German Industry and Global Enterprise

BASF: The History of a Company

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CAMBRIDGE
UNIVERSITY PRESS

PUBLISHED BY THE PRESS SYNDICATE OF THE UNIVERSITY OF CAMBRIDGE
The Pitt Building, Trumpington Street, Cambridge, United Kingdom

CAMBRIDGE UNIVERSITY PRESS
The Edinburgh Building, Cambridge CB2 2RU, UK
40 West 20th Street, New York, NY 10011-4211, USA
477 Williamstown Road, Port Melbourne, VIC 3207, Australia
Ruiz de Alarcón 13, 28014 Madrid, Spain
Dock House, The Waterfront, Cape Town 8001, South Africa

http://www.cambridge.org

First published 2004

Printed in the United States of America

Typeface Sabon 10/12 pt. *System* LaTeX 2ε [TB]

A catalog record for this book is available from the British Library.

Library of Congress Cataloging in Publication Data

ISBN 0 521 82726 4 hardback

Contents

I

Becoming a Global Corporation – BASF from 1865 to 1900

Wolfgang von Hippel

At the beginning of the twentieth century, the Badische Anilin & Soda-Fabrik (BASF) was "without question the largest chemical factory in the world,"[1] at least in the field of organic chemical production. The firm's history – and especially its early history – mirrors to an unusual degree the development of an entire industrial sector, the coal-tar dye industry.

The coal-tar dye industry came into its own as the most important "new" industrial sector in Germany during the second half of the nineteenth history, prior to, but also alongside the electrical industry. Through the increasingly scientific basis of its production, it proved an important force for economic modernization in imperial Germany. Furthermore, within the space of just a few decades, the industry was able to secure a virtual international monopoly owing to its capabilities in production and sales of synthetic dyestuffs. In fact, on the eve of World War I, it manufactured more than 80 percent of world production and accounted for 90 percent of world trade in the field. What is more, the industry had also expanded into new areas of production. The largest firms had already incorporated into their planning and production programs promising new areas such as pharmaceuticals, photographic supplies, and the synthesis of rubber and ammonia.

When the German coal-tar dye industry first started out, its rapid rise to a commanding position in the world economy could not have been predicted. After all, the starting conditions in England were certainly far better, in terms of supply of raw materials and availability of capital, but also in terms of application of industrially proven technical processes (e.g., the soda industry). Markets, on the other hand, were favorable everywhere and helped bring about the industrial expansion of synthetic dyestuffs production. In the international marketplace of textile production, in particular, the new dyes faced competition only from natural dyestuffs, which were generally more expensive. They soon demonstrated their superiority over these traditional products in their range of colors, the ease with which they could be used in the production process, and, to an ever-increasing degree, in colorfastness, too.

[1] Weltausstellung, 68.

So it was that, by the twentieth century, the coal-tar dye industry developed in a close symbiosis with one of the leading branches in early industrialization, the textile industry. The prospect of high profits provided sufficient incentive for a substantial number of producers in England, France, Germany, and Switzerland to move into the new area.[2] However, the market, which was contested with increasing bitterness, allowed firms to operate successfully in the long term only if they:

1) had chosen a production site that was advantageous both from a technical and a commercial point of view;
2) were able either to translate rapid progress in scientific and technological knowledge into industrial innovations within the shortest possible time, or else had secured an effective position of scientific and production leadership through a systematic research program;
3) possessed the wherewithal to build up a healthy market for their products, thus establishing the most important precondition for profitable large-scale production.

The second and third of these points, which are closely linked with the effectiveness of systems of education, training, and science and with economic and social attitudes, eventually proved especially important for the astonishing success of the German coal-tar dye industry as a whole, and for BASF in particular.

In the first decades of its existence, BASF concentrated on the manufacture of synthetic dyestuffs and products associated with them. The company was able to achieve a leading market position internationally in this area and thus laid a solid basis for further expansion. Around 1900, a number of developments took place both within and outside of the firm, which signaled that even greater changes would take place, changes that would require substantial investment and a corresponding increase in share capital. In the firm's major area of interest, dyestuffs, key breakthroughs came in the form of full-scale industrial production of synthetic indigo (1897) and the discovery of the indanthrene dyes (1901). In the field of inorganic production, the process for liquefying chlorine (1888), the contact process for sulfuric acid (1890/98), and the electrolytic manufacture of chlorine all set the stage for new technological directions that led eventually to synthesis of ammonia and, with that, a fundamental change in the product spectrum of the company. In the area of sales, the first "small" community of interest

[2] The most important overviews of the history of the chemical industry in Europe and North America are in the works of L.F. Haber and, from the standpoint of technical development in particular, Hohenberg, Chemicals. For the dyestuffs industry (with particular emphasis on its scientific development), see more recently Travis, Rainbow Makers, and also the contributions in Homburg, Travis, and Schröter, *Chemical Industry*. For Germany in particular, see Beer, Emergence, and Wetzel, Naturwissenschaften.

("*Dreibund*") between BASF, Bayer, and Agfa (1905–16), an initiative established in competition with the similar agreement between Hoechst, Cassella, and Kalle ("*Dreiverband*"), had as its goal a restructuring of the market and of market strategies and had, therefore, a pronounced impact on internal firm organization.

However, if there was a stronger pattern of change around 1900 than was previously the case, this does not mean that the first 35 years of the history of the BASF firm were a period of idyllic calm. Contemporary actors, who anticipated an uncertain future, experienced the beginnings of the coal-tar dyestuffs industry much more often as a new departure. Despite all of the tensions, vicissitudes, and occasional complaints, it was also a departure that was experienced and generally acted out with optimism and positive expectations, and, in retrospect, appears largely as a success story.

1. THE PREHISTORY

Friedrich Engelhorn – Pioneering Entrepreneurship

Even though corporate structures and the anonymous forces of the market seem to play a huge role in the development of modern big business, what we now term "human capital" (something frequently valued as the decisive resource of the economy) remains extremely important. This human capital includes, in particular, the senior management of firms, mostly owing to the extensive responsibilities they carry. During early and high industrialization, when the economy and society underwent especially dramatic change, the personal element was at its most important. The pioneer role of the "dynamic entrepreneur" (J.A. Schumpeter) in Germany's move into the period of high industrialization is exemplified especially well in the life and works of Friedrich Engelhorn (1821–1902), the founder of BASF.

