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978-0-521-10119-6 — German Industry and Global Enterprise
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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.

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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.

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("*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.

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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

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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.

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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.

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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.

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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.

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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).

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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.

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