, 514 f., 518
Elster, Julius 141
Email Brugge N.V., Belgium 438
Emails S.p.A. see Bayer Italia S.p.A.
emerald green 54
Emergency Association of German
Science 210
Emil Fischer Society for the
Promotion of Chemical
Research 211
Empedic 485
also see Canesten
also see Mycelex
employee insurance see fund
employee protection system 32, 166,
492 f.
also see occupational safety
employee spokesmen 372 f., 375
employee stock option 333, 556
also see stock
employers' liability insurance
association
see Berufsgenossenschaft
employment agreement 372 f., 441,
558, 559
—policy on maternity and paternity
leave 375
enamel 371
—enamel factory 243, 438
energy 348, 354, 364, 479, 533
Engerfeld 81
engineer 64, 67, 83, 89, 109, 113 f.,
124, 129, 133, 141, 268, 383, 420, 453,
491, 501 f., 526
—Engineers' Conference 109, 124,
349
engineering
—Central Engineering 560, 606
—Engineering (Corporate
Division) 460
—Engineering Department 89, 96,
151, 317, 355, 490
—Engineering Science
Department 126
Engl, Joseph Benedikt 209
England see United Kingdom
entrance pass 308
Environmental Protection Agency
(EPA) 468
Environmental Protection and
Occupational Safety
—Board Committee 563
environmental protection 30, 146,
199, 349, 354 f., 357, 402, 420, 422,
426, 452, 470, 480, 503, 505, 532,
535, 562, 571, 593, 599, 600, 606,
608 f.
—department 146, 149, 428, 505
enzyme 55, 519, 572
Epernon 313
epilepsy 197, 267
Epontol 417
Erfurt 459
Erhard, Ludwig 399, 401, 429
Erholungshaus recreation center
152, 178, 180, 448, 513, 554
also see reading room
Escherichia coli 568, 571 f., 574
Essen 117, 152 f.
ethanol 238
Ethiopia 277, 476
ethyl mercaptan 92
ethylene 358, 360, 395 f.
Ets. Kuhlmann, France 235
Eucken, Rudolf 71
Eugénie, empress of France 33
eugenol 344
Eukanol 255
Eulan 215, 289, 387, 453
European Patents Office,
Munich 123
Evipan-Natrium 271
Ewer & Pick, Berlin 118
explosion 202, 205
explosives 201 f., 358
Extramycin 505, 508, 512
- F**
Fabrica Argentina de Anilinas,
Buenos Aires 347
Fachinformationszentrum Chemie
GmbH, Berlin 124
Factor VIII 573
factory gate 4 294, 300 f.
Falkau 365
Farbenfabriken Bayer & Co., Bombay
see Bayer India Ltd.
Farbenfabriken of Elberfeld
Company, New York 117,
farmer 404, 455, 458, 548
Faserwerke Lingen GmbH 559
fast bluish-violet 59
fast reddish-violet 59
FBA Pharmaceuticals, United
States 469
also see Baychem Corporation
FBA Pharmaceuticals, United
Kingdom 553
FC Bayer 05 Uerdingen e.V. 162, 169,
499, 523
Fedco Bayer & Cia. see Bayer
Hispania Industrial S.A.
Federal Association of German
Industry (BDI) 488
Federal Bureau of Health, Berlin 576
Federal Department of Research and
Technology 129
Federal Patents Court 120
also see patent law
Federal Polytechnic School,
Zurich 173
Federation of German Trade Unions
(DGB) 365
Federico Bayer & Cia., Buenos
Aires 356
Fedobayer & Cia. see Bayer Italia S.p.A.
feldspar 438
fertilizer 129, 253, 415
Feuerbach, Ludwig 520
fibers 86, 238, 253, 277, 296, 311, 330,
361, 400, 516, 587, 590
—Fibers Business Group 338, 560
—Fibers Division 460
also see name of product
fibers pilot plant 337
Fibretex Ltd., United Kingdom 553
Fichte, Ludwig Gottlieb 71
Filago 438
Filago plant see Bayer Italia S.p.A.
film 117, 197, 202, 245, 253, 280, 326,
487
—cinematographic film 169, 181, 253,
281, 410, 487
—color film 278, 413
—film emulsion 411
—film factory Leverkusen 309, 317,
351
—film factory Wolfen 181, 281
—rolls 229, 410
finance
—Corporate Finance 561, 563
—Finance and Accounting
(Corporate Division) 460, 463
—Finance (Board Committee) 563
—Finance Department 355
Fine Blue 30
Finland 48, 153, 205, 299, 429
fire alarm 151, 536, 537
fire department 150, 536
also see works fire department
fire inspector 178
firemen 150, 151, 536, 539
fire-extinguishing vehicle
—Wendelin 539
—Polymer 539
Firmenich, Geneva 342
Fischer, Edwin 181
Fischer, Emil Hermann 90, 117, 141,
153, 157, 169, 210, 211
Fischer, Hans 388
Fischer, J. Arnold 95
Fischer, Rudolf 281
fixing salts 153
flagellate protozoan 474
flashbulb powder 153
flavanthrene 172 f.
flavors 45, 342, 345, 347, 455
Flechtner, Hans-Joachim 110
Fleckenstein, Albrecht 497 f.
Fleming, Alexander 247, 276, 506 f.,
509
Flers 49
Flers factory 48, 49, 133
Flittard guest house 521
Florence 17, 436
Florey, Howard Walter 507, 509
Florida 317, 347, 468, 487
flue-gas filter 505
fluid bed process 350
fluidized bed process 577
fluorite 177, 357
Fluorostat 518
fluorspar see fluorite
Flury, Ferdinand 492
foam 284 f., 288 f., 309, 318, 319, 321,
366, 390, 434, 440, 469
also see polyurethane
Focke, Heinrich 289
Folidol M 405,
Fontane, Theodor 153
Ford, Gerald Rudolph 493
Ford, Henry 105, 166, 181
Ford 17 M 330
Ford Model T 181, 199, 337
Ford Motor Company, United
States 181, 199, 229, 337
Ford Scorpio 434 f.
Forde, Robert Michael 149
foreign subsidiaries
also see city
also see company name
also see country
formaldehyde 256, 326, 419, 459
Forum 448
Fotopapierfabrik Mimosa AG, Kiel
410
founding of company 24, 314
Fox, Herman Herbert 324
fragrance 342
France 20, 26, 34, 38 f., 46, 49 f., 60,
63, 73, 153, 165, 186, 198, 205 f., 208,
212, 219, 235 f., 248, 257, 277, 291,
296, 299, 310, 317, 347, 365, 371, 383,
389, 397, 410, 414, 429, 447, 453, 486,
499, 518, 594
Franck, James 203
Francke Foundation 316
Franco Bahamonde, Francisco 499
Frank, Eugen 58, 60, 77
Frankfurt am Main 28, 60, 77, 115,
126, 141, 160, 224, 230, 233 f., 247,
267, 338, 340, 403, 453, 488, 556
Frankland, Percy Faraday 146
Franz Ferdinand 200, 205
Fredco Bayer & Cia., Portugal 185
Frederick II, named the Great, king
of Prussia 97
Frederick III, emperor of
Germany 19

- Frederico Bayer & Cia.
see La Quimica Industrial "Bayer"
Weskott y Cia., Buenos Aires
Fred. Bayer & Cia. see Bayer do
Brazil S.A.
free-flow system 521
Freiberg 107
Freiberg Mining Academy 107
Freiburg 92 f., 326, 497
Fremerey, Max 236
Fresno 175
Freud, Sigmund 117
Friedrichshafen 145
Friedr. Bayer & Co., Arnheim
see Bayer Nederland B.V.
Friedr. Bayer & Co., Japan see Bayer
Japan Ltd.
Friedr. Bayer & Co., Russia 48, 133,
156, 516
—Moscow plant 48
Friedr. Bayer & Co., Shanghai
see Bayer China Co. Ltd.
Frings, Josef 309
Fritz, Gerhard 563
Fritzsche, Carl Julius 19
From Plant to Plant see company
journal
Frossard, Jose 208
Fructusan 567
Fuad I, king of Egypt 253, 445
Fuadin 253, 444, 445
fuchsine 26, 26, 29, 30, 31, 35, 63,
280
—fuchsine plant 26, 28 f., 30, 31, 36,
45, 64
fumung sulfuric acid see oleum
fund
—Bayer Relief Fund 373
—Bayer Staff Fund 309
—employee health insurance 40,
55, 79, 104, 168, 309, 373, 554 f., 607
—fund for salaried staff 97
—fund for wage earners 97
—health insurance fund 44
—pension fund 129, 168, 309, 373,
554 f., 607
fungal disease 482, 546
fungicide 482, 484, 546, 549, 559
Funk, Casimir 197
Furniture Fair, Cologne 338
furniture varnish 247, 368
Fürth 14
fuselage covering 239
- G**
Gaddifi, Muammar 453
Gagarin, Yuri 389
Galen, Galenus 497
Galenus Prize 446
also see PRIX Galien
GalErie am Werk 449
gallic acid 256
Gamp-Massaunen, Clara von
see Bayer, Clara
Gandhi, Mahatma (born Mohandas
Karamhad) 211, 309
Gandhi, Indira 429, 577
Ganghofer, Ludwig 153
Garbagnate 439
Garbagnate plant see Bayer Italia
S.p.A.
garching 365
gardener 150, 452
Garmisch-Partenkirchen 333
gas gangrene 272
Gasmotorenfabrik Deutz 29
gasoline 271, 295, 360, 395, 433
Gaston, Jerry 126
Gaulle, Charles de 299, 371, 401,
429, 453
Geary Chemical Company, United
States 466
also see Chemagro Corporation
Gebrüder Gessert, Elberfeld 51
Gebr. Borchers AG, Goslar
see Hermann C. Starck Berlin
GmbH & Co. KG
Gebze 429
Gediz river 391
Geiger, Johannes Wilhelm 181
Geitel, Hans Friedrich 141
Gelsenkirchen 403
Gemayel, Beshir 551
Gemeinnützige Wohnungsbaugesellschaft mbH (Gewoge) 271
also see company housing
Genentech Inc., San Francisco
571 f.
- General Electric Company, United
States 331, 378, 583
General Foods Corporation, United
States 516, 583
General German Trade Union
Federation (ADGB) 209
general meeting for share-
holders 67, 253, 317, 374, 488,
557, 562
General Motors Corporation, United
States 434
General Tire, Akron, Ohio 251
General Workers' Committee 372
also see workers committee
also see Works Council
General Workers' Society 47
genetic engineering 103, 267, 519,
551, 568, 570, 581 f.
Genetics Institute, Boston 571
Geneva 29, 103, 342, 347, 375, 583
Genoa 436
Gerhardt, Charles Frédéric 136
geriatric drug 365
German Association for Chemistry
Teaching 210
also see Justus Liebig Society
German Association for the
Protection of the Environment and
Nature 429
German Chemical Society 33, 60
German Democratic Republic 280,
313, 333, 357, 371, 383, 389, 441, 459,
477, 485, 493
German Diabetes Association 441
German industrial standard
specifications (DIN) 243
German Institute for Medical
Documentation and Information
(DIMDI), Cologne 129
German insurance code of 1911 42
German measles 583
German Museum, Munich 56, 430
German Research Community 492
German Workers' Protection Act
97
Germanin (Bayer 205) 215, 216, 221,
262, 476, 578
Gester, Heinz 374
Geuther, Anton 46, 71
Gevacolor cinematographic film
282
Gevaert, Lieven 97, 408
Gevaert N.V., Morsel, Belgium 411
Gevaert Photo-Producten N.V.,
Morsel, Belgium 97, 253, 408,
487
also see Agfa-Gevaert AG
Gevaert-Agfa N.V., Morsel, Belgium
see Agfa-Gevaert AG, Leverkusen
Ghana 476
Gierek, Edward 535
Giessen 19, 45, 98
Gilbert, Walter 513
Girtler, Ludwig 89, 114, 156, 158
Giscard d'Estaing, Valéry 493
Givaudan, Geneva 342
Glasgow 552
glass 326, 330 f., 436, 459, 590, 597
glass fiber 330, 417, 432, 435, 590
Gleiwitz (today Gliwice) 193
Glenn, John Herschel 399
Glidden, Carlos 45
Glucobay 578
Glucometer 518
glutamic acid 572
glycerol 144, 202, 245 f., 286
glycol 286, 360
Glyptal 247
Goddard, Robert Hutchins 243
Goethe, Johann Wolfgang von 152
Gogh, Vincent van 605
gold 214, 261, 469
Golden Scissors 338
Goldschmidt, Theo 315
Goltix 513
Gomułka, Wladyslaw 459
Goodhue & Muurling, Boston 35
Goodwin, Hanibal W. 83
Goodwin, James 280
Goodyear 189, 289
Gorbachev, Mikhail 583, 599, 605
Göring, Hermann 295, 298
Goslar 594
Gotha 47
Göttingen 71, 345
Government Rubber Styrene 251
Gowers, William Richard 59
Gothenburg 493
Graebe, Carl 35, 170
Graf Zeppelin airship 253
grain screen process 278, 281
- Gram, Hans Christian 511
graphic systems 487
Grasse, Otto 130
Grasselli Chemical Co., United
States 208, 229
gray ointment 218
Great Britain see United Kingdom
Great Depression 215, 250, 252,
260 f., 290, 292
also see inflation
Greece 106, 197, 244, 299, 493
green dyestuffs 52
Greene, Graham 137
Greenford Green 20, 66
greensalt 364
Greenwich 105
Greifswald 272
grenade-filling unit 205
Grenoble 312
Griesheim 28, 115, 203
Griesinger, Wilhelm 442
Griess, Johann Peter 56, 57, 58 f.,
74, 77
Griess 26
Grimaux 67
Groeber 222
Grohe, Karl 508
Gropenglesser, Curt 228
Grosse Ledder 168, 197
Gründgens, Gustaf 291
Grüneburg 233, 234, 267
Grünwald, Herbert 374, 488, 488,
514, 543, 562
guanine 570
Guareschi, Giovanni 137
Gugelot Design GmbH,
Neu-Ulm 430
Guillaume, Günter 493
gum mastic 244
gun cotton 202, 236
Günther, Willy 194
Guntrum, Hugo 239
Gusathion 333, 406, 407, 467
Gustav V 276
gyrase 513
- H**
Haan 30, 93
Haan unit 30
Haarmann, Wilhelm 45, 345 f.
Haarmann & Reimer GmbH,
Holzminden 45, 105, 313, 342 f.,
346, 356, 439, 455, 485, 489,
519, 589
—Bushy Park plant 346, 519
Haber, Fritz 185, 203, 294
Haberland, Ulrich 240, 299, 303,
314, 315 f., 316, 317, 329, 355, 388,
440, 448, 564
Haber-Bosch process 108 f.
Hachioji 588
Haeckel, Ernst 71
Haffkine, Waldemar Mordecai Wolff
109
hafnium 596
Hagens, Gunther von 383
Hauge, The 141
Hahn, Otto 203, 291
Haldane of Cloan, Viscount Richard
Burdon 197
Halle 250, 316, 564
Hamburg 19, 33, 64, 95, 137, 194,
220, 307, 361, 388, 422, 478, 605
Hancock, Thomas 189
Hanover 190, 192, 307, 316, 430, 459,
593, 599
Hanover Industrial Trade Fair 391,
430, 577
Hansen, Gerhard Henrik Armauer
39
Hansen, Kurt 325, 374, 388, 388,
400, 440, 459, 478, 488
Hantzsch, Arthur 496
hard hat 491, 492
Harmon Colors, United States
513
Harries, Carl Diedrich 190
Harrisburg 523
Harvard University 337
Harvey, Lillian 257
Hasche, Max 356, 357
Hašek, Jaroslav 137
Hassencamp, Hugo 52, 54
Hata, Sahatshiro 219
Hauptman, Gerhart 152
Hauschild, Wilhelm 162
Haworth, Walter Norman 271
health advisory service 44
- Health Care Sector 103, 258, 312,
388, 471, 495, 561
also see Pharmaceutical
Department
hearing protection 132
heart 383, 494, 495
heart transplant 441, 497
Hebgen, Hans 567
Heereman von Zuydtwyck, Baron
Constantin 374
Heidelberg 98, 272, 383, 488
heimtextil Fair, Frankfurt 338, 340
Heinrich VI 262
Heinrichs, Elke 288 f.
Heisenberg, Werner Karl 247
Helsinki 485
Hemastix 517
hemoglobin 59
hemophilia 573
Henkel KGaA, Düsseldorf 177
hepatitis B see jaundice
Hepp 90
Herbert Grünwald Foundation
543
herbicide 466, 513
Hercules Powder, Wilmington,
Delaware 247
Hermann C. Starck Berlin
GmbH & Co. KG 489, 562,
589, 594
Hertz, Gustav 203
Hertz, Heinrich Rudolf 83
Herzberg, Martin 73
Herzog, Ewald 81
heterocyclic compounds 386, 570
Heumann, Carl 173
Heuss, Theodor 313
hexamethylene diamine 336
Hexeton 495
Heyden, Friedrich von 137
Heymann, Bernhard 216, 219
Hess, Christian 86, 194
Hibernia AG, Hanover 429
high-pressure hydrogenation
process 261
Hilfszug Chemie 536, 537, 543
Hillary, Edmund Percival 333
Himmeler, Heinrich 298
Hindenburg, Paul von Beckendorff
and von 202, 235, 253, 271, 292
Hinsberg, Oskar 73, 92 f.
Hippocrates 136
Hirohito 243, 303, 469
Hiroshima 299, 448
History and Development of Farben-
fabriken vorm. Friedr. Bayer & Co.
in its First 50 Years 173, 436, 553
Hitler, Adolf 221, 235, 253, 257, 267,
271, 276 f., 283, 291 f., 293, 299, 307,
314, 559
Hochapfel, Walter 303, 567
Hoechst AG, Frankfurt 28, 35, 58,
66, 77, 90, 106 f., 145, 158, 170, 175,
203, 219, 224, 230, 248, 314, 394, 440,
447, 503, 583
Hoelscher, Ludwig 181
Hof 403
Hoff, Jacobus Henricus van't 149
Hoffmann, Felix 129, 135, 139
Hoffmann, Hans 374
Hofmann, August Wilhelm 14, 16 f.,
20, 21, 26, 33, 46, 56
Hofmann, Fritz 175, 190 f.
Hofu 588
holiday resort for employees 333
Holland see Netherlands, The
Hollerith, Hermann 97
Hollerith machine 97, 193
Hollywood 253
Holzminden 45, 105, 342, 345 f., 485
home for the elderly see Ulrich
Haberland Haus
Hong Kong 86, 371, 455, 471, 587
Hönningen 115
Honold, Gottlob 153
Hoover, Herbert Clark 253, 261
Hörlein, Heinrich 197, 219, 272, 314
Horticultural Department 228
hospital 130
also see polyclinic
hot-air balloon 140, 267
household products 564, 567
housekeeping school 167
Houston 141, 453, 605
Hubert, Emil 337
Hübner, Hans 71
Hückeswagen 69
Hudson River Aniline and Color
Works, United States see Albany
plant
Hüls 295, 397