Besides the problems of raising capital, the expansion of coal-tar dyestuffs production posed unusual technical and commercial challenges. The purchase of raw materials that had previously been scarcely in demand had to be organized, efficient production methods and the necessary technical apparatus had to be developed, and the new products had to be sold to a customer base that was frequently traditional in its orientation. Thus we find among the successful founders of coal-tar dye factories not only dye merchants and master dyers but also pharmacists and trained chemists. Additionally, however, there were also men who were active in a number of different business fields, men who have been characterized as all-round entrepreneurs.[3]

Friedrich Engelhorn belongs to this last group.[4] He was born in Mannheim on July 17, 1821, the third son and fourth child of the brewery master

[3] Kocka, Unternehmer, 45f.

[4] Engelhorn's biography is dealt with extensively in Schröter, Engelhorn.

and later wine merchant, Johann Engelhorn, and his wife, the daughter of a nearby innkeeper. In social terms, therefore, he was a child of the urban middle class.

When his parents sent the nine-year-old boy to a well-respected grammar school in Mannheim, it seems likely that their motivation in his case, as in that of his elder brothers, was not only to provide an opportunity for an excellent education, but also to provide opportunities for the boys to enter new professional territory outside the family tradition. (One of his brothers became a publisher, the other an attorney.) Nevertheless, Friedrich's school career ended early. In 1834, before the end of his third year, he left the grammar school to take up an apprenticeship with an established Mannheim gold and silversmith. In 1837, the sixteen-year-old apprentice went on a nine-year journey that took him to a number of different places, including Frankfurt, Munich, and Vienna, and later to Switzerland. He ended up in France, where he visited Lyon, known as the metropolis of silk processing, and, in particular, Paris, the European center for practically all luxury goods.

In 1846, he returned to Mannheim, where in March 1847 the young "gold worker," "bijou maker," or "jeweler" (as he called himself) obtained citizenship and guild rights in the city. He opened a workshop and, a few months later, married the daughter of a Mannheim brewer, Marie Brüstling. This was in every sense a "good match," particularly because her dowry secured the basis for his professional independence.

Thanks to his many years spent abroad in much larger cities of central and western Europe, Engelhorn had seen with his own eyes many of the major developmental trends of his age. Now at home in an environment in which the beginnings of intensive industrialization could be detected, he set his sights beyond his craft from the beginning. During the revolutionary year of 1848, together with a Belgian engineer and another member of the Mannheim middle class, he founded a limited liability company known as "Engelhorn & Cie.," in order to produce and sell " portable gas" (i.e., bottled gas). Engelhorn was the largest financial contributor to the company, and he began trading by the end of the year, this in spite of the fact that the Belgian partner proved unreliable and the Mannheim partner died unexpectedly.

In entering into his first large-scale business enterprise, the one-time goldsmith demonstrated characteristics that would help ensure his remarkable success in the coming decades. In addition to decisiveness and stamina, he also showed a willingness to take calculated risks on the basis of clear insight into the long-term possibilities of a given project. In 1848, on the basis of existing experience, it was beyond question that the industrial manufacture of gas for lighting was a safe venture. The same was true at the beginning of the 1860s for the newly discovered aniline dyes. After all, gas lighting was already widespread in the 1840s, especially in England and the United States, and Engelhorn had come into contact with this personally during his itinerant years, in Vienna and Paris at least. In the Upper Rhine area, artificial

lighting had been introduced in the spa town of Baden-Baden in 1845, and – after some teething problems – in 1846 in the capital of the Grand Duchy of Baden, Karlsruhe. In 1849 the leaseholders in the latter sought to include Mannheim in their lucrative business. The potential competitive situation between these newcomers and Engelhorn was resolved at the beginning of 1851, when together with him they formed the Badische Gas Lighting Company (*Badische Gesellschaft für Gasbeleuchtung*) that took over a long-term and profitable lease of the Mannheim gas works (which the city had commissioned them to build). Engelhorn, who brought his bottled-gas works and its customers into the firm, served as its local commercial and technical director for the following decade and a half. In 1865, however, he sold his share of the company to business partner Friedrich August Sonntag, turning his full concentration to the new dyestuffs business.

After all, as early as 1859/60, gas works director Engelhorn – by now a wealthy, respected, and politically active member of his parent city's middle class and on the best possible terms with the local financial and economic elite – was clearly on the lookout for favorable investment opportunities. An indicator of this was his, admittedly quite short, financial engagement in a machine factory and the founding of a commission and freight company (Engelhorn & Co.) in New York on September 15, 1860. The managing director of the latter was Friedrich's younger brother Louis, who, through unlucky speculation, soon drove the firm into bankruptcy. Engelhorn, however, remained much closer to home in his own business dealings, especially when in 1860 he decided to build an aniline and dyestuffs factory next to the Mannheim gas works.

A Massive Market – The Beautiful World of the New Dyestuffs

The discovery of the first aniline dyes, which drew notice from far and wide, and the unusually high profits that their production promised thanks to lively demand from the outset naturally did not remain hidden from Engelhorn. Only relatively few effective dyestuffs were available on the domestic market, and all of them were from "dye plants," plants "whose roots, wood, bark, stems, leaves, flowers, or fruits contain dyes which are subject to technical application, or else can deliver this after suitable processing."[5] One of the most important of them was Turkish red, which came from the madder root native to the Levant and which, beginning in the sixteenth century, was cultivated in western and central Europe. Another was the blue and black dye that was extracted from woad and that through the addition of other dyes could give brown or green tones.[6] Also important for yellow shades were

[5] Meyers Konservations-Lexikon, vol. 6 (1894), 188.

[6] For this and the following, see Lauterbach, Geschichte; Georgievics, Handbuch, 466ff; Reckel, Aufstieg und Fall.

buckthorn (Persian berries), dyer's luteolin, or reseda, dyer's broom, and dyer's safflower. Orseille, a red dyestuff, was raised in only mediocre quality from lichens in central Europe. But better quality and larger quantities were available only from Madagascar, Zanzibar, South America, and the Canaries. In any case, the discovery of America and of the sea route to India and the Far East decisively enriched the range of available dyestuffs. These new geographic discoveries brought with them access to a large number of previously unknown plants and trees such as turmeric (Indian saffron), fustic wood, redwood, logwood or campeachy wood, sandlewood, and quercitron or flavin (the bark of the North American dye oak). At times, the new goods managed to drive out previous products, as for instance in the case of indigo. Cultivated primarily in India, indigo, with its strong dye content, effectively destroyed the competitiveness of domestic woad, or wild indigo, cultivation, which had its main focus in Thuringia.

