The Business Side of German Science—VII

Making Money With the Aid of Technically Trained Men

By Waldemar Kaempffert

[*THIS is the seventh of a series of articles, written by the Managing Editor of the* SCIENTIFIC AMERICAN, *on German industrial conditions. The author was sent abroad by the publishers for the express purpose of gathering the material on which the articles are based. In this and the article to follow, the part played by the technically trained man in German business is pictured.*

The amazing industrial development of modern Germany is to be attributed in large part to technical education and to the application of science to business. Capital and science work hand in hand. Every one of the great chemical discoveries of our times, most of them made in Germany, are the result not of haphazard experimenting, but of systematic research that has meant the expenditure of princely sums. All German manufacturing is so thoroughly saturated with science, that even the small producer practises on a miniature scale the methods of his larger rivals.]

THE notion that industrial success is largely a matter of luck dies hard. The huge American trust is a refutation of the oft-repeated fable that chance plays the largest part in business success. In Germany the evidence that conspicuous industrial success is not nowadays attained without well-directed effort, without the aid of technically trained men, is even more apparent than in America. Every prominent manufacturing firm in Germany maintains its department for industrial research.

The Wonderful System and Organization of the Germans.

The scientific work of a great German manufacturing company naturally divides itself into three classes. In one class men are to be found whose duty it is to control the manufacturing operations from a special laboratory; in another will be found men who are engaged to do research work pure and simple, for the purpose of improving existing manufacturing processes, devising new ones, or discovering new products; and finally in the third class are men who try out a new discovery on a miniature factory scale in order to determine its commercial possibilities.

Perhaps the finest example, outside of the chemical industry, of the technical control of manufacturing operations is to be found at the cast steel works of Krupp at Essen. The uniformity of the Essen products is to be attributed entirely to the rigorous scientific control of the entire cast steel plant. Each step in the manufacture of steel is checked up in the laboratory. Analyses are made by the hundred. The work has been so systematized that boys and young men do the actual work under the supervision of a chemist. Thus it becomes possible to make five hundred analyses of iron for carbon dioxide in a day. The laboratory workers simply see to it that Bunsen burners are lit, that retorts are boiling, and that filters are working properly. The supervising chemists are thus permitted to perform more important duties than that of watching a burette or a test tube. The laboratory workers are simply tools in the hands of their supervisors. They must be intelligent enough to perform the tasks assigned to them, but they must not be so intelligent that they are led to experiment for themselves. A similar method of employing intelligent workmen is followed by the United States Steel Corporation.

Research is not conducted simply by intelligent young men, but by university graduates, as may be supposed. The work is so subdivided that often two chemists working side by side may know nothing of the problem as a whole.

When after countless trials and failures a discovery is made by a research chemist that seems to have commercial possibilities, a small experimental plant is erected in which the same type of apparatus which is to be used for actual work operation, is employed. The conditions are industrial conditions. Little factories are equipped with little autoclaves, little filtering presses, little hydraulic presses, and little vats. At a great coal tar dye factory near Frankfurt I saw new dyes being tested on a small scale which involved practically the erecting of a miniature leather dyeing plant, a miniature paper dyeing plant, and a miniature textile dyeing plant. Thus the suitability of newly discovered dyes for special industries was ascertained. Upon the dozens of scientific men