Hülensbusch, Carl 73, 86, 145, 194
Hülsmeier, Christian 65
Humbert I, king of Italy 145
Hungary 205, 211, 357
Hussein I, king of Jordan 459
Husum 478
Hyatt, John Wesley 326
Hyderabad 457
hydrazine plant 505
hydrochloric acid 106, 109, 419
hydrocyanic acid 289, 336, 338
hydrofluoric acid 355, 465
hydrogen 480
hydrogen peroxide 177
hydrogen sulfide 100, 422
Hydronalium 289
hypertension 177

ice plant 113
ICI see Imperial Chemical Industries PLC
Icmesa, Meda 505
Idris I, king of Libya 453
Igelit P.C.O. 337
Igepon A 253
I.G. Farbenindustrie AG 109, 177, 211, 222, 226, 230, 236, 244 f., 248, 252, 261, 264, 267 f., 271, 280, 287, 289 f., 292, 295, 296, 302 f., 306, 309 f., 313 f., 316, 329, 337, 346, 356, 362, 366, 388, 394, 411, 420, 436, 444, 455, 464, 471, 586
—Auschwitz plant 297 f., 306
—Berlin Division 233
—Bitterfeld plant 233
—Central Rhine Division 233, 253
—Dormagen works 233, 236, 239, 271
—Elberfeld works 229, 233, 239, 264, 267, 271, 283, 445, 510
—Hoechst works 233
—Landsberg plant 337
—Leuna plant 233, 243, 247, 271, 295
—Leverkusen works 229, 233, 235, 247, 249, 254, 267 f., 277, 283 f., 289, 291, 294, 296
—Lower Rhine Division 181, 230, 233, 252, 271, 291, 294 f., 302 f., 307, 314, 316
—Ludwigshafen works 233, 245, 249, 257, 267, 304
—Munich plant 297
—Oppau plant 233, 304
—Pharma und Pflanzenschutz Bayer sales organization 233, 586
—Schkopau plant 250, 289 f., 299 f., 329, 338, 362, 438
—Uerdingen works 233, 240, 244 f., 283, 316, 330, 358, 366
—Upper Rhine Division 233
—Wolfen plant 233, 281 f., 297, 302, 337, 346
I.G. Farben trial 298, 304, 314
ilmenite 362
immunology 582
Imperial Chemical Industries PLC (ICI), United Kingdom 235, 291, 387
Imperial Patents Office, Berlin 60, 79, 134, 165, 345
incineration 422, 426, 429, 485, 600, 603
—liquid-waste incineration 426, 551, 605
—plant 426, 456, 480, 505, 605
also see waste water treatment plant
Indanthren 173, 174 f.
Indanthrene Blue RS 172 f.
indanthrene dyestuffs 170, 289
India 55, 84, 86, 149, 198, 307, 311, 383, 388, 417, 429, 456, 458, 459, 528, 552, 577
indigo 17 f., 73, 80, 83, 129, 160, 170, 171, 173
Indigo Pure BASF 173
Indonesia 346, 454
Industrial Dyestuffs Ltd. see Bayer Dyestuffs Ltd.
industrial accident 182, 491 f., 505
Industrial Democracy Act 372
industrial electrician 452
Industrial Products Sector 561
Industriegewerkschaft Chemie, Papier, Keramik (trade union) 374
infantile paralysis (polio) 97, 441, 583

inflation 206, 212, 222, 226, 253
also see Great Depression
influenza 92, 139, 141, 474
Information Technologies Sector 561
also see Agfa-Gevaert
injection molding machine 328
innovation 608
Inorganic Chemicals Department 106 f., 113, 177
Inorganic Chemicals (Business Group) 176, 561
inorganic chemistry 106
insect growth inhibitor 468
insecticide 103, 306, 383, 405, 413, 474, 547, 549, 551, 559
also see product name
Institute for Biotechnology see Agrochemicals Center, Monheim
Institute for Chemotherapy, Elberfeld 193, 401, 484
Institute for Clinical Pharmacology, Elberfeld 590
Institute for Environmental Research, University of Hamburg 243
Institute for Experimental Pathology and Bacteriology, Elberfeld 272
Institute for Toxicology, Elberfeld 133
Institute for Tropical Diseases, London 506
Institute for Tropical Medicine, Hamburg 220, 263
insulin 215, 429, 569, 578
insurance
—accident insurance 55, 83, 491
—casualty insurance law 40
—health insurance 41 f., 73
also see fund (employee health insurance fund)
also see Social Security Act
—invalidity insurance 41
also see Social Security Act
—pension insurance 41, 560
—unemployment insurance 247
integrated crop production 546, 549
also see agriculture
Interessengemeinschaft der deutschen Teerfarbenindustrie 161, 177, 203, 208, 215, 222 f., 229, 232, 280
also see Triple Confederation
also see Tripartite Association
also see I.G. Farbenindustrie AG
also see Double Alliance
intermediates 45, 51, 74, 113, 355, 364, 586
Intermediates Department (ZW) 83, 319, 418, 419 f., 488
International Automobile Exhibition, Berlin 249, 295
International Chemical Documentation Center, Frankfurt 127, 453
International Congress for Applied Chemistry, New York 192
International Nitrogen Conference 290, 291
International Plastics Trade Fair, Düsseldorf 318, 430 f., 434, 470, 472
invert soap 272, 274
Investment and Technology (Board Committee) 563
in-house inspection 129, 503
in-house mail service 95
iodine 123
Iodine Green 30, 52, 54
iodoform 90
iodothylin 123, 495
ion exchanger 355, 420, 493
ionone 346
Iran 48, 177, 271, 383, 391, 413, 455, 535, 543
Ireland 133, 215, 313, 383, 477
also see Northern Ireland
iron ore 208, 597
iron oxide pigment 240, 429
also see Bayferrox
iron oxide pigment 429
also see yellow iron oxide pigment
isatin 73
isocyanate 109, 286, 318, 321, 355, 369, 417, 440, 453, 465
isoeugenol 344
Isolette camera 289
isoleucine 572
Isopan FF 13 DIN 351
Isopan Ultra 25 DIN 351
isophthalic acid 329
isoprene 188, 190
isotope laboratory 347
Israel 309, 325, 441, 485, 551

Issy-les-Moulineaux 313
Istanbul 429
also see Constantinople
Italy 39, 67, 89, 205, 235, 247, 262, 277, 290 f., 299, 303, 365, 389, 436, 605
Itzehoe 478, 481

J
Jacobi, Fritz 314, 315
Jagat Chemicals Ltd., India 459
James, Sidney Price 264
James, Christopher Gordon 220
Janke, Margret 599
Japan 145, 193, 229, 243, 247, 271, 283, 289, 299, 303, 307, 311, 317, 325, 341, 376, 383, 388, 399, 404, 413, 433, 445, 449, 485 f., 544, 562, 577, 584, 585
Japanese Garden 70, 376, 376 f.
Jaruzelski, Wojchiew Witold 543
jaundice 571
Jay Cook & Co. Bank, United States 40
Jeker, Robert A. 374
Jena 71, 152
Jerusalem 441, 513
J. J. Müller & Cie., Basel 28
J. M. Steel & Co. Ltd. see Bayer Chemicals Ltd.
Joachimsthal 133
John Paul II, Pope 519, 543
John Paul I, Pope 519
Johannesburg 89
Johnson, Lyndon Baines 401, 413
Juan Carlos I, king of Spain 499
Jubilareverein see Verein der Jubilare der Bayer AG Leverkusen e.V.
Jüllich 239
Julius-Drucker-Haus 365
jumbo jet 334, 371, 459
Jung 45
Junkers Luftverkehrs AG 243
also see Deutsche Lufthansa AG
Junkers "Ju 52" 291, 471
Justus Liebig Society for the Promotion of Chemistry Teaching 210