Many of these vegetable dyes, however, turned out to be not especially light or colorfast. Intensive methods (such as extraction and fermenting) therefore had to be employed to get superior, more concentrated and pure materials from the natural starting materials. These included plants, woods and even insects (such as the cocheneal scale insect, which came from Central and South America for the most part and which provided the expensive red carmine). The madder root, for example, contained only about .5 to 1.5 percent dyestuff, which in a natural state was mixed with a large number of brown-colored contaminants. What is more, the techniques that had to be used to manufacture and apply dyes were complicated and time-consuming. The Turkish red dyeing process using madder, for instance, required up to twenty separate operations, which took about six weeks to complete. In addition, there was no standardization of colors, and impurities led to unwanted shades. The reliability of the dyeing process thus remained limited, even in the case of dye masters with lengthy experience. On top of this came the problem that various materials – in particular textiles such as wool, cotton, silk, and mixed fabrics, but also leather and paper – had to be treated initially through the so-called mordant process (especially using metal oxides) so that the dye would take. The dye process, just as the dye-printing process for cotton, thus remained a craft that required a good deal of experience and tacit knowledge. It also produced a pronounced tendency toward extreme secrecy with regard to individual dye recipes.

Given these difficulties, the synthesis of an artificial dyestuff in the chemical laboratory by the 18-year-old Englishman William Henry Perkin in 1856 created a sensation. For the first time, there arose the attractive possibility of producing dyestuffs independently of certain plant-based raw materials, in almost any quantity desired and of a standardized quality. Moreover, it could all be achieved without the risks associated with cultivation and uneven harvests, or longhaul transport.

Perkin's accidental discovery was, however, not entirely an accident. Instead, it was the product of a scientific branch that had been developing rapidly over several decades, that of organic chemistry or the chemistry of carbon compounds. German, as well as French and British, chemists contributed substantially to the success of the new field. A center of modern chemical research in the German area was of indirect significance for the discovery of this beautiful new world of dyestuffs, and for the transformation of the chemical craftsman, with his generally undirected experimentation, into an academic pursuing systematic and analytical investigations. It was founded by Justus (von) Liebig, who in 1824 at the age of 21 was named to a professorship in chemistry at the University of Giessen. His legendary chemical laboratory for experimental instruction in the context of university study was the training ground in the new field for a whole generation of chemists, including August Wilhelm (von) Hofmann (1818–92). Between 1845 and 1865, Hofmann served as professor at the Royal College of Chemistry in London, which had been established using Giessen as a prototype. It was in this capacity that he became the father of the British dyestuffs industry.[7]

Through his investigations into aniline as a derivative of benzene, Hofmann himself laid the scientific basis for dyestuff chemistry, and his own discoveries contributed to the emerging era of vast variation in dye colors. In 1856, his young student and assistant William Henry Perkin (1838–1907), stumbled upon the coal-tar dye "Tyrian Purple," or "mauve" (named after the hollyhock bloom) in the course of an attempt to synthesize quinine. Shortly afterwards, in a small factory and with the financial support of his family, Perkin paved the way to industrial production of this unusually pure dye, which was difficult at first but which yielded very high profits.[8]

The mauve mania that followed in France and England in the next few years brought with it patent-infringing imitation in France. But it also stimulated the search both for alternative processes and for other artificial dyes. Thus, in 1859 in Lyon, François Emmanual Verguin succeeded in producing aniline red, also known as fuchsin, or magenta. Just as was the case with Perkin's discovery, commercial exploitation soon followed. Fuchsin, however, was only the first in a long series of success stories in the coming years, virtually all of which came from Britain and France.

In 1862, at the London World Fair, British and French firms displayed their products "of this remarkable chemical revolution" (A.W. von Hofmann) to an astonished public. What followed can only be described as a sort of gold rush in the dyes market, which was accompanied by pell-mell inventive activity. Those who secured know-how or licenses early enough were assured

[7] On Hofmann, see especially Meinel and Scholz (eds.), Allianz.
[8] Travis, Rainbow Makers, 31 ff.

substantial profits. After all, the new dyestuffs were at first almost literally worth their weight in gold.

One of the First Coal-Tar Dye Factories in Germany

For Engelhorn, these developments opened up previously unimaginable perspectives. It was only a short leap of imagination to come up with the idea of using coal tar – which to that point had been a by-product of gas production both burdensome and difficult to dispose of – in a profitable way in his own manufacturing plant. Engelhorn raised the capital for a dyestuffs factory together with two of his previous business partners, Friedrich August Sonntag and the "merchant" Otto Dyckerhoff, the latter Engelhorn's compatriot in the unsuccessful New York commission business. The choice of an expert technical director was without doubt essential for the success of the new company. In making it, Engelhorn benefited from his contacts in the Mannheim business community and from the fact that a number of significant chemical firms had already been established in the Mannheim area. Liebig's former student and assistant, Carl Clemm-Lennig, the co-proprietor and director of the Mannheim Düngerfabrik (fertilizer factory), was instrumental in establishing a connection with his nephew, Carl Clemm (1836–99). After a technical education in Karlsruhe, study of chemistry in Giessen, and his first practical work in his uncle's factory, Clemm had pursued research and developed new knowledge in the area of aniline dyes, which were worth their weight in gold. Now, with the capital put up by his business partners, he was able to begin a career as an entrepreneur.[9]

It is true that Otto Dyckerhoff, the commercial director, and Carl Clemm, the technical director, gave their names to the new company "Chemische Fabrick Dyckerhoff, Clemm & Comp.," which was founded on June 8, 1861, but with contractually retroactive effect from October 1, 1860.[10] Engelhorn, however, played a decisive role in the planning and implementation of the project, including the stated aim of the company's founding document. For the next 15 years, production at the company was "supposed to consist initially of the preparation of aniline and coal-tar dyes, but later to extend to other technical products" (Paragraph 1 of the founding document). In this way, following hot on the heels of the firm of Rudolph Knosp in Stuttgart, one of the first coal-tar dye factories in the German area came into existence in Mannheim. The nucleus of the later BASF, it was founded at about the same time as the Weiler aniline factory in Cologne-Ehrenfeld (1861), two years prior to Kalle & Co. in Biebrich on the Rhein (1863), and six years before

[9] Contract from April 15, 1865, BASF UA, C 627/1. A collection of material relating to Carl Clemm is in BASF, W1.

[10] Documents in BASF UA, A 0/1/7 and A 0/2/1; Urkunden vol. 1, 8.

the Gesellschaft für Anilinfabrikation (later the AG für Anilinfabrikation, or Agfa) near Berlin in 1867. In similar fashion to Knosp in Stuttgart, other firms took up coal-tar dye production at first only in addition to their previously existing commercial ventures. These included, for example, Karl G.R. Oehler in Offenbach on the Main, which did so in 1860, and it was followed three years later by Meister, Lucius & Brüning in Höchst and Friedrich Bayer & Co. in Elberfeld. The latter two became BASF's main competitors in the coming decades. To name just one other prominent example, the precursor of Geigy was founded in Switzerland in 1860.

From the very beginning, Engelhorn appears to have envisaged a large-scale operation. In any case, even in the founding phase, he followed a plan for creating a comprehensive production program (see Paragraph 1 of the founding contract). Through vertical integration and simultaneous diversification of the product palette, the idea was to operate as flexibly and inexpensively as possible in a market that was difficult to gain an overview of and ever changing, but that, in the long term, was expanding strongly.[11]

There was little difficulty in gaining the required concession for a chemical plant, which took only a few weeks.[12] Already on November 13, 1860, it was granted "to the gentleman manufacturer Engelhorn" from the Grand Duchy's city office in Mannheim "under the condition that in the course of production the neighborhood would not be burdened or disadvantaged by noxious odors or through poisonous effluents, for which case further authorization would be necessary." Such problems apparently did not arise. On July 21, 1860, Engelhorn and his partners had acquired a preparation plant for zinc ore, the "zinc foundry" (Friedrichshütte) on the Jungbusch, for 45,000 guilders. The foundry operated on a relatively modest scale for the time (about 30 workers), and it employed the simplest methods of production. Still the plant installed there developed with relatively few teething difficulties. Although its development was not quite as rapid as Engelhorn and his colleagues had perhaps hoped,[13] its weekly production of 10 hundredweight of aniline oil (which was further processed into red and violet dyes[14]) resulted in considerable profits. This is clear from the few known statistics: The company's capital was supposed to be 100,000 guilders (25,000 per partner); against that, the pure profit in the 1862/63 business year (after deduction of interest and depreciation) stood at 266,000 guilders.[15] Furthermore,

[11] On the significance of integration and diversification and their interactions with economic expansion and change in firm structure, see Kocka, Expansion.

[12] The following is based on materials in BASF UA, A 0/1; Urkunden, vol. 1, 5.

[13] See materials on the quarrels with the firm Heinrich Dietze & Co. in BASF UA, A 0/2/6 and A 0/2/7.

[14] This in September 1862, according to Caro, Reden, 220.

[15] Contract with the Verein Chemischer Fabriken of May 7, 1864, BASF UA, A 15 (previously A 19/1/8).

when it was transferred to the newly founded BASF in mid-1865, the material value of the firm was set at more than 529,000 guilders,[16] with additional consideration in terms of business value (the business, its customers, and its business secrets) comprising an additional 147,000 guilders.[17]

Early in the brief existence of the factory, the number of dyes manufactured there rose – fuchsin (magenta, or aniline red) was joined by Hofmann's violet and aniline blue. What is more, total usage of aniline increased within one-and-one-half years from 500 to 4,500 kilograms per week. Plans were made for still greater volume. As a consequence, Engelhorn arranged for August Clemm (1837–1910), the younger brother of Carl, to be taken on at the beginning of 1862. Like Carl, August had been trained in Giessen, where he took his doctorate, and he was apparently the better chemist. August Clemm moved from the Karlsruhe Polytechnic to Mannheim to become the firm's second technical expert[18] and a partner in what was now known by January 2, 1863 as "Sonntag, Engelhorn & Clemm."[19] Dyckerhoff, in the meantime, pulled out of the firm at his own wish at the end of 1862 in order to turn his attention to the cement business.

In keeping with both the founding spirit of the young chemical industry and his own nature, the successful entrepreneur set a course for expansion. Despite impressive profits, Engelhorn recognized very early on the necessity of tackling costs in the interest of long-term competitiveness. The question was whether was it cheaper for the company to manufacture the inorganic materials (such as arsenic, hydrochloric, nitric, and sulfuric acids, as well as soda) it required rather than purchasing them from the Verein Chemischer Fabriken in Mannheim, as it had done previously. After all, faced with a de facto monopoly the aniline factory was in danger of becoming dependent on the Verein.[20] The latter, founded in 1854 and with factories in Mannheim, Worms, and Heilbronn, had seen off all competitors for its products in the region, and therefore did a land office business. In economic terms, close cooperation was in the interest of both sides, since their production areas complemented each other and promised cost-minimizing (and/or profit-maximizing) synergy effects. As the considerably smaller company, which was dependent on the Verein for its supplies, the aniline factory was in the weaker negotiating position. But the prospect of the Verein's best customer, if push came to shove, starting its own production in competition to the Verein added considerable weight to that initial position. The directors and the administrative council of the Verein consequently

[16] This consisted of a selling fee of 453,000 guilders and an additional payment of 76,236 guilders (see note 28).

[17] BASF UA, A 0/2/5.

[18] Appointment contract of February 10, 1862; Urkunden, vol. 1, 9, BASF UA, A 0/1/7.

[19] Urkunden, vol. 1, 10–11.

[20] On the following, see in addition to Hintz, *Werden und Wirken*, also Schröter, Engelhorn, 104ff.

agreed to enter into a fusion agreement, which was to take effect, if possible, from July 1, 1864.[21] But the general assembly of the Verein, which had at first also ratified this course of action, eventually reconsidered owing to the influence of altered opinions at the executive level of the Verein. It thus turned down the contract. In view of rapidly growing competition within the dyes market, the long term prospects of Engelhorn's company were by now viewed much more skeptically than had previously been the case.