K
Kafka, Franz 137
Kaha 413
Kahn 90
Kahrès, Jean 105
Kaiser Wilhelm Gesellschaft for the Promotion of the Sciences 193
Kaiser Wilhelm Institute for Coal Research, Breslau 193
Kaiser Wilhelm Institute of Berlin 203
Kalle & Co. AG, Biebrich 28, 58, 90, 92, 161, 230, 232 f.
Kanal 2000 604, 605
Kandlakoya 457
Kansas City 466, 468, 487
Kapstadt 220
Karachi 413
Karamanlis, Konstantin 493
Karlsruhe 357
Kasino 152, 195, 196, 197, 207, 222, 223, 521
also see works canteen
Kaske, Karlheinz 374
Kassel 459
Kast, Alfred 92
Keene, Thomas 258
Kekulé Library 124, 125
—Kekulé Library System (KEBIS) 127
Kekulé von Stradonitz, Friedrich August 29, 98, 124, 125
Kellner, Lucia 495
Kempff, Wilhelm 181
Kendall, Edward Calvin 277
Kenia 476
Kennedy, Robert Francis 447
Kennedy, John Fitzgerald 389, 399, 401
Kerenski, Aleksandr Feodorovich 205
kermes insect 16
Keuter, Anton 105
Keynes, John Maynard 208
khellin 497
Khomeini, Ruhollah 523

Khruschchev, Nikita 357, 375, 399, 413
Kiel 190, 410
Kiesinger, Kurt Georg 429
Kikuth, Walter 263 f., 266
King, Martin Luther 401, 441
Kinshasa 67
Kirst, Hans Helmut 137
Kitasato, Shibusaburo 97, 109
Kitty Hawk 157
Klarer, Joseph 274
Klebert, Ludwig 177, 314, 315
Kleine, Friedrich-Karl 220
Kleiner, Helmut 249
Kleist, Heinrich von 178
Klemperer, Georg 169
Klimsch, Fritz 70, 166 f.
Klug, Peter 374
Knapp, Friedrich Ludwig 254
Knapsack 250
Knaus, Hermann Hubert 253
Kneipp, Sebastian 67
Knitsch, Rudolf Theophil Joseph 107
Knorr, Ludwig 90
Knut, Bernd 164
Kobe 193, 588
Koblentz 221
Koch, Robert 51, 55, 67, 73, 149, 169, 216, 218, 220
Kocke, August 36
Kodak, United States 281, 410
Kohl, Helmut 551
Köhler, Heinrich 314 f.
Kolbe, Hermann 46, 56, 137
Kölliker, Rudolf Albert von 79
Köln-Rottweil AG 243
Kolyonos 564
König, Hermann 73, 106, 145, 194
Konrad, Erich 249 f.
Korrea 109, 309, 313, 333, 449
Kothé, Richard 219
Kraack, Erich 181
Kramer, Wilhelm 105
Krauch, Carl 295
Krauss-Maffei AG, Munich 434
Kraut, Karl Johann 136
Krefeld 24, 28, 42, 45, 50, 55, 71, 86, 115, 123, 145, 162, 169, 171, 181, 307, 315 f., 427, 499, 519, 607
Krefeld technical college see Royal Technical College Krefeld
Krekele, Karl 194, 271
Kronos Titan-GmbH, Leverkusen 317, 362
also see Titangesellschaft mbH
Krupp, Friedrich Alfred 117, 153, 168
Krupp works, Essen 152 f.
krystallin 19
Kuala Lumpur 438
Kubitschek de Oliveira, Juscelino 354 f.
Kuhn, Richard Johann 289
Kühne, Hans 55
Kühne, Willy 181, 271, 294, 299, 316
Kurt Hansen Foundation 459
Kurtkotten airfield 375
Kurtz, Peter 299, 336, 338
KVP (veterinary and pharmaceutical products of Kiel) 505
kyanol 19

L
La Condamine, Charles Marie de 186
La Felguera 465
La Porte 141
La Química Comercial y Farmacéutica S.A. see Bayer Hispania Industrial S.A.
La Química Industrial "Bayer" Weskott y Cia., Buenos Aires 356
Laacherhof estate 399
Laboratoires des Spécialités Pharmaceutiques Bayer S.A., Monaco 312
also see Bayer Pharma S.A.
laboratory assistant 291, 452
laboratory journal 274
laboratory technician 452
Labstix 517
Lagos 499
Lagow 272
Lampit 459, 474
Landerer, Albert 67
Landsberg 306
Landsteiner, Karl 145
Langel 115
Langen, Eugen 29
Langer, Bernhard 583

- Larsen, Jack Lenor 340
 Lassalle, Ferdinand 29
 latex 312, 398, 433
 Latin America 139, 165, 206, 221, 474, 563
 also see South America
 Laufenburg 594
 Laufenburg plant see Hermann C. Starck Berlin GmbH & Co. KG
 laundry day 307
 Lausanne 215, 267
 Laux, Julius 240
 Laux, Paul 374
 Lavoisier, Antoine Laurent de 46
 Law, Patents and Insurance Department (Corporate Staff Division) 563
 lead chamber process 107 f.
 learning-by-doing course 453
 leather 18, 254, 387, 421
 —dyeing unit 254
 —leather applications unit 255
 —leather tanning process 399
 —split leather 257
 —velour 257
 Lebaycid 371, 383
 Lederer, Hugo 167
 Ledner, Emil 137
 Lee, Robert Edward 29
 Legal Department 355
 Legien, Karl 157, 207
 legionaire's disease 582
 Leguval 325, 330, 433, 434
 Lehmann, Jürgen Eric 324
 Leibniz Gottfried Wilhelm 126
 Leipzig 118, 194, 197, 232, 605
 Lenin (born Ulyanov), Vladimir Ilyich 209, 229
 Lennings, Manfred 374
 Leo XIII, Pope 103
 Leonov, Alexei 417
 Leopold, prince of Hollenzollern-Sigmaringen 39
 Leopold II, king of Belgium 67
 Lepetit, Emilio 200
 Lepetit, Dollfus & Gansser see Bayer Italia S.p.A.
 leprosy 39, 181
 letter Bunas see Buna N
 leucine 572
 Leukomycin 325, 508, 510
 Leuna 243, 247
 Levacast process 257
 Levafix 384, 386
 Levaflex 397
 Levapren 313, 389, 396, 397, 429
 Levasint 577
 Lever Brothers, United Kingdom 50
 Leverkusen, Carl Friedrich Wilhelm 103, 106, 113
 Leverkusen
 —Bürrig 114, 180, 257, 422, 425, 429, 524
 —Düsseldorfer Street 96, 520
 —Hitdorf 115
 —Kaiser-Wilhelm-Allee 22, 194, 196 f., 400
 —Küppersteg 69, 114, 151
 —Manfort 96, 316
 —Moskauer Street 607
 —Opladen 149, 314
 —Rheindorf 115, 257
 —Schlebusch 257
 —Schwarzer Lane 194, 197
 —Steinbüchel 257
 —Wiesdorf 66, 103, 114, 152, 168 f., 178, 180, 209, 221, 257
 Leverkusen Model 164 f., 538
 Leverkusen works 22, 44, 50, 66, 69 f., 95, 102 f., 106 f., 109, 110, 111 f., 115, 115, 117 f., 129, 133, 140, 141, 145, 148 f., 151, 153, 156, 162, 164, 166 f., 175, 176 f., 181, 191, 194, 197 f., 200, 202 f., 205 f., 207 f., 213, 221, 225 f., 228, 247 f., 257, 268, 277, 280, 282, 291 f., 293, 294 f., 300, 302 f., 308 f., 311, 313 f., 316 f., 324, 330, 333, 338, 347 f., 361 f., 365, 371, 375, 383, 388, 400 f., 402 f., 405, 408, 414, 418 f., 422, 425, 427, 429, 436, 437, 438, 440, 441, 448 f., 451, 452, 464, 477, 480, 493, 505, 509, 513, 520, 521 f., 524 f., 536 f., 538, 541 f., 554, 556, 562, 577, 588, 601, 604 f.
 —water tower III, 115, 141, 293
 Levinstein & Company Ltd., Manchester 209
 also see British Dyestuffs Corporation Ltd.
 Lewatit 355, 420 f., 493
 Lexone 468
 also see Sencor
 Leyendeckers, Robert 104
 Leysen, André 374, 410
 Libau 280
 Liebermann, Carl Theodor 35, 170
 Liebig, Justus von 19, 22, 45 f., 56, 69, 98, 211
 Liebig Scholarship Society 210
 also see Justus Liebig Society
 Liebknecht 209
 Liegnitz 272
 Liesegang, Paul Eduard 157
 Liesegang plant, Düsseldorf 157, 177, 197
 ligase 572
 Light Blue dyestuffs 30, 33
 light bulb 59, 79, 236, 597
 light-exposure and weathering unit, Engerfeld 81
 lignin 344
 Lilienthal, Otto 103, 123
 Lille 49, 59
 Lillo 417
 Lilly (Eli) & Co., Indianapolis, Indiana 573
 Lima 356, 441, 453
 lime 151, 202, 298, 420
 Lincoln, Abraham 29
 Lindbergh, Charles Augustus 247, 267
 Linde, Carl von 117
 linen 52, 334, 384
 Linke, Paul 84
 linoleic acid 246
 linotype machine 73
 linseed oil 244 f., 246
 liquidation certificates 316, 317
 Lisbon 277, 471
 Liston, Sonny Charles 413
 lithium 602
 lithographic application 411
 lithopone 185
 Liverpool 50, 263
 Livingstone, David 39
 loan association for German students 211
 Löb, Fritz 295
 Locarno 235, 290
 Lodz 77, 105
 Loehr, Helmut 563
 Loehr, Oskar 314, 315
 Logemann, Heino 299
 logistics 540
 Logistics and Services (Board Committee) 563
 logo
 see Bayer cross
 see Bayer lion
 Lommel, Wilhelm 203
 London 14, 17 f., 20, 39, 46, 56, 68, 84, 95, 97 f., 103, 109, 120, 141, 212, 236, 276, 278, 291, 307, 471, 506, 519, 552 f., 559
 Lorenz, Konrad 289
 Los Angeles 164 f., 447
 Lost 203
 Löw, Wilhelm 105
 Lübbert, Ernst 79
 Ludendorff, Erich 202
 Ludwig II, king of Bavaria 83
 Ludwigshafen 28, 35, 115, 144, 152, 225, 314
 Lukas, Peter 150 f.
 Luminal 197
 Lünen 403
 Lunge, Georg 107
 Luxembourg 299, 365
 Luxemburg, Rosa 209
 Lyons 35, 280, 313, 371
 L. Gevaert und Cie. see Gevaert Photo-Producten N.V.
 Mackensen 105
 Mackintosh, Charles 186
 Macrolex 389
 madder (root) 16, 34, 38
 Madison 518
 Madras 94
 Madrid 313, 465
 Maginot, André 257
 magnesium 151
 magnetic tape 277, 313, 411, 487, 532
 Maimann, Theodore Harold 383
 main factory entrance (Leverkusen works) 373, 520
 Main Scientific Laboratory 79, 97, 98, 99 f., 199, 201, 294, 308, 330, 401, 509
 main train station, Cologne 327, 331
 Mainz 551
 Makarios III (born Michael Christodoulos Mouskos) 493
 Makrofol 331, 357
 Makrolon 326, 327, 331 f., 331, 332 f., 371, 434, 559, 583
 also see compact disc
 malachite green 52 f., 54, 58, 117
 Malaga 464
 malaria 20, 229, 247, 262, 271, 333, 442, 445, 459, 476
 Malaysia 438, 455, 597
 maleic acid 368
 Malmö 493
 MAN Maschinenfabrik Augsburg-Nuremberg AG, Augsburg 133
 Management Development and International Personnel Coordination (Corporate Staff Division) 561, 563
 Manchester 59, 123, 401, 552, 605
 manganese 596
 manganese blue 242
 Manila 347
 Mann, Rudolf 94 f., 194
 Mann, Thomas 137, 322
 Mannesmann AG, Düsseldorf 79
 Mannheim 83, 126, 469
 Mansfield, James 17
 Mao Tse-tung 313, 505, 543, 592
 Marburg (Lahn) 56, 211, 253, 441
 Marconi, Guglielmo 123
 market researcher 84
 Marl 177, 394
 Marle-sur-Serre 313
 Marne 481
 Marrison, Warren Alvin 271
 Marschall Dairy Laboratories, Inc., Madison, Wisconsin 518
 Marseilles 271
 Marshall, George Catlett 307, 333
 Marshall Plan 307, 309, 333
 Martin 244
 Martin, Jacques 311, 313
 Martius, Carl Alexander von 280
 Marx, Karl Heinrich 29, 33
 Maschinenfabrik Hennecke GmbH, St. Augustin 318, 321, 391 f., 435, 441, 469
 Massachusetts 105, 243, 517, 594
 Massolle, Joseph 209
 maternity benefits 44
 also see employment agreements
 maternity home 167
 Matrex Corporation, Northvale, New York 487
 Matthews, Francis Edward 248
 Matthis, Hermann 73
 Mauss, Hans 263, 265
 mauve (Aniline Purple) 18, 20, 21, 35
 Max Planck Institute for Breeding Research, Cologne 543, 551
 Max Planck Institute for Carbon Research, Mülheim on the Ruhr 397
 Max Planck Institute for Polymer Research, Mainz 551
 Max Planck Society 193
 Maxibraun 567
 maximum workplace concentration 492
 Maxwell, James Clerk 278
 May Day celebration 293, 294
 McCandless, Bruce 577
 McCollum, Elmer Werner 209
 McKinley, William 149
 MDI see diphenylmethane-4,4'-diisocyanate
 measles 441
 measurement and control operator 452
 Meda 505
 Medical Department 130, 133, 309, 491, 536
 also see ambulance service
 also see polyclinic
 medical diagnostics 412, 413
 Medin, Karl Oskar 97
 Meister Lucius & Brüning see Hoechst AG
 Mellanby, Edward 209
 melt-spinning process 238
 Memmingen 564, 605
 Memorandum on the Establishment and Organization of the Farbenfabriken Works in Leverkusen 109, 110 f., 160, 166, 419, 606
 Memphis 466
 Mendel, Johann Gregor 33
 Mendeleev, Dimitri 33, 126
 Mendelssohn, Moses 280
 Mendelssohn Bartholdy, Felix 280
 Mendelssohn Bartholdy, Paul von 280
 meningitis 272, 275, 509
 menthol 188, 344, 346, 485, 519
 mercaptan 93
 Merck E., Darmstadt 444, 446, 535, 599
 mercury 218, 228 f., 278, 549
 Mergenthaler, Ottmar 73
 Mering, Baron Josef von 157
 Mersey Chemical Works Ltd., United Kingdom 50, 177
 Mesnil, Felix 216
 Messina 181
 Metastox 371, 407, 467
 methane 26, 176, 360
 methanol 233
 methionine 572
 methyl aniline 45
 methyl chlorosilane 378, 380, 382 f.
 methyl green 32, 54, 58
 methyl iodide 45
 methyl rubber 187, 189, 192 f., 202, 398
 methyl violet 30, 32, 280
 methylene-diphenyl-isocyanate 355
 metribuzin 467, 468
 also see Lexone
 also see Sencor
 Metz 178
 Metzeler Kautschuk AG, Munich 493, 599
 Metzeler Schaum GmbH, Memmingen 493, 605
 Mexico 16, 325, 404 f., 438, 518, 605
 Mexico City 577
 Meyer, Julius Lothar 33, 126
 Meyer, Martin 315
 Meyer, Paul J. 73
 Meyer & Riemann, Hanover 316
 Meyer-Larsen, Werner 334
 Meyfarth Ulrike see Nasse-Meyfarth, Ulrike
 Meyrinck & Co., Shanghai 67, 86
 microelectronics 438, 530 f., 534
 microfilm 413
 microscope 261, 273
 middle management 462
 Middlebury 398
 Midway 299
 Mietzsch, Fritz 263, 265, 274, 322
 Milan 79, 200, 209, 243, 340, 394, 436 f., 439, 505
 Miles, Franklin Lawrence 67, 514 f.
 Miles Almanac 515
 Miles Inc., Elkhart, Indiana 67, 73, 258 f., 313, 356 f., 458, 488 f., 514, 515 f., 549, 559, 567, 573
 —Ame Division 517
 —Household Products Division 516
 Miles Pharmaceuticals, West Haven, Connecticut 519, 575
 —research center 519, 562, 575
 Miles-Sankyo Com. Ltd., Tokyo 589
 mining 169, 176, 176 f., 233, 597
 Mini-Cooper 434
 Miracil D 309, 333, 444
 Missouri 440, 468, 487, 599
 mites 413
 Miyairi, Keinosuke 442, 445
 Mobay Chemical Company
 see Mobay Corporation
 Mobay Corporation, Pittsburgh 243, 331, 347, 435, 438, 440, 440 f., 459, 467, 469, 487, 505, 535
 —Agricultural Chemicals Division 467 f.
 —Bushy Park Plant (formerly Verona Corp.) 447, 469, 487, 535
 —New Martinsville plant 347
 Modena 439
 Moderno 505
 Moers 403
 Molecular Diagnostics Inc., West Haven 489, 519, 551, 575
 Möllendorff, Wichard von 201
 Moltke, Helmuth von 78
 Moltipren 429
 molybdenum 594, 596, 597
 Monet, Claude 45
 Monheim 229, 399, 513, 519, 544 f., 607
 monoisocyanate 287
 Monsanto Company, St. Louis 347, 388, 415, 440, 487
 Montevideo 257
 Monza 145
 Morestan 413
 Morgan, John Pierpont 149
 Moro, Aldo 519