Unable to attain his goal of product self-sufficiency in the easiest possible way of a fusion with a suitable partner, Engelhorn had only one path open to him – the undoubtedly more risky one of producing the required materials in-house and thus entering into hard-fought competition with the Verein Chemischer Fabriken. Because of the very scale of this project, and in contrast to previous ventures, he and his partners had to turn to the capital market. They had reasons to expect success, however standing within the circle of the economic middle class in Mannheim – particularly through the close friendship with Seligmann Ladenburg (1797–1873),[22] who was experienced in industry and railway financing and the leader of the renowned Mannheim bank W.H. Ladenburg & Sons (after 1905 the Süddeutsche Disconto-Gesellschaft AG). Engelhorn and his partners also exuded confidence in the prospects for success in the dyestuffs industry. Within the short time, these advantages helped them secure the basis for a joint-stock corporation. The company's initial capital of 1.4 million guilders corresponded approximately to the estimated capitalization of the Verein Chemischer Fabriken. The first German coal-tar dye factory that simultaneously produced the inorganic materials required for its organic manufacturing processes could now be christened.

2. THE EARLY YEARS (1865–1873)

Mannheim or Ludwigshafen? The Dramatic Establishment of the Corporation

On March 25, 1865, in the house of Seligmann Ladenburg, a small, handpicked circle of men, all with considerable capital behind them, met to come to some sort of agreement on the means through which the new joint-stock corporation was to be established.[23] Several newcomers joined the existing partners in the aniline factory, including six members of the Ladenburg family. These included Seligmann and his sons Carl (1827–1909) and Ferdinand (1835–99) as well as his nephew and son-in-law Moritz Ladenburg (1818–71). The latter three were all involved in the Mannheim Bank. Additionally, Seligmann's son-in-law Dr. Ferdinand Beit (1817–70), a

[21] BASF UA, A 15 (previously A 19/1/8).

[22] See Pieper, Ladenburg, or more extensively Jacob, Ladenburg. On the family, see Waldeck, Mannheimer Familien, 67 ff.

[23] The contract is in Urkunden, vol. 1, 12, BASF UA, A 11/1/5.

Hamburg banker, and his youngest brother, Dr. Leopold Ladenburg (1809–89), a barrister in the high court and an important personality in Mannheim public life, were both present. The Seligmann family members were joined at the meeting by Friedrich Reiß (1802–81), a salesman who had served as lord mayor of Mannheim from 1849–52, had been active for many years in the city council, had been a friend of Engelhorn since the years of revolution in 1848/49, who had subsequently co-founded the Rhine Credit Bank in 1870. Also present was the "Particulier" Carl August Fries (1808–84). Fries was already experienced in the sector as one-time partner in a madder factory in Heidelberg and then as the co-founder of a chemical factory in Wohlgelegen and as a shareholder in the Verein Chemischer Fabriken. Finally, the grand ducal district court councillor Moritz Ellstätter was present also. He had served for several years as a syndic in the Berlin-based Diskontobank and later became president of the finance ministry in Baden.[24]

In a smart move, Engelhorn also brought another partner, Julius Giese, into the corporation. Beginning in 1854, Giese had served as a deputy technical director of the Verein Chemischer Fabriken and thus possessed professional knowledge about the manufacture of inorganic products, which would soon be urgently needed. The heavy conventional penalty of 10,000 guilders, which was imposed when he moved to another company with similar product lines to the one he had just left, was paid on his behalf by the new firm, which also committed itself to giving him a respectable stock package (35 shares). Of the total of 1,400 stock shares with a nominal value of 1,000 apiece, 600 went to the owners of the previous firm of Sonntag, Engelhorn & Clemm, amounting to six times the value of the founding capital of 1861. Of that, 435,000 guilders went for property (buildings, grounds, and equipment) and 147,000 guilders for the business, for its customers, and for production secrets. A further 380 stock shares were subscribed to by the small circle of those present, led by Engelhorn himself (110) and the Ladenburg banking house and Friedrich Reiß (100 each). The remaining 385 shares were to be placed by the Ladenburg banking house among suitable interested parties. For the next ten years, Engelhorn committed himself "to take over the top leadership of the firm as the first director without a fixed salary, and neither directly nor indirectly to participate in any way with a competing business." The Clemm brothers and Giese became the technical directors, but, unlike Engelhorn, could only sign contracts on behalf of the firm "with a collective signature of any two of these gentlemen."[25]

The sales contract between the old and the new firm and the founding contract of the new joint stock company were notarized in Mannheim on April 6, 1865,[26] a date that is also considered the founding date of the Badische Anilin- & Soda-Fabrik (BASF) even if the company did not come

[24] See Ellstätter, Moritz Ellstätter. [25] Rundschreiben, July 1, 1865, BASF UA, A 11/2.
[26] BASF UA, A 11/1/6, A 11/1/9, A 12/1/6, A 12/1/7; GLA 276/1302; Urkunden vol. 1, 14.

into formal effect until April 15.[27] The ending and starting balance sheets of June 30/July 1, 1865 were so advantageous to the previous owners of the firm that, in addition to the stock shares with a nominal value of 600,000 guilders, they were able to insist on an additional payment of 76,263 guilders.[28]

It is, of course, true that the new company was faced with some initial turbulence when its founders started their search for a suitable site for the planned new large-scale factory.[29] Naturally, Engelhorn wanted to locate the new establishment in Mannheim, and the preconditions for this seemed favorable: Already on April 5, 1865, the banking house of W.H. Ladenburg & Sons was able to sign a preliminary contract to purchase a well-suited piece of real estate within the city on behalf of the "company that was in the process of being formed."[30] The prospective site included over 14 hectares of land directly on the Neckar River with immediate access to the "port ring railway," that connected the Mannheim port with the train station. This guaranteed supplies of the large quantities of water necessary for the production process and ensured the shortest possible connection to the most modern transport.

But if the deal, which had been worked out in such a hopeful fashion, was eventually to fall through, it was owing to differing expectations within the city's self-administration bodies. The agreed price of 2,500 guilders per hectare for the property was seen as a moderately cheap sales price, although in view of the expected indirect economic advantages for the city it was also perceived as fair enough. For this reason the local council and the small citizens' committee gave their blessing to it. When, however, the large citizens' committee – the final arbiter within the city in property matters – turned down the proposed deal on April 12, 1865 with a clear majority, it was above all because of hopes for a higher yield for the city's coffers.[31] The basis for these hopes was, in turn, a purchase offer brought into play at the last minute by the Verein Chemischer Fabriken – an offer, it soon became evident, that was not serious, but was instead meant to get rid of threatened competition. Despite this, however, the city of Mannheim persisted in its interest in getting a firm to locate on the controversial site. This was something the BASF leadership used skillfully over the coming days and weeks in order to strengthen their own negotiating position in moving forward as quickly as possible with plans for locating across the Rhine in the Bavarian Palatinate.

The prompt reaction of the leadership in the aftermath of the vote in the large citizens' committee makes it clear that they had already decided to try the other side of the Rhine in the event of an (even temporary) rejection by Mannheim's government. On the very same day of the vote, Engelhorn

[27] Copy in BASF UA, A 11/2/1 and A 12/1/6; Urkunden, vol. 2, 76.
[28] Urkunden, vol. 1, 23 and 26; BASF UA, A 11/2/1.
[29] Documents related to the following are in BASF UA, A 11/2/4. A recent depiction is in Schröter, Engelhorn.
[30] BASF UA, A 11/2/5. [31] See the press reports in BASF UA, C 8212.

together with Seligmann and Carl Ladenburg traveled across the river to Ludwigshafen in order to examine a suitable parcel of land in the Hemshöfe area north of the city for possible purchase.[32] Two days later, the (provisional) administrative council of BASF authorized Engelhorn to carry out the corresponding negotiations. On April 19, he signed a contract to make the first purchase of a parcel of land, subject to official permission for building plans. To be sure, news of this stimulated considerable positive attention in Ludwigshafen, especially owing to the potential positive impact on the city's economy and inhabitants. After all, the location of BASF on the left bank of the Rhine offered Ludwigshafen the chance to catch up to some degree in its competition with Mannheim and also the possibility of being able to draw additional firms to locate there. The city council therefore pursued the project with the district government in Speyer, and, despite some initial reservations, authorities quickly signaled their readiness to reach an agreement.

So it was that, on April 24, Engelhorn was able to submit his "initial application for a concession for a chemical factory"[33] near Ludwigshafen to the Speyer district office without any fear of rejection. The application indicated that the factory would produce "sulfuric and nitric acids, sulfate, raw and refined soda, and calcium chloride" for sale in the Palatinate, in Hesse, and in Rhenish Prussia. Its reference to "the positive welfare consequences" of the intended commercial activity "for economic, social, and political life," for "improving the prosperity of individuals," and for the "enrichment of the entire area" mobilized "national economic reasons" for approving the application. Its indication that the factory lay so far away from Ludwigshafen that the city would never expand to reach it, combined with its limited descriptions of planned manufacturing processes, were meant to sweep away any reservations in terms of environmental policy.

This aspect, however, did not seem to affect on the decision-making process for the authorities, as was clear in the breakneck speed with which approval was granted. After positive expert reports from the construction authorities and the district health office (with the latter especially thin in terms of content) completed on May 5, 1865, followed by a short public hearing on May 6, the Speyer district office, which had authority over the concession, issued approval on May 8. It granted permission "to erect... on the so-called Hemshof field next to the Rhine, near Ludwigshafen, a chemical factory and brickworks." The concession was thus granted with the added proviso that the plans be executed exactly as had been submitted and, furthermore, that all governmental regulations and police ordinances that "in the general interests were deemed to be necessary at some later date

[32] See documents in BASF UA, A 14/1/1 and 14/1/3 as well as A 11/2/7. On the following, reproductions of relevant documents are available in Werk and in the protocols of the provisional supervisory board of BASF in BASF UA, C111.

[33] Werk; Urkunden vol. 1, 20–21; and materials in A 13/1/2, A 13/1/3, and A 0/2/5. On the following, additional documents are in SALU, Abt. 2330, BASF I.

were followed precisely." Just one week later, ground was broken for the construction of a factory, initially only for the manufacture of inorganic products. Basic permission to construct rail links between the factory site and the banks of the Rhine and to join up with the tracks of the state railway via a line passing along the main Rhine embankment followed on June 20, 1865.

It may therefore come as a surprise to learn that the new firm was entered in the commercial register in Mannheim on June 15, 1865. In fact, until 1919, the official and formal seat of BASF was in Mannheim, and the Ludwigshafen factory was listed in the commercial register in Ludwigshafen merely as a branch. Undoubtedly, Mannheim was a much more prestigious address by virtue of being an economic and – to an increasing degree – banking metropolis. In addition, the firm's founders and its financial backers were quite literally at home here and were also well-connected to the economic middle class and the cultural ambience of the city. These factors may help explain why Mannheim remained the seat of the firm for so long.

The Large-Scale Project to Begin Anew in Ludwigshafen

Engelhorn and his cohorts fully exploited the chances presented for their new joint-stock company by the competition between not only Mannheim and Ludwigshafen but also, more indirectly, the Grand Duchy of Baden and the Kingdom of Bavaria. Between May and July 1865, the director moved quickly and deliberately to acquire the desired site near the Rhine, more than 13 hectares in all. The real estate itself to be sure cost nearly double the price of the Mannheim alternative, but, on the other hand, offered nearly ideal conditions for the planned facilities. The site's placement to the north of – and well apart from – the city rendered possible conflicts regarding air and water pollution unlikely from the outset. The ground itself proved to be well-suited for construction. The Rhine provided large amounts of water and a place to get rid of wastewater easily. The Rhine embankment secured the low-lying site from high water and provided a foundation for rail tracks with connection to the main railway lines. Branch lines could easily be laid into the works and onto the banks of the Rhine, which, owing to a correction designed by Tulla, offered a long stretch of straight ground that served as a natural port. In addition, the city of Ludwigshafen demonstrated a willingness to improve the road access to the plant at its own cost. Good connections into superregional, indeed international, rail networks were guaranteed for the site, especially because the construction of a permanent, bridge over the Rhine, which had already begun, would also soon offer rapid, inexpensive transport toward the east and far beyond the borders of the German Reich.

Last but not least, Ludwigshafen itself offered an expressly industry-friendly climate. The relatively new town, which had only attained legal status as a municipality in 1853 and which was elevated to the status of city in 1859, had managed to become the most important spot in southwest

Germany on the left side of the Rhine in terms of transshipment between water and land transport. It had thus managed to establish itself as a smaller rival to Mannheim. By 1865, the number of inhabitants in Ludwigshafen had climbed to somewhere over 5,000. Only a few industrial plants had so far located there, characteristically, however, especially those from the chemical sector.