Morocco 476
Morris, Colin John O.R. 289
Mortsel 282, 291, 410, 487
Moscow 48, 64, 105, 133, 209, 280,
307, 351, 357, 389, 459, 516, 535, 605
Mosso, Angelo 97
moth laboratory 209
moth repellent 215, 289
moth repellent detergent see Movin
moths 387
Moulinex 313
Mourgue, Oliver 340
Movecator film projector 289
Movex camera 289
Movin 564
Mozambique 476
Mozart, Wolfgang Amadeus 178
Mudrow-Reichenow, Lily 264
Muhammad, Ali (born Cassius
Clay) 413
Mühlheim (Ruhr) 397
Mülheim steamboat company 115
Müller, Hermann 208
Multistix 10 SG 516, 517
multivitamin specialties 365, 514 f.,
515
multi-scanning printer 559
Munich 45, 56, 71 f., 123, 135, 165,
170, 215, 221, 247, 280, 291, 309, 317,
365, 388, 403, 407 f., 410 f., 413, 430,
434, 477, 577, 599
Mussolini, Benito 209, 215, 235
mustard gas 203
Muurling, Ido J. Reinhard 105, 145
Münster 272, 274
Mycelex 485
also see Canesten
also see Empecid
mycosis see fungal disease
Mycospor 484 f., 559

N
Nachrichten der Landwirtschaft-
lichen Abteilung (Agricultural
Department News) 228
Nagasaki 299
Naguib, Ali Muhammad 347
Nagoya 597
Nairne, Edward 186
naldixic acid 512
Namu 106
naphtha 189, 360
naphthalene 51, 90, 176, 358, 419
naphthionic acid 82
naphthylamine plant 133
Naples 436
Napoleon I, emperor of France 136
Napoleon III, emperor of France 39
Nasser, Gamal Abdel 347, 357
Nasse-Meyfarth, Ulrike 164, 165
National Academy of Science, United
States 139
National Aeronautics and Space
Administration (NASA), United
States 459, 485, 598
National Cancer Institute, United
States 505
National Health Office (Second
Reich), Berlin 220
National Lead Company, United
States 247, 317, 362
National Socialism 44, 180 f., 235,
253, 257, 267, 271, 277, 290, 292, 306,
372, 448
natreen 399, 567
Natta, Giulio 397, 432
natural dyes 16, 24, 170, 585
natural gas 358, 480, 500
natural rubber 188 f., 246 f., 396,
398, 458
natural silk 238, 337, 341
Nauen 199
Navy Blue 201
Nazi Party see National Socialism
Neckarsulm 365
Neguvon 365
Nemacur 389, 468
Neomycin 509
Neostibosan 253
Neoteben 276, 322, 323, 324, 325,
578
Neo-Salvarsan 218 f.
Nernst, Walther Hermann 203
Nero 16
Nervine 67
Netherlands, The 17, 63, 181, 199,
207, 248, 299, 365, 414
Neuhaas company, Elberfeld 66

Neully 313
Neu-Ulm 430
Neville acid 81 f.
New Blue 26
New Green No. 1 53, 54
New Haven 189, 575
New Jersey 289, 365, 487, 513, 518
New Martinsville 347, 440, 487
New Orleans 158
New York 14, 24, 36, 47, 51, 105, 117,
129, 139, 192, 200, 221, 229, 247, 252,
257, 261, 324, 337, 340, 347, 417,
466 f., 469, 485, 516, 518, 568, 575
New York State 29, 36, 50 f., 67, 154
Newbury 552, 553
news bureau 175
Newton, Isaac 126
Ney, Elly 181
nickel 417, 594, 596
Nicolas II, czar of Russia 141, 169
Nicolle, Maurice 216
Nicotoben 325
Nietzsche, Friedrich Wilhelm 20
nifedipine 496 f. 499
also see Adalat
Nigeria 441, 476, 499
Nihon Tokushu Noyaku Seizo,
Japan 325, 586
Nihoa 588
Nimotop 496, 499, 577
niobium 177, 594, 596 f.
Nissan 588
Nitokuno, Japan 588
also see Bayer Japan, Ltd.
nitrendipine 577, 499
nitric acid 106, 109, 202, 205, 236,
296, 419, 504
nitrile rubber 249, 395 f.
also see Buna N
also see Perbunan N
nitrobenzene 240, 242, 345, 357, 519
nitrocellulose 236, 238
nitrofurane 475
nitroglycerin 495
Nixon, Richard Milhous 453, 459,
477, 493, 577
Nobel, Alfred 117, 149, 276
Nobel Industries Ltd., England 235
Nobel Peace Prize 149, 175, 235, 276,
333, 469, 499, 519, 559
Nobel Prize 117, 276 f.
also see Nobel Peace Prize
Nobel Prize for chemistry 68, 149,
153, 169 f., 193, 261, 326, 397
Nobel Prize for literature 71, 149, 417
Nobel Prize for medicine 141, 149,
169, 262, 276, 333, 509, 513, 568
Nobel Prize for physics 149, 193, 261,
357
Noddack, Walter Karl Friedrich 597
Noddack-Tacke, Ida 597
Noll, Walter 378
nominal value see stock market
quotation
noradrenaline 496
Nördlingen 24
Norgay, Tenzing 333
Norköpping 105
North Rhine-Westphalia 334, 403,
536
North Rhine-Westphalian pollution-
control authority 403
North Sea 535, 551
Northern Ireland 333, 447
also see Ireland
Norway 106, 299, 383
Noske, Gustav 209
Novodur 333, 336, 357, 361, 417, 434
nuclear magnetic spectrometer 602
nuclear power station 347, 523, 599
nuclear spin tomography 497
nun moth caterpillar 103, 547
Nürburgring race track 251, 430
Nuremberg 14, 60, 303 f., 307
Nuremberg trials 303, 304, 314
also see I.G. Farben trial
Nurmi, Paavo Johannes 211
Nylon 287, 291, 330, 337

O
occupation during wartime 205,
300, 309, 351
occupation zones 280, 305, 307, 313
occupational health 132, 420
occupational medicine 130, 132,
Occupational Safety Act 130
occupational safety 132, 182, 354,
357, 452, 462, 490 f.

also see employee protection system
also see Staff Suggestion Scheme
occupational safety department 491
Odysseus 289
Oelsner, Georg 105
Offe, Hans Albert 324
office clerk 452
office communication systems
410, 413
Ogino, Kiusako 253
oil 176, 349, 358, 360, 391, 395, 488,
500, 591 f., 597
—mineral oil 229, 233, 252 f., 295,
358
—oil industry 358
—refinery 360, 371
oil crisis 361, 488, 566
oil of angelica 346
Oldsmobile Starfire 435
old-age pension scheme 399, 554, 559
olefin 395
oleum 107 f., 145, 202
Olympic Games 123, 145, 164 f., 211,
281, 283, 477, 535
onchocerciasis see river blindness
One-A-Day 515
Onton 465
on-site railroad 113
on-site traffic 94 f., 113 f., 491, 523
on-the-job training program 513
opening balance sheet 315
operating manual 354
Oppau plant see BASF AG
Oppertshäuser, August 105
Optima camera 375, 411
Optimate 518
Optocillin 512
Oralopen 383, 511
Oranienburg 19
Oratren 347, 510
ore 294 f., 362, 364
organic chemicals
—Business Group 355, 419, 560
—Division 460
organic chemistry laboratory,
Wolfen 281
Organic Products Sector 560
organizational structure (Bayer AG)
309, 388, 460, 461, 463, 549, 560, 561
Ortega y Gasset, José 137
Ortizón 564
Osaka 588, 596
Osenberg, Gerd 164
Oslo 149
Ossietzky, Carl von 276
Ott Shokai see Bayer Japan Ltd.
Otto, Nikolaus August 29
Otto, Werner 105
Otto Bayer Foundation 551
Otto Bayer plaque 285
Otto II, emperor of Germany 262

P
Padutin 257, 495
Pagenhardt, Eduard von 280
Pahlavi, Reza 271, 523
painkiller see analgesic
Pakistan 307, 383, 417, 469
Palermo 338
pancreas 257, 375, 569
Panton, Verner 340
Panvitan 567
paper 18, 362, 382, 387, 389, 592 f.
Paracelsus, (born Theophrastus
Bombastus von Hohenheim)
93, 495
parachute silk 337
parafuchsin 54
parasitosis 445
Parathion see E 605
Paris, Raymond 312
Paris 39, 46 f., 73, 84, 97, 103, 105,
109, 117, 133, 145, 189, 212, 244, 247,
276, 289, 310, 312 f., 317, 340, 347,
371, 383, 389, 401, 485, 497, 596, 599
Pasalon 324
Passy, Frédéric 149
Pasteur, Louis 45, 63, 97
Pasteur Institute, Paris 97, 216
Patart, Paul 208
patchouli oil 346
patent 20, 35, 49 f., 52, 58, 60, 61, 67,
73, 76, 80, 83, 93, 118, 121 f., 124,
134, 142, 144, 155, 165, 170, 182, 185,
190, 198, 221, 233, 236, 244, 247 f.,
264, 271, 281, 288, 309, 326, 345, 366,
369, 400, 402, 422, 440, 485, 498, 518,
580

patent blue 120
Patent Department 52, 118, 199
patent law 21, 49, 59 f., 118, 447, 467
Patent Office 78, 123 f., 145, 169, 309
patent protection 50, 142, 455
patent suit 58, 118, 120, 144
Patents, Trademarks and Licenses
(Corporate Division) 462, 463
Paul VI, Pope 519
Paulinchenhof farm 228
PBU see Progil-Bayer-Ugine
PCB see polychlorinated biphenyl
Pearl Harbor 299
Peary, Robert Edwin 185
PeCe fiber 261, 287, 337
Pechiney Cie., France 235
Peetz, Hilla see Schnöring, Hilla
Peine 593
Peking 289, 485, 543
Pemberton, John Stythe 83
Penelope 289
penicillin 218, 247, 276, 325, 347,
375, 383, 399, 506, 508, 508, 510, 512,
549
also see acylureido penicillin
Peoria 507
peppermint oil 344, 346
perborate 177
Perbunan C 357, 371, 395, 439
also see Baypren
also see Buna N
Perbunan N 249, 336, 338, 361, 371,
395
perfume 342, 346 f.
perfumer 342, 343, 345 f.
Pergut 246 f., 267
Perizin 583
Perkin, Thomas 20
Perkin, William Henry Jr. 14, 18, 20,
21, 26, 35, 66
Perkin, William Henry Sr. 20
Perkin & Sons, England 20, 66
Perlon 302, 330, 337, 383, 417, 505
Permafex 384, 387
Perón, Juan Domingo 351
Perón, María Estella Martínez de,
named Isabel 505
peroxide 397
Persil 177
personnel 460
—Board Committee 563
—Department 215, 460, 560, 607
—Service Division 560, 563
Peru 59, 262, 341, 356, 389, 413, 441,
453
Perutz Photowerke, Munich 410
also see Agfa-Gevaert AG
perylene 389
pesticide 209
petrochemical 358, 360, 388
Petrogard see St. Petersburg
Petzold, Max 105
Peugeot 313, 434
Pflitzer, Hans 181
Pflanzenschutznachrichten
bulletin 548
Pflüger, Eduard Friedrich
Wilhelm 103
Pharma Chemical Corporation 487
also see Verona Corporation
pharmaceutical 90, 103, 156, 175,
201, 206 f., 216, 230, 233, 295, 322 f.,
351 f., 362, 365, 399 f., 413, 455 f.,
464 f., 471, 476, 482, 489, 516, 519,
553, 571, 575, 578 f., 581, 586, 588,
590, 599, 609
also see product name
—Pharmaceutical Department 109,
113, 130, 133, 149, 177, 181, 190, 199,
219, 257, 261, 272, 291, 299, 357, 578
also see Health Care Sector
—Pharmaceutical Research Center,
Aprath 129, 133, 573, 580 f.
—research 488, 578, 583, 588
—scientific research laboratory 123
pharmacist 69, 90, 137
pharmacy 471, 564
Phenacetin 90 f., 91, 93, 156,
216, 578
Phenistix 517
phenol 82, 176, 326, 329, 330, 336
phenyl ethylurethane 286
phenylamine 19
Philadelphia 51, 337
Philip Morris Company Inc.,
New York 583
Phnom Penh 499
phosgene 203, 286 f., 329 f.
phosphate 570
phosphoric acid ester 307, 317, 405,
406, 407, 547

- photocomposition equipment 412, 413, 487
 photocopier 408, 412, 413
 Photographic Department 280
 photographic developer 89, 103, 197, 280
 photographic paper 157, 177, 201, 215, 280, 283, 410
 —photographic paper plant 157, 197, 280, 317, 383
 photographic products factory 177, 229
 photography 239, 278, 279, 408, 413
 also see photokina Fair
 photoinitiator 368
 photokina Fair, Cologne 282, 357, 383
 Phrapradaeng 455
 phthalic acid 150, 245 f.
 phthalic anhydride 245 f.
 Phthalogen dyestuffs 317
 physical therapy 133
 physician 131, 132 f., 136, 175, 485, 497, 512
 —company physician 130
 physics laboratory 532
 Phytochem see Bayer France S.A.
 Piccard, Auguste 267
 Piechota, Helmut 563
 Pierstorff, Julius 71
 pigments 215, 240, 241 f., 362, 363, 382, 387, 532
 piperazine 93
 Pirelli Société Générale S.A., Basel 599
 Pisa 436
 Pittsburgh 260, 435, 440, 467, 486 f., 489, 599
 Pittsburgh Coke and Chemical Co., United States 466, 487
 also see Chemagro Corporation
 Pius XI, Pope 253, 261
 plague 109, 133
 Planck, Max 145
 Plant Administrations,
 Environmental Protection and Occupational Safety (Service Division) 561
 also see Plant Management (Department)
 Plant Administrations (Service Division) 491, 561
 plant foreman 28, 490, 530
 plant lice (aphid) 209, 371, 407
 Plant Management (Department) 113 f., 462, 491, 561
 also see Plant Administration
 Plant Safety and Technical Inspection Section 354, 500
 plasmids 572
 Plasmochin 229, 247, 263
 plasmodia 262 f.
 plasticizer 330
 plastics 86, 169, 188, 238 f., 257, 284 f., 326 f., 331, 333, 361 f., 366, 378, 382, 387, 391, 397, 399 f., 415, 419, 421, 430, 432, 435, 439, 465, 471, 487, 500, 502, 516, 532, 562, 590
 —Business Group 560, 592
 —plastic car 430 f., 433
 —Plastics and Coatings Division 460
 plastination process 383
 plumber's workshop 219
 pneumonia 272, 275
 pneumococci 506
 Pocan 329, 434
 Poelzig, Hans 233
 Poggendorf, Johann Christian 19
 Pohl, Jakob 185
 Poland 205, 211, 296, 306, 535, 543
 Policy guidelines for environmental protection and safety at Bayer 562, 600, 604
 polio see infantile paralysis
 Polivital 325
 polonium 133
 polyacrylic fiber 313, 338
 polyacrylonitrile 52, 334, 336, 338, 384
 polyaddition process 286 f., 299, 318, 328, 338
 polyamide 277, 287 f., 328, 330, 336 f., 341, 384
 polycarbonate 326, 329, 331, 357, 417
 polychlorinated biphenyl 382, 426, 493, 559, 604
 polyclinic 130, 131, 132, 145
 also see Medical Department
 polycondensation process 287 f., 328
 polyester 238, 286, 288, 325, 341, 368, 384
 polyester fiber 238, 351
 polyester resin 325, 328, 330, 333, 366, 368, 432, 441
 polyether 286
 polyisocyanate 286, 366, 392
 polymerization 188 f., 192, 249, 288, 326, 328, 338, 368, 397
 polymethylsiloxane 380
 polyol 286, 318 f., 392
 polypeptide 153
 polyphenylene sulfide 329, 417, 435
 polypropylene 188
 polysiloxane 378
 Polystal 590, 591, 592
 polystyrene 257
 polyurethane 88, 284, 312, 318, 328 f., 329, 333, 341, 347, 354, 361, 366, 382, 390, 397, 400, 416, 434, 440, 465, 480 f.
 —Business Group 88, 355, 562
 —igloo 391, 392, 485
 —pilot plant 383, 393
 —polyurethane production unit, Belford Roxo 355
 polyurethane chemistry 286, 417, 419, 487, 593
 polyvinyl chloride (PVC) 257, 261, 329
 Polyvital 325
 Pompidou, Georges 453, 493
 Ponceau dyestuffs 58
 Pontiac Fiero 435
 Ponto, Jürgen 513
 Pont-a-Marcq 313
 Porofoor ADC 396
 Porsche, Ferdinand 193
 Porsche 924 Carrera GT 430, 434, 523
 Port Arthur 165
 Port Said 268
 portable medicine case 265
 Porto 185
 Portugal 106, 185, 383
 Port-Jerome 312 f., 397
 potassium nitrate 108
 potatoes 466, 468
 Potosan 309
 Pottier, Eugène 39
 power station 112, 113, 235, 348 f., 540
 —Block G power station 235, 348, 349
 —Block Y power station 283
 Prague 29, 105, 447
 Prato 436
 Praziquantel 444, 446
 also see Biltricide
 predatory bug 474, 475, 477
 Preiss, Daniel 28
 Prent 496, 499, 513
 also see Sali-Prent
 preservative 419
 —food preservative 245, 421
 Presinol 496, 498
 Preussag AG, Hanover 593
 preventive medicine 44, 132
 Preventol 399, 420 f.
 pre-retirement vacation 374
 Priestley, Joseph 186
 Primo de Rivera y Orbaneja, Miguel 221, 257
 prisoner of war 204, 297
 Prix Galien 312, 446, 497, 535
 also see Galenus Prize
 process control systems 354, 375, 452, 530, 534 f.
 —Department 533, 535, 561
 Process Engineering Reports (VtB) 126
 process manual 505
 process technology 87, 317, 426, 486, 532, 533
 Prochaska 105
 Productos Quimicos Sintéticos S.A., Madrid 313
 Produits Chimiques et Pharmaceutiques de Monaco (Dr. Paris) 312
 also see Bayer Pharma S.A.
 professional training centers 149, 450
 Progil-Bayer-Ugine (PBU), Paris 312, 543
 Project Engineering 354, 354, 561
 Prominal 267
 Prontalbin 274
 Prontosil 274 f., 275, 289
 propane 380
 propylene 336, 360, 361, 395
 propylene oxide 286, 360 f.
 protective glasses 490, 492
 protein 153, 188, 238, 256, 568, 570, 572
 protozoa 274
 Proust, Louis Joseph 46
 Prudhomme see Sully Prudhomme
 Prussian Institute for Infectious Diseases 220
 Prussian Patent Office 35
 Public Relations Department (Corporate Staff Division) 561, 563
 purchasing (department) 158, 233, 354 f.
 Purchasing (Division) 462, 560
 purple dyestuffs 16, 18, 21
 Purwien, Peter 374
 Puteaux 310, 313
 PVC see polyvinyl chloride
 pyrethroid 468, 559
 pyrethrum 559
 pyrimidine 386
 pyrite 96, 106, 108
 pyrophosphoric acid tetraethyl ester 405
-
- Q**
 quay 95 f., 415, 541
 Quenty 567
 Quimica Farmacéutica Bayer S.A. see Bayer Hispania Industrial S.A.
 Quimicas Unidas, Mexico 325
 quinine 20, 90, 137, 262
-
- R**
 radioactivity 123, 141, 599
 railroad 14, 33, 48, 95, 113 f., 115, 137, 151, 331, 369, 532 f., 540, 543
 —narrow-gauge railroad 96, 115
 Ramon, Gaston 271
 Rapidogen dyestuffs 257
 Rappe, Hermann 374
 Rathenau, Walther 201
 Rattee, Ian Durham 387
 Rauma 429
 raw material warehouse 94, 178
 Rayleigh, John William Strutt, 3d Baron 124
 rayon 239, 289, 334
 reaction injection molding (RIM) 432, 434
 reactive dyestuffs 384
 reading circle 97, 103, 124
 also see Chemists' Conference
 reading room 152
 also see Erholungshaus recreation center
 also see works library
 Reagan, Ronald Wilson 543, 577, 583, 599, 605
 Recklinghausen 177, 394
 recycling 90, 240, 243, 597
 Regional Coordination and Controlling Department (Corporate Staff Division) 561, 563
 Reichenbach 83
 Reichenbach (Town) 105
 Reichstein, Tadeusz 271
 Reimer, Karl 345 f.
 Reims 299
 Rein, Herbert 337 f.
 reinforced reaction injection molding (RRIM) 432, 434, 523
 Reis, Johann Philipp 51, 389
 Relief fund of the Alizarin Factory of Friedrich Bayer & Co., in Elberfeld see fund (employee health insurance)
 Remington, Philo 45
 Renard Frères et Franc, Lyons 35
 Renault Alpine 434
 Rensselaer 156
 repairs 208, 212, 222
 rescue float 535
 research 46 f., 88, 126, 158, 460, 609
 —Research and Development (Board Committee) 563
 Resochin 264 f., 264, 271, 333, 459, 578
 Resolin dyestuffs 351
 Restren 333
 Retingan 256, 357
 Reuling, Wilhelm 118, 120
 Reye Syndrome 139
 Reykjavik 599
 Rheinpreussen colliery 207
-
- Rhein-Chemie Rheinau GmbH, Mannheim 469, 560
 Rhenish-Westphalian Coal Syndicate 176
 rhenium 594, 596
 rheumatism 90, 135, 139, 264, 575, 582
 Rhine river 95, 103, 106, 111, 115, 146, 148, 194, 202, 205, 207, 212, 268, 303, 349, 414, 427, 429, 481, 539, 541, 544, 605 f.
 Rhinechem Corporation, United States 489, 513 f.
 Rhineland-Westphalian Sulfuric Acid Syndicate 106
 rhodamine 120
 Rhone-Poulenc, S.A., Paris 235, 311, 499, 543
 ribbonmaker 69
 ribonucleic acid 570
 rice 404, 405, 454, 455, 457
 Richmond 447, 553
 rickets 209, 247
 Ridgefield Park 487
 Rietzschel, Anton Heinrich 411
 Riess, Kurt 314, 315
 Rinke, Heinrich 288
 Rio de Janeiro 94, 193, 352, 356 f., 471, 523
 Rio Grande Valley Farm 468
 river blindness (onchocerciasis) 221
 road surfaces 241, 242
 Robert Emanuel Schmidt Foundation 197
 Rochester 139
 Rochow, Eugene George 378
 Rockefeller, John Davison 39, 67
 Rockefeller University, New York 568
 Rödenthal 599
 Rodinal 280
 Roehl, Wilhelm 219, 262 f.
 Roesler, Oswald 314, 315
 Rohe, Ernst-Heinrich 563
 Röhm, Ernst 271
 Röck, Marika 281
 Rolff, Wolfgang 165
 Romania 67, 211, 429
 Rome 16, 39, 267, 436, 559
 Röntgen, Wilhelm Conrad 117, 149
 Roosevelt, Franklin Delano 271, 275, 299
 Roosevelt, Franklin Delano Jr. 275
 Roosevelt, Theodore 149, 165, 175
 Rosegger, Peter 153
 Rosenberg, Ethel 317
 Rosenberg, Julius 317
 Rosendahl, Heidemarie see Ecker-Rosendahl, Heidemarie
 Roskydal 325, 366, 369
 Ross, Ronald 262 f.
 Rothschild, Nathan Meyer 47
 Rott, André 291
 Rotterdam 95, 106
 Roubaix 49, 59
 Rouen 39, 109
 Royal Carolinian Medical-Surgical Institute, Stockholm 276
 Royal College of Chemistry, London 19 f., 56
 Royal Dutch Shell Company, United Kingdom 177
 Royal German Academy of Sciences, Berlin 278
 Royal Technical College, Krefeld 28, 36, 86
 RTHC Bayer Leverkusen 164
 rubber 86, 186, 187, 188, 191, 201 f., 246, 248, 288, 295, 312, 330, 361, 394, 399 f., 419, 439, 441, 458, 480, 487
 also see product name
 also see rubber type
 —Business Group 191, 249, 398, 560
 —Central Laboratory 251
 —chemicals 399, 417, 456, 458, 465, 480
 —Division 460
 —production 190, 295, 299
 —testing center 447
 —testing unit 87, 191, 250 f., 398
 Rübél, Fritz 58
 Rubens, Peter Paul 414
 Rübénstrunk 38
 Ruffer, Marc Armand 442
 Ruhrort 212
 Rummelsburg 280
 Rumpff, Carl Heinrich Christian Ludwig 36, 37, 38 f., 55, 62 f., 66 f., 72 f., 78, 83, 92 f., 97, 118, 552, 562, 608, 609
 Runge, Friedlieb Ferdinand 19, 26

Ruska, Ernst August Frederick 261
Russia (Soviet Union) 32, 39, 45, 48,
50 f., 84, 89, 141, 153, 169, 177, 198,
205 f., 209, 211, 229, 283, 297, 299,
309, 317, 351, 357, 371, 383, 399, 401,
469, 477, 499, 516, 523, 551, 583, 592,
605
Rust, Mathias 605
rutile 362, 364

S
Saccharin 308
saccharin see artificial sweetener
Sadat, Anwar al 513, 519, 543
safety
—competition 490 f.
—delegate 132
—regulation 153, 492
—training 491
safflower 16
safranin 47
Saigon 499
Sajodin 177, 495
Sakhalin 559
Sakharov, Andrei 499
salary 38, 42, 44, 47, 50, 97, 156, 167,
204, 212, 222, 235, 252, 297, 308, 374,
441, 481, 499, 556
—annual bonus 243, 556
Sale 401
sales 38, 66, 103, 198, 202, 214, 280,
316, 356, 361, 400, 410, 417, 419, 458,
468, 474, 486 f., 518, 523, 540, 552,
564, 566, 587, 589, 594, 608
sales department for chemicals 419
Sales Office
—American section 86, 133, 145
Sales Office
—English section 133
salicin 137
salicylic acid 90, 135 f., 389
Salisbury, Robert Arthur Talbot
Gascoyne-Cecil 79
Sali-Adalat 499
Sali-Prent 499
salt electrolysis unit 197
Saltillo 438
saltpeter 59
Salvarsan 218 f.
San Diego 285
San Francisco 175, 283, 299, 317, 573
San Nicolas 389
Sanger, Frederick 513
Santiago de Chile 485
Sao Paulo 357, 444, 485, 562
Sarajevo 200, 205, 208
Sarin 407
Sarney, José 357
savings bank for workers 141
Sayville 199
scarlet warehouse 59, 94
Schaal, Eugen 38
Scheel, Walter 453
Scheibe, Adolf 271
Schelde Chemie, Brunsbüttel 480 f.,
513, 583
Schelde river 414 f., 417, 480
Schelploh plant 93, 133
Schering AG, Berlin 441
Schering Corporation, United
States 505, 508, 512
Schiffilin 26
schistosomiasis 442 f.
schistosomiasis see bilharzia
schizont 263
Schkopau 250, 295
Schlack, Paul 291, 330, 336 f.
Schleswig-Holstein 459, 479, 481
Schleyer, Hanns Martin 513
Schliemann, Heinrich 39
Schmatz, Gerhard 564
Schmelting, Max 257
Schmidt, Hans 322
Schmidt, Helmut 493
Schmidt, Otto Theodor 488
Schmidt, Robert Emanuel 89, 97,
142, 143, 144 f., 172 f., 194, 197
Schmidt-Ott, Friedrich 210
Schmunck, Ludwig 178
Schneider, Manfred 563
Schneider, Wilhelm 281
Schnell, Hermann 326, 330
Schnöring, Hilla 95
Schoonaerde 176
Schopenhauer, Arthur 371
Schönbein, Christian Friedrich 236
Schönhöfer, Fritz 263
Schradler, Gerhard 317, 405, 407

Schulemann, Werner 263
Schultz, Gustav Theodor August Otto
118
Schumpeter, Josef Alois 608
Schweitzer, Albert 417
Schwimmverein
Bayer Uerdingen 08 e.V.
(swim club) 164
Scientific Literature
Department 126
SCM Glidden Company, United
States 438
Scotland 552
Scott, Robert Falcon 193
Sea Blue 30
Seaford 337
secondary resin tanning 255
Securopen 508, 512
Sedan 39
Seeborn, Johanna see Duisberg,
Johanna
seed dressing 199, 226, 227, 253, 485,
547, 549
seed dressing for cereals 546
Seidler, Paul 58, 74, 77
Seipp, Walter 374
selenium 169
Sencor 466, 548
—also see Lexone
seniority bonus 115, 129
Sens 313, 429
Seoul 559
Seralyzer 518
Serbia 197, 205
Service Division 127, 560 f., 563
—also see Corporate Division
—also see Corporate Division name
—also see Service Division name
Setzer, Eugen 105
Seveso 500, 505, 538
Seville 464
Shah Alam 438
shampoo 346
Shanghai 67, 86, 94, 105, 199, 592
Shanghai Dental Materials
Factory 592
share see stock
share capital see stock
Sharkey, Jack 257
Shell
—see Deutsche Shell AG
—see Royal Dutch Shell
Shikoku Electric Power Co., Inc.,
Takamatsu City, Japan 588
Shipping Office 94, 233, 261, 560
—also see Engineering Department
—also see Traffic and Distribution
Services
Shockley, William 357
shoe polish 382
Sholes, Christopher Latham 45
short-time work 252, 505
—also see working hours
sick pay 42, 44
side effects 90, 137, 139, 219, 264,
267, 484, 498, 580
Siebold, Carl Theodor Ernst 442
Siefken, Werner 324
Siegburg 318, 321
Siemens, Werner von 14, 29
Siemens AG, Munich 365, 605
Siemens-Martin process 29
Sighurta, Italy see Bayer Italia S.p.A.
silane 380
Silbernagel, Artur 105
Silcher, Friedrich 315
silicate 177
silicate filler 333, 351
silicic acid 351
silicon 378, 380
silicon dioxide 378
silicon nitride 598
silicon oxide 598
silicone 325, 378, 383
silicone elastomer 382
silicone oil 381, 382
silicone resin 382
silicone rubber 257, 378, 379, 381,
382
silk 21, 52, 59, 69, 78, 236, 244, 334,
384, 386, 585
silkworm 236 f.
Siller, August 28, 39, 55, 64, 67
Siloper 325
siloxane 380
silver 410 f.
silver salt diffusion process 291
Simmiler, Walter 374
Singapore 190, 455
Sinpro 567
Sionon 567

Sisomicin 508, 512
skin cream 346
—also see Quenty
skiver see leather
Skladanowsky, Emil 117
Skladanowsky, Max 117
Sklodowska, Marie see Curie, Marie
slave labor 297
sleeping drug (soporific) 90, 93, 197
sleeping sickness 149, 215, 216, 220,
474, 476
smallpox 175, 441, 505
smelting furnace 594
Smithsonian Institute, Washington D.C.
404
snail 16
soap 345
soccer 162, 163, 165, 257, 499, 523
social secretary 193
Societe Anonyme des Produits Fred.
Bayer & Co., France 49
Société Générale des Produits
Chimiques (SOGEP) see Bayer
France S.A.
Society for Further Education of the
Workers and Craftsmen of
Farbenfabriken vorm. Friedr. Bayer
& Co. 178
Society of German Chemists 126
Society of the Friends and Promoters
of the Friedrich Wilhelms
University, Bonn 210
soda 438
sodium 248
sodium carbonate factory 79
sodium hydroxide 108, 197, 419
sodium phenolate 136
sodium salicylate 135 f.
Solbar 228
Solingen 149, 427
Sollstedt 316
Solucillin 510
Solvay, Ernest 29
Sophie, Baroness Chotek 200
Soulé, Samuel W. 45
sound-control van 493
sound-track projector (iron box)
209
South Africa 89, 220, 357, 371, 445
South America 176, 186, 206, 221,
267, 352, 356, 442, 455, 482
—also see Latin America
Soviet State Committee for Science
and Technology 516
Soviet Union see Russia
soybeans 455, 468
Spain 39, 106, 133, 221, 257, 438, 464,
499, 513, 605
special dyehouse 157
Specialty Chemicals and New
Products (Business Group) 560,
583, 590
Spezzano 439
spiraea shrub 136
spirochaete 219, 274
Spokesmen's Committee for Middle
Management 462
sporocysts 445
sports clubs 162
sports for the handicapped 165, 543
sports grounds 164, 393
Springfield 105, 468
Springfield Farm, Nebraska 468
Springhill 435
Sri Lanka 190, 267, 309
Staab, Heinz A. 374
Staff Suggestion Scheme 182, 183 f.,
374, 499
Stalin, Joseph (born Iosif
Vissarionovich Dzhugashvili) 229,
298, 309, 357, 389, 516
Standard Oil of Ohio Company 39,
336
Standard Oil Trust, United States 67
Stanford University, California 569
Stanley, Henry Morton 39, 67
Stanley Research Farm, United States
467
Stapenor 399, 508, 511
—also see Dichlor Stapenor
staphylococci 506
Starck, Hermann Carl 594
Starhemberg, Ernst Rüdiger von 257
statutory pension 554
Staudinger, Hermann 326
Sta. Cruz de Tenerife 464
steam boiler 113, 348 f., 501
steam engine 14, 32, 348
stearate 246
stearic acid 246
Steinbuch, Karl 126

Steinkopf, Wilhelm 203
stemborer 404
Stempel, Max 105
Stephan, Heinrich von 45
Stephen, William Elliott 387
stereorubber 396 f.
Sterling Drug Inc., New York 137 f.,
206, 221, 459, 486 f., 489, 553
Sterling Products Company, United
States 205
—also see Sterling Drug Inc.
Sticker, Georg 133
Stinnes, Hugo 207
stock 64 f., 74, 79, 280, 316, 317, 333,
411, 556, 557, 589
—also see liquidation certificates
—also see stock market quotation
—exchange 14, 40, 65, 129, 252, 589,
605
—market quotation 40, 79, 556
—also see dividend
Stockholm 46, 149, 276, 383, 493
Stoke-on-Trent 438
stomach acid 510
stomach ulcer 79
Stone, Edward 136
Stoph, Willi 459
Strabag, Düsseldorf 592
Strange, Edward Halford 248
Strasburger, Eduard Adolf 79
Strasbourg 73, 170, 371
Strenger, Hermann Josef 357, 562,
562, 563, 600, 604
streptococci 272, 274 f., 506 f.
streptomycin 508, 511
Streptomycin "Bayer" 324, 510
Stresemann, Gustav 235, 290
strike 97, 165, 204, 209, 214, 535
stroke 519
—also see apoplexy
strophanthin 495
Studienstiftung des deutschen
Volkes (scholarship foundation)
211
Stuttgart 83, 105, 194, 513
styrene 249, 333, 368, 397
styrene-butadiene rubber (SBR) 351,
394, 398
St. Gobain, France 235
St. Fons 280
St. Germain 209
St. Louis 165, 347, 440, 466, 599
St. Malo 429
St. Nazaire 313
St. Petersburg 24, 48, 169, 177,
205
Surárez, Adolfo 513
Sudbury 20
sugar 202, 309
suggestion program see Staff
Suggestion Scheme
sulfanilic acid 58
Sulfanol 92, 93
sulfate process 363
sulfathiazole 322
sulfonamide 263, 272, 289, 302, 322,
325, 507, 510, 578
sulfur 108, 188 f., 397, 549
sulfur dioxide 108, 402 f.
sulfur trioxide 402
sulfuric acid 18, 32 f., 106 f., 145, 177,
202, 205, 236, 256, 296, 355, 363 f.,
402, 415, 419, 504, 551
—plant 107, 112, 145, 181
Sully Prudhomme, pseudonym
of René Francois Armand
Prudhomme 149
Sumitomo Bayer Urethane Co. Ltd.,
Amagasaki 453, 588 f.
—also see Bayer Japan Ltd.
Sumitomo Chemical Co. Ltd., Osaka
453, 588
Sumser, Bert 164
sun cream 564
Sun Yat-sen 193
superpolyamide 337
Supervisory Board (Bayer) 28, 50,
64, 67, 72, 79, 106, 190, 194, 307, 314,
316, 374, 388, 462
Supracen dyestuffs 267
Supranol 247
Supreme Court (Second Reich),
Leipzig 58, 118
Suzuki, Minoru 442
SV Bayer Wuppertal 164
Swan, Josef Wilson 73, 126,
236
Sweden 276, 311, 324, 347, 383,
493, 562
Switzerland 26, 155, 197, 291, 347,
383, 449, 469, 539

synthetic fibers 52, 141, 188, 238 f., 252, 287, 291, 318, 334, 358, 384, 399
Synthetic Patents Company Inc. see Hudson River Aniline and Color Works
synthetic resin 326, 420
synthetic rubber 175, 185, 186, 191, 243, 248, 294, 295, 306, 317, 394, 395, 431, 471
also see Buna
syphilis 218 f.
Systox 317, 406, 407, 467
Szent-Györgyi von Nagyrápolc, Albert 271

T
Tabun 407
Taiwan 124, 505
Takamine, Jokichi 149, 518
Takamine Laboratories, Clifton, New Jersey 518
Taka-Diastase 518
Takeda, Yoshizo 588
Takeda Pharmaceuticals, Japan 588
Talbot, William Henry Fox 278
Tanigan supra LL 254, 256
tanner
—tanners' island 255
—tanners' paring-bench 255
tannery 603
Tannigen 109
tannin 32, 254, 347, 352, 387, 471, 562
—auxiliary tannin 256
—synthetic replacement 255, 256
tantalum 177, 594, 596 f.
Tanzania 476
tar distillation factory Schoonaerde, Belgium 176
Tardocillin 510
Tarragona 453, 465
TBI 303
TDA see diaminotoluene
TDI see toluylene diisocyanate
teaching laboratory 289, 450
Technical Control Board (TÜV), Germany 503
Technical Development and Applied Physics (Department) 561
Technical Service Laboratories 458
Tedur 329
Teheran 523, 535
telecommunications 592
telemobiloscope 165
TEMES emission-control network 403
temple to flora 70
ter Meer, Edmund 55
ter Meer, Fritz 225, 271, 306 f.
teratogenic properties 580
terephthalic acid 329
Tereshkova, Valentina 401
Terrorism 509
tetanus 97, 253, 271, 441
tetrachlorodibenzodioxin (TCDD) 505
Tetracyclin 551, 510
tetracylin 511
textiles
—industry 17, 24, 49, 86, 146, 155, 198, 338, 436, 459, 464, 552 f., 585
—textile auxiliaries 355, 387, 471, 487
—textile fiber 238, 261, 340, 415, 431, 471, 500
—Textiles Museum, Krefeld 171
TGV super-express trains 313, 371
Thailand 413, 454, 455, 597
thallium 221
Thane 456 f., 459
Thane plant see Bayer India Ltd.
Thatcher, Margaret Hilda 523, 559
The Bayer Company Ltd., Manchester 552 f.
also see Bayer UK Ltd.
The Chemical Foundation 206
The Egyptian-German Joint Project for Bilharzia Control 446
The Elberfeld Farbenfabriken Company Ltd., Manchester 123, 552
The Farbenfabriken of Elberfeld Company, New York see Bayer USA Inc.
Theophrastus 136
Therapeutic Reports 175, 197
Therban 396, 398, 583
Thiele, Emil 67, 83
thiophosphoric acid ester 547

thiosemicarbazone 322, 325
Thomson, Robert William 190
thromboembolism 141
thymine 570
thymol 344
Tibras, Brazil 357
Tiemann, Ferdinand 345
Tientsin 87
Tiguvon 429
tire 87, 190, 191, 192 f., 192, 249, 250, 251, 294, 295, 313, 334, 394, 398, 431, 458
tissue plasminogen activator (TPA) 571
Titangesellschaft mbH, Leverkusen 247, 317
also see Kronos Titan
titanium 362, 598
—ore 177, 362
—white enamel 438
titanium dioxide 357, 362, 363 f., 417, 459
—plant 317, 362
Titicaca Lake 356
Titov, German 389
TNT see trinitrotoluene
Tobey 275
Tokyo 221, 587, 589
tolidine 77, 80
Tolosa 464
toluidine 26
toluene 286, 358, 361, 419
toluylene diisocyanate (TDI) 286, 513
toolmaker (fitter) 45, 182, 450, 451, 452
—workshop 502
toothpaste 346, 362, 421, 564
also see Kolynos
Toronto 365, 371, 596
Tourcoing 50
Tower Biology 424, 427, 456, 524, 524 f., 532
Toyada 588
Toyohashi 577
Toyota Motor Corporation, Japan 588
track-and-field athlete 162, 164
trade union 42, 47, 141, 157, 165, 168 f., 204, 207, 292, 372, 374, 447, 462, 535, 543, 577
trademark 51, 175, 207, 303, 400, 439, 489, 553
Trafford Chemical Company, United Kingdom 291
training 87, 450, 481
training workshop 149, 450, 451
transparency 281, 371
Trasylol 375
traveling technician 85 f., 105
Tredalat 499
Treener, J. Maurice 258
Trepow 280
Triafol 313, 330
Trianon 211
triazinone 468
Tribunil 457
trichlorophenol 505
Triest 291
trimethylol propane 286, 368
trinitrotoluene (TNT) 202
Trional 92 f.
Tripartite Association 158, 203
also see Interessengemeinschaft der deutschen Teerfarbenindustrie
triphenylmethane dyestuffs 26, 54
Triple Confederation 50, 158, 176 f., 203, 232, 280
also see Interessengemeinschaft der deutschen Teerfarbenindustrie
triple-layer reversal film 281
trisilane 380
tristearin 246
trityl 484
Troja 39
Tropenwerke Dinklage & Co., Cologne 453
tropical diseases 132, 220, 253, 262, 442 f., 475, 499
troparium, Monheim 545
Trorion, Brazil 357
Trotsky, Leon (born Lev Davidovich Bronstein) 229
Truman, Harry Spencer 299, 303, 307
trypan dyestuffs 219
trypanosomes 216, 219, 475, 477
also see sleeping sickness
Tschunkur, Eduard 248 f.
tsetse fly 217

TSV Bayer 04 Leverkusen e.V. 163 f., 523
—Gymnastics and Games Society of Farbenfabriken vorm. Friedr. Bayer 162, 178
—Leverkusen Sports Association 04 162, 283, 477
TSV Bayer Dormagen e.V. 164
Tuan-fang 175
tuberculosis 55, 67, 169, 275 f., 322, 507
Tucholsky, Kurt 137
tungsten 594, 596 f.
Turin 436
Turkey 197, 205, 221, 391, 429
Tust, Eduard 36, 38 f., 42, 52, 60, 64, 67, 78
Tutankhamen 215
Twain, Mark 152 f.
typewriter 45, 104, 105, 375
typhus 442

U
Uerdingen Tennis Club 1900 e.V. 145
Uerdingen works 50, 86, 102, 107, 127, 240, 243, 247, 303, 315, 325, 330 f., 346, 361 f., 365 f., 371 f., 388, 417, 427, 429, 450, 459, 519, 599, 605, 607
also see Chemische Fabriken vorm. Weiler-ter Meer
Uexküll, Baron Jakob Johann von 243, 422
UFA see Universum Film AG
Uliron 289
Ulrich Haberland Haus 351
ultramarine dyestuffs 60
uncertainty theory 247
unemployment 247, 252, 371, 577
Unger, Hans 374
Union Carbide & Carbon, United States 235
Union Quimica Comercial S.A. see Bayer Hispania Industrial S.A.
Uniroyal Inc., Middlebury, Connecticut 397
United Alkali, United Kingdom 235
United Kingdom 14, 19 f., 24, 39, 46, 51, 60, 63, 73 f., 79, 153, 165, 177, 190, 198 f., 204 f., 207 f., 211, 215, 229, 235, 248, 276, 291, 296, 299, 307, 309, 311, 333, 347, 383, 413, 447, 477, 486, 506 f., 523, 551 f., 559, 592, 605
United States 14, 29, 33, 35 f., 47, 50, 63, 67, 92, 97, 109, 126, 133, 137, 141, 145, 149, 153, 154, 158, 164 f., 177, 189, 198 f., 205, 207 f., 211, 215, 221, 229, 235, 247, 251, 253, 255, 257 f., 264, 271, 275, 290 f., 299 f., 304, 307, 309, 311, 317 f., 321 f., 325, 330 f., 333, 337, 341, 346 f., 351, 358, 363, 365, 369, 371, 378, 383, 388 f., 391, 404, 410, 413, 429, 431, 435 f., 437, 440 f., 453, 455, 466 f., 477, 485, f., 488, 493, 499, 505, 507, 509, 512 f., 515 f., 519, 540, 543 f., 549, 553, 559, 564, 571, 575, 577, 584, 588 f., 592, 594, 597, 599, 605
United States Steel Corporation 149
university 46, 79, 98, 102, 126, 133, 210, 226, 378, 453, 519, 533, 543, 544, 551, 576
—Berlin 294
—Bonn 19, 210
—Breslau 294
—Cairo 442
—Cologne 599
—Freiburg 92, 326
—Giessen 19, 46, 219
—Göttingen 46, 71, 345
—Halle 316
—Hamburg 243
—Heidelberg 46, 488
—Jena 46, 71
—Marburg 137, 211
—Munich 46, 72, 135, 388
—Münster 272
—Strasbourg 73, 170
—Tübingen 442
Universum Film AG (UFA) 281
Unverdorben, Otto 19
uracil 570
uranium 123, 291
urban, Johann 236
Urbana Farm, Illinois 468
urea 219, 508, 512

Urepan 325
urethane 286
Uspulun 199, 226 f., 227, 547, 551
U.S. Society of the Plastics Industry 285
Ustin 229

V
vacation 167 f., 374
also see working hours
Valencia 464
vanadium 596
vanadium pentoxide 108
Vancouver 153
Vane, Gétulio 141
vanillin 45, 344, 345
Vargas 257
Varroa mite 583
vat dyestuffs 18, 153, 170, 173, 175
also see Agol dyestuffs
Vater, Wulf 497
Veba AG, Berlin 488, 519
Vega, de 262
Velden, Reinhart von den 79
Venetan 209, 229
Venice 60, 436
Vera Cruz 94
Verdun 205
Verein der Jubilare der Bayer AG Leverkusen e.V. (long-service association) 165, 211
—annual reception 193, 197, 233
Vereinigte Glanzstoff-Fabriken AG, Aachen 141
Vereinigte Stahlwerke AG 243
Vereinigte Ultramarinfabriken vorm. Leverkusen, Zeltner & Consorten AG Nuremberg, Leverkusen plant, Cologne 66, 103, 114, 149
also see Dr. Carl Leverkus & Söhne
Verguin, Emanuel 26, 35
Verne, Jules 152 f.
Vero Beach 347, 468
Vero Beach Laboratories, Florida 469 f., 487
also see Mobay Corporation
Verona Corporation, Union, New Jersey 365, 469, 487
also see Baychem Corporation
also see Mobay Corporation
Verona Dyestuffs Division 365, 447
also see Mobay Corporation
Verona Dyestuffs Ltd., Montreal 371
Veronal 157
Versailles 39, 205, 208 f.
Victoria, queen of Great Britain and England 17, 55, 59, 149
Videla, Jorge Rafael 505
video cassette 152, 383, 532
Vienna 39, 40, 47, 67, 105, 194, 322, 459, 485, 523
Vigantol 247
vinyl acetate 396, 447
violet oil 45
viscose process 236, 238
Visiona 338, 340
Vistra 289
vitamin A 289, 515
vitamin B 197, 283, 325, 515
vitamin C 140, 209, 271, 469
vitamin D 289, 515
vitamin tablets 515
Vittoria 438
Vogt, Hans 209
Voigt, Wilhelm 175
Volkswagen beetle 434
Volkswagen K 70 433
Volkswagenwerk AG, Wolfsburg 434
Vollmann, Heinrich 93
Volvo 434
von Heyden chemical works, Dresden 136, 137
Vorländer, Daniel 316
Vulcacit MOZ 396
vulcanization 188 f.
vulcanized fiber 326
vulcanizing agents 88, 193, 396
Vulkanox 4020 396
Vulkasil 333

W
Wachtberg GmbH, Frechen 177
wagebook 39
wages see salary

Waggon- und Maschinenbau AG,
Donauwörth 430
Waksman, Selman Abraham 324,
508 f.
Waldeyer-Hartz, Wilhelm von 79
Walesa, Lech 535, 559
Wallace, Edgar 137
Walsrode 221
Walzy, Lindt & Cia. see Bayer do
Brazil S.A.
Wandt 72
Wankel, Felix 365
Warsaw 459
Washington 89, 401, 459, 543, 605
waste 422, 603
—solid waste 90, 240, 243, 422, 428
also see controlled dump
waste air 149, 417, 422, 477, 603
waste water 146, 149, 255, 422,
424 f., 480, 519, 526, 600, 602
also see Kanal 2000
—treatment plant 422, 424 f., 456,
469, 480, 499, 519, 524, 524 f., 600,
603, 605
—waste water and emission control
laboratory 347
—Waste Water Commission 146, 148,
149, 199, 313, 422
water flea 147
waterworks 350 f., 479
water-biology laboratory,
Leverkusen 375
Watson, James Dewey 333, 568
Weber, Johann Friedrich 72
Wedel 605
Wegner, Gerhard 551
Wehmer, Carl Friedrich
Wilhelm 105, 518
Weichmoltopren soft foam 309
Weigert, Carl 45
Weimar 208 f., 211
Weimar Republic 201, 209, 211, 257,
372
Weinheim 488
Weise, Eberhard 563
Weismann, August 79
Welfare Department 165 f., 167, 299,
309, 317
Welles, Orson 291
Wells, Herbert George 291
Wendelin 538 f.
Wenk, Berthold 314, 315
Wesenberg, Georg 226
Weskott, Engelbert 24
Weskott, Friedrich Richard Jr. 55,
64, 67
Weskott, Johann Friedrich Sr. 14, 24,
25, 26, 28, 30, 36, 38, 51, 62 f., 66
West Haven 519, 551, 562, 575 f.
Westphal, Kurt 283
wet-spinning process 238
Weyde, Edith 291
wheat 457, 466
White, Edward Higgins 417
white pigment 362
whitening agent 389
Wickham, Henry 190
Widia 594, 596
Wieland, Heinrich 68
Wiesdorf Oratorio Society 180
Wiesdorfer Arkaden 607
Wiesdorfer Eck 607
Wiesdorfer Treff 607
Wilden, Rita 477
Wilhelm I, emperor of Germany 39,
97
Wilhelm II, emperor of Germany 97,
192, 193, 204, 207
Wilhelms, August 73
Wilkins, Maurice Hugh Frederick
568
Williams, Charles Greville 190
willow bark 136
Willstätter, Richard 203
Wilmanns, Gustav 281
Wilmington 247, 337, 551
Wilson, James Harold 205, 413
Wilson, Thomas Woodrow 208
Wimbledon 583
wine cellar 197
winegrowing 311, 341, 549
Wingler, August 263
Winkler, Clemens 107
Winthrop Chemical Co., United
States 221, 264
Wislicenus, Johannes 120
Witt, Otto Nikolaus 80
Wittrock, Heinz 315
Wöhler, Friedrich 46, 71
Wohlthat, Helmuth Christian
Heinrich 315

Wojtyla, Karol see Pope John Paul II
Wolf, Hermann 182
Wolf, Max 105
Wolf, Wilhelm 182 f., 185
Wolfen 181, 280 f., 302, 315, 420
Wolff, Anna Emmy Julie, née
Bayer 62
Wolff & Co., Walsrode 221, 560
Woller, Reinhard 77
wood 344, 382, 393
wood coatings 371
wool 17, 52, 53, 58 f., 238 f., 334, 341,
384, 386
wool dyes 153, 247
workers committee 168, 204
also see General Workers'
Committee
also see Works Council
workers' and soldiers' council 207
working hours 30, 47, 63, 96 f., 104,
115, 141, 166, 185, 252, 261, 267, 307,
365, 374, 472, 493, 577
also see short-time work
also see vacation
working student 215
workplace control 492
works bicycles 150, 522 f.
works canteen 104, 114, 150, 196,
480, 520, 521
also see Kasino
Works Council 303, 372, 523, 567,
607
also see General Workers'
Committee
also see workers committee
works design 606
works fire department 63, 97, 150,
151, 536, 536, 538 f.
works library 152, 153, 167, 180
also see reading room
works railroad 96, 114, 479
Works Security Department 150,
522
workshops 96, 113, 183, 480
World Exhibition 17 f., 26, 33, 51, 97,
189, 276, 289, 464
World Health Organization (WHO)
267, 441, 446, 505, 599
World War I 51, 65, 124, 137, 169, 177,
180, 189, 193, 198, 200, 206, 210, 212,
215, 220, 222, 226, 228, 245, 248, 272,
277, 280, 290, 294, 399, 436, 450,
486, 502, 552, 586
World War II 126, 151, 153, 162, 167,
177, 181, 229, 235, 251, 268, 282, 288,
291 f., 296, 300, 305, 308, 311, 313,
322, 325, 329, 337, 346, 352, 356,
358, 366, 372, 378, 388, 399, 405,
419 f., 445, 448, 450, 464, 467, 474,
482, 486, 503, 506 f., 516, 543, 552,
556, 564, 584, 586, 603
wound fever 272
Wright, Orville 157
Wright, Wilbur 157
Wunderlich, Hermann 563
Wupper river 24, 30, 69, 114, 148,
194, 427, 429, 525
Wuppertal 106, 427, 580, 607
—Aprath 73, 580, 607
—Aprather Lane 580, 607
—Barmen 24 f., 29 f., 33, 39, 59 f.,
64, 69, 72, 77, 93, 130, 133, 146,
307
—Berliner Street 28 f.
—Elberfeld 24, 26, 29 f., 33, 36, 39,
42, 45, 51, 56, 59, 61 f., 64 f., 69, 72 f.,
77, 81, 84, 86, 94 f., 100, 109 f., 114 f.,
117, 129 f., 133, 146, 149, 151, 156, 158,
162, 175, 209, 270, 314, 352, 356, 464,
510, 607
—Heckinghausen 52, 93
—Heckinghauser Street 26, 27, 29 f., 69
—König Street 95
—Rittershausen 17, 26, 27, 29
—Rutenbeck 427
—Vogelsaue 29
—Vohwinkel 133
—Wichlinghausen 24
Würzburg 63, 492
Wüster, Friedrich 32 f., 63
Wüster, Hermann 28, 63
Wyrough & Loser, Inc., Trenton, New
Jersey 489

X-ray 117, 497, 504, 597
—film 169, 408, 410 f., 413, 487
—paper 302

Y
Yale University 519, 575
Yersin, Alexandre John Emile 109
Yokohama 94, 193, 388, 586
Yoshitomi Pharmaceutical Industries,
Japan 588
Young, Owen D. 215
yperite 203
Ypres 203
Yugoslavia 211, 271, 299
Yuki 562, 588

Z
Zaire 476
Zambia 476
Zarate 356, 485, 535
Zeiss, Jena 152, 168
Zello 221, 229
Zeltner, Johann 60
Zentsuji 404
Zephirol 272, 273, 274
Zeppelin, Count Ferdinand von 145
ZeTO see Central Pilot Plant for
Organic Chemicals
Ziegler, Karl Waldemar 397, 432
Ziegler-Natta catalysts 396
Zimbabwe 476
zinc oxide 245
zinc sulfide lithopones 243
Zinin, Nikolai 19
Zinoviev, Grigory 229
zirconium 597
zirconium ore 177
Zittau 105
Zoeller, Christian 271
Zola, Emile 129, 152
Zürich 107, 173
Zuse, Konrad 291
Zwirschky, Otto 105
Zyklon B 306

X
Xanthan 593
xenodiagnosis 477
xylene 358, 419

Photographs and illustrations

A

Agfa Gevaert, Leverkusen 409, 410
 Aisfasser, Hartmut, Leverkusen
 424
 Archiv für Kunst und Geschichte,
 Berlin 45

B

Baumann, Traudel, Hamburg 467,
 469, 484, 515, 517
 Bayer-Archiv, Leverkusen 16, 19, 21,
 25, 27, 28, 29, 31, 32, 33, 35, 37, 38,
 39, 45, 48, 49, 50, 51, 52, 53, 54, 55,
 57, 58, 59, 60, 61, 64, 65, 67, 68, 69,
 70, 72, 75, 76, 78, 79, 80, 82, 83, 85,
 86, 87, 89, 91, 95, 96, 97, 99, 100, 105,
 107, 110, 111, 112, 114, 115, 116, 121, 123,
 131, 133, 137, 141, 143, 145, 148, 149,
 151, 152, 153, 155, 158, 160-161, 163,
 165, 167, 168, 169, 172-173, 174, 175,
 176, 177, 179, 180, 183, 185, 192, 199,
 207, 208, 209, 210-211, 213, 214, 217,
 219, 220-221, 224-225, 227, 228, 232,
 233, 234, 235, 237, 239, 245, 249, 250,
 251, 254, 255, 257, 260, 261, 263, 264,
 265, 266, 267, 270, 271, 273, 274,
 276-277, 278, 280, 283, 284, 285, 288,
 290, 291, 293, 294, 295, 300-301, 303,
 306, 313, 315, 316, 325, 330, 335, 337,
 348, 353, 357, 367, 375, 387, 399, 407,
 433, 443, 445, 446, 451, 456, 457, 470,
 471, 497, 501, 503, 516, 520, 521, 523,
 553, 555, 585, 586, 587, 592, 608
 Bayer do Brasil, São Paulo 355, 357
 Bayer Italia, Milan 437
 Bayer Japan, Tokio 589
 Becker, Horst, Heidelberg 486, 489
 Bertelsmann-Verlag, Gütersloh 126
 Bildarchiv preußischer Kulturbesitz,
 Berlin 16, 39, 47, 59, 60, 67, 79,
 103, 123, 133, 141, 185, 197, 209, 235,
 252, 253
 Bitter, Heiko, Opladen 524
 Bundesarchiv, Koblenz 200-205,
 296-299
 Bunte Syndication, Munich 237, 239

C

Compugraphic Corp., USA 412

D

Darching, Jupp, Bonn 488, 562
 Deutsche Bundesbahn Zentrale,
 Mainz 369
 Deutsches Museum, Munich 51, 55,
 83, 97, 117, 165, 185, 209
 DPA, Frankfurt 443
 Dressler, Fritz, Worpswede 395, 398
 Drugofa, Köln-Porz 565

E

Emallierwerk Hanover Haselbacher
 GmbH & Co. KG, Hannover 438

F

Fischer, Richard, Rauenberg
 bei Heidelberg 558
 Ford AG, Köln 434, 435
 fotofabrik, Leverkusen Titel, Vorsatz-
 blatt, 5, 15, 21, 52, 75, 116, 122, 140
 (Frg. Reg. Präs. D'dorf 52A2), 147,
 168, 171, 187, 191, 223, 229, 230, 231,
 259, 266, 274, 279, 282, 284-285, 286,
 327, 332, 373, 376-377, 385, 390, 403,
 423, 443, 452, 473, 475, 477, 478,
 479, 481, 485, 501, 504, 509, 513, 520,
 522, 529, 533, 538, 545 (Frg. Reg.
 Präs. D'dorf OV 3463), 547, 550, 553,
 557, 567, 569, 591, 593, 604

G

Gaertner, R., Verkehrsamt
 der Stadt Köln 63
 Gelderblom, H.R., Hamburg 582
 Geller, Wolfgang-Peter,
 Hamburg 374, 563

H

Haarmann & Reimer, Holzminden 343
 Hanser-Verlag, Munich 320, 328,
 392, 432
 Heimbach, Fred, Leichlingen 147
 Heintzeler, Wolfgang, Heidelberg 305
 Henkel KG, Düsseldorf 177
 Hermann C. Starck Berlin
 GmbH & Co. KG, Goslar 595, 597
 Himmer, Siegfried, Cologne 159, 535

I

Interfoto, Munich 47

K

Kadlec, Vladimir, Cologne 557, 558
 Kellner, Lucia, Wien 495
 Keystone Pressedienst, Hamburg 55,
 149, 169
 Kicker, Offenbach 163
 Knops-Feiler, Gabriele, Leverkusen
 454
 Koshofer, Gert, Leverkusen 281
 Kratz, Heide, Darmstadt 16, 32, 43,
 53, 66, 85, 93, 110, 156-157, 163,
 172-173, 181, 215, 221, 233, 234, 237,
 257, 265, 275, 309, 317, 383, 531

L

Länderpress, Düsseldorf 458
 Lieder-Mikrodias, Ludwigsb. 263, 475

M

Mauritius, Mittenwald 598
 Mertes, Harald, Koblenz 310-311
 Miles Pharmaceuticals, West Haven,
 USA 514, 515, 516
 Millitz, Claus, Haan 23, 57, 70, 111,
 112, 195, 196, 349, 350
 Möller, Bernd-Christian, Hamburg
 102, 345, 346, 347, 498, 507, 511, 512,
 574, 576, 581
 Moll, Bernhard, Neuss 62, 65, 70, 81,
 87, 99, 125, 127, 128, 129, 138, 153,
 167, 171, 241, 243, 312, 319, 321, 329,
 339, 362, 363, 364, 365, 369, 391, 393,
 397, 415, 416, 465, 483, 531, 532, 537
 Mosler, Axel, Dortmund 196, 403,
 521, 539
 Müller, W., Locarno 12

R

Riese, Karsten de, Bairawies
 bei München 555

S

Schreiber, Horst, Solingen 131, 132,
 331, 359, 534, 547
 Schroeder, Hajo, Leverkusen 447, 455
 Schuster, Bernd, Cologne 339, 340
 Silvestris, Kastel/Obb. 548
 Simon, Sven, Essen 409
 Strässer, Dieter, Cologne 339

T

Tait, Andrew, Leverkusen 41
 Turner, Pete, New York, USA 154-155

U

Ullstein Bilderdienst, Berlin 303,
 333, 375, 399, 401, 429, 519, 535

V

Vander, Norbert, Neuss 165, 288-289
 VCI, Frankfurt 424

Z

ZEFA, Düsseldorf 283, 405