From the very start, BASF undertook planning on a scale that was previously unknown, but, as soon became clear, it was still quickly overtaken by actual developments in the industry. The long-term decision in favor of large-scale production, including all of the necessary preproducts and intermediates, on an extensive and easily extended site was clearly the most significant step in the direction of the unchallenged position of leadership enjoyed by BASF in the coal-tar dye industry over the next decades. The systematic thoroughness with which Engelhorn moved forward with the construction of the new factory after 1865 was, however, unique for its time. Indeed, it was only surpassed under the more advanced conditions of the 1890s when Carl Duisberg planned the new Bayer works in Leverkusen.[34]

What is more, on the legal and financial side, BASF enjoyed a leadership position that was imitated by Hoechst and Bayer only in 1880 and 1881, respectively. The company form of the joint-stock corporation secured above all the rapid and flexible supply of capital in the event of necessary expansion of production facilities. But for BASF, this form proved advantageous for yet another reason, as evidenced in the first directory of shareholders:[35] In addition to influential members of the Mannheim economic middle class, other chemical firms and previous customers of the Mannheim aniline factory were important shareholders and thus bound more closely to the new corporation's interests.[36] Included among the stockholders were, for instance, the pharmacist Christoph Boehringer of Stuttgart (100 shares), a brother-in-law of Engelhorn's brother and co-proprietor of a quinine factory, F.C. Boehringer & Söhne. In 1870, this firm was to move from Stuttgart to Mannheim where it took over the site of the old aniline factory that had been founded by Engelhorn. Other stockholders included the Weinsteinsäurefabrik Benckiser based in Pforzheim, which from 1858 had a branch in Ludwigshafen (30 shares); the firm of Heinrich Siegle, Stuttgart, which from 1863 was under the leadership of Gustav Siegle and soon became a partner of BASF (10 shares, with an additional 8 "for an ultramarine factory").

The distribution of shares to the firms of Rudolph Knosp (based in Stuttgart, 30 shares) and Dahl & Co. (based in Barmen, 10 shares) involved not just two valued customers of the products of the former Mannheim aniline factory. More than that, it clearly paved the way for an agreement

[34] On this, see Flechtner, Duisberg, 141 ff. [35] Urkunden, vol. 1, 17.
[36] Verwaltungsrat April 4, 1865, BASF UA, C 111.

on placing limits on production areas with potential competitors and for cooperating with them as well. To be sure, the initiative for this did not come from Engelhorn, but rather from Rudolph Knosp in Stuttgart. On the basis of his knowledge of markets and people, the experienced merchant anticipated that in the future BASF would be able to produce fuchsin, or magenta, more cheaply "than any other" and feared in any case massive overproduction.[37] He was able to convince his business friend Dahl to enter into an agreement with Ludwigshafen that would ward off such a development as far as possible. Already on June 1, 1865, the three firms were able to bring their discussions to a mutually satisfactory conclusion: Knosp and Dahl ceded to BASF the rights to all manufacture of aniline and hydrochloric- or arsenic-acid-based red aniline (fuchsin). They also agreed to sell only BASF products in this area. In return, BASF agreed that it would not bring any other dyes produced from fuchsin (violet and blue shades) onto the market.[38]

This agreement, which had to be renewed each year, secured for Knosp and Dahl not just the market in BASF aniline and fuchsin at stipulated prices but also provided a good basis for these firms' own production of certain aniline dyes. BASF, on the other hand, was able to concentrate fully on the construction and expansion in particular of its inorganic department, without having to tie itself down in the longer term. The contract thus marks one of the earliest examples within the coal-tar dye industry of an agreement to divide the market, something that in the coming decades would feature more and more prominently in the industry as a way of avoiding undesirable competition. For BASF's development in particular, the contract took on special significance during the following two and a half decades by strengthening the Ludwigshafen-based firm's ties to Knosp in Stuttgart (in spite of occasional friction), thus paving the way for an eventual fusion, which occurred in February 1873. A contract with Dahl dated March 20, 1873 similarly followed the "guiding principle" that "direct competition" between the two firms should be avoided, and even after the fusion, Dahl & Cie., with its own "extended customer base," remained a valuable customer for BASF.[39]

Engelhorn was able to exercise the considerable freedom of maneuver that had been granted to him as leader of the firm by the administrative council in the interest of the young corporation. The rapid construction of required buildings in Ludwigshafen concentrated at first on production facilities for the inorganic materials needed by the firm, as had been specified in the original concession. In October 1865, production of nitric and arsenic acids began,[40] in spite of the fact that no explicit permission had been given for the latter, which involved a highly toxic manufacturing process. The production

37 Knosp to Dahl, April 25 and May 15, 1865, BASF UA, A 15 I/5.
38 BASF UA, A 15 I; see also Urkunden, vol. 1, 25.
39 BASF UA, A 15 (previously A 19/1/4) as well as A 15 I.
40 Verwaltungsrat October 16, 1865, BASF UA, C 111.

of the other required starting materials – sulfuric acid using the lead-chamber process, soda using the Leblanc process, caustic soda, sulfate, hydrochloric acid, calcium chloride[41] – came on-line by the middle of 1866. Within a few years, initially planned levels of output had been exceeded many times over.

On June 28, 1866, as the next phase of the establishment of the Ludwigshafen works, Engelhorn applied for a concession to build a facility for manufacturing aniline and aniline dyes, in all an ensemble of 10 buildings. He also applied for permission to build a gas factory "for the purpose of lighting of the entire locality of the factory."[42] Once again, the governmental review process for this application was a short one, lasting hardly more than a month, although prior to the official granting of permission on August 1, 1866, reports from the construction authorities and the district health office were carried out once more, and a public inquiry took place. As a matter of fact, several objections were made by some of the factory's neighbors, registering their concern about possible damages arising from production in the new plants. But even if some difficulties were raised in conjunction with the disposal or storage of various waste products, there were no serious restrictions placed on the firm, just as had been the case a year earlier. The district medical officer, who had in the meantime also taken on a part-time position as a factory doctor in the service of BASF, used his expert report to take the opportunity to characterize the factory's production of arsenic, which was already underway, as unproblematic. What is more, he viewed as completely safe a practice that had been used in Mannheim, that of storing calcium arsenate in sheds with asphalt bottoms. Sensitivity about possible environmental damages appears at least in this case to have lagged well behind even contemporary norms.

In matters related to the facilities themselves, Engelhorn and his technical directors had made careful plans. The chairman of the administrative council, Seligmann Ladenburg, was able to report to the first general assembly of stockholders on October 15, 1866 "that the transfer of the aniline and fuchsin plants from Mannheim to our factory near Ludwigshafen [had] already [been] completed." Furthermore, he insisted that all production was now concentrated there in a cost-efficient manner.[43] The production and cost calculations of the firm's founders had worked out completely, and the share capital that had been paid in permitted the construction of even larger facilities than initially planned. Consequently, interest payments, which had been forecast at 5 percent, could be paid without any problem whatsoever from the plant's profits.

[41] Glaser, Erlebnisse, 16; von Nagel, Fuchsin, 15 ff.

[42] Reproductions of the relevant documents are in Werk (1940); Urkunden, vol. 1, 28–29. Further documents are in BASF UA, A 13/1/4. See also Andersen, Technikfolgenabschätzung, 248–249.

[43] Urkunden, vol. 1, 31.

An image of the factory as it would have presented itself to a visitor at about this time was later captured by Otto Bollhagen. Even in this early stage of development, it is not difficult to recognize the carefully thought-out conception that lay behind it. In retrospect Carl Glaser, who joined the firm in 1869, celebrated from his expert perspective the "grand, highly directed, and entrepreneurial spirit" that was mirrored in the factory and its facilities. One could easily recognize "Friedrich Engelhorn's lion paw," the mark of its "future-oriented, daring, and strong-willed creator."[44] Thus this was indeed a pilot plant, since there were no other prototypes for Engelhorn to rely on orientation. On the other hand, one should not assume anything special about the buildings themselves. Construction took place quickly and cheaply with the most basic materials. Firewalls were relatively rare among the mostly one-story buildings, which were generally also constructed without cellars. The outside walls amounted to no more than "wooden Fachwerk filled with bricks and festooned with wood on the one hand or freestanding wood frames on the other."[45] Newly required buildings, once permission had been granted, were simply added to existing stock using the existing building scheme.[46]

From Imitation to Independent Research – Heinrich Caro

The company developed at a truly breathtaking pace, carried along in part by the generally favorable upturn in the economic cycle that took place against the background of the process of German unification, which as it turned out developed along "small German" lines, excluding Austria (1866–71). The workforce, originally envisaged to be about 400 workers, grew beyond this already by late 1867, while production had reached nearly three times its originally intended volume by 1867/68.[47] The range of products also grew by leaps and bounds. Every year newly discovered dyes were added to the originally limited palette. A price list from 1873/74, for instance, cataloged 21 different categories of dye, most of which had several products within them, which amounted to a total of 81 products in all.[48] At first, these consisted only of imitations, but the situation began to change quickly in this regard after 1868.

Engelhorn, who had once gone so far as to try to obtain advanced methods of fuchsin manufacture from competitors in London through industrial

[44] Glaser, Erlebnisse, 15–16. [45] VT I, 129.

[46] A large amount of documents on this are in SALU, Abt. 2330, BASF I and II; in addition, see BASF UA, A 13/1/7ff.

[47] Report of Ladenburg to the general assembly of stockholders, 1868, BASF UA, C 111.

[48] For example, there were 7 different Magenta products, 12 blue products soluble in water, 9 different types of water-soluble methylene violet and methylene green, and so on: VT, Tri-Farben, 66–67; slightly differently reported in VT I, 149 ff.

espionage (an attempt that ended in wretched failure),[49] set off from 1867 on a course of innovation that was successful in the middle and long term. He did this initially through purchasing production processes developed elsewhere, and later through BASF's own research.

Early on, licensing contracts with the French chemist Jean Théodore Coupier enabled BASF to deploy the (nitrobenzene) process developed by Coupier in the manufacture of fuchsin, thus avoiding what had been necessary previously, that is, the application of toxic arsenic.[50] The same strategy enabled the firm to use Coupier's processes for the production of pure aniline, toluidine, and induline dyes.[51]

However, much more significant than such licensing agreements was the decision to employ scientifically trained personnel not just for technical facilities and in the supervision of production – this work was done for the most part by the Clemm brothers. Instead, such qualified personnel were especially brought to bear on the improvement of production methods and on the development of new dyes. Thanks to pioneering theoretical work beginning in the late 1850s, especially that done by August Wilhelm Hofmann and Friedrich August Kekulé, it became possible to do systematic research in the area of organic chemistry, and in particular dyestuff chemistry. Such systematic research promised rich yields well beyond those offered by mere experience and tacit knowledge or by the hitherto much more accidental synthesis of dyes. The leadership of BASF was able to exploit this situation with a fine feeling for future developments.

There was hardly another German chemist who represented so completely the close connection between scientific theory and industrial technology as Heinrich Caro (1834–1910).[52] He has consequently been characterized for good reason as the "father of industrial research in the German chemical industry."[53] Trained as a chemist and colorist at the Royal Commercial Institute in Berlin, Caro moved to a cotton-printing plant located in Mühlheim on the Ruhr River. During the period 1859–66, he assembled a rich range of experience with the new coal-tar dyes as a salaried worker, and eventually as a co-proprietor, of Roberts, Dale & Co. in Manchester. It was there that he developed a new process for the manufacture of mauve already in 1860. By 1862, he had discovered an aniline black and, together with the Hofmann student Carl Alexander Martius, whom he had hired into his firm, had synthesized several dyes (or else had solved technical problems

[49] Glaser, Erlebnisse, 13; this account is corrected in Reinhardt, Forschung, 64.

[50] November 24, 1868. On the manufacture of Magenta using arsenic acid, see Andersen, Technikfolgenabschätzung, 229 ff.

[51] Contract of January 8, with addendum of January 9, 1869, in BASF UA, A927; VR from January 14, 1869, BASF UA, C 111.

[52] On Caro, in addition to BASF UA W 1, see in particular Reinhardt, Forschung, and now more exhaustively Reinhardt, Travis, *Caro*, which has extensive citations to relevant literature.

[53] Reinhardt, Travis, *Caro*, 126. On the cooperation between universities and industry in general, see Borscheid, Naturwissenschaft, in particular 111 ff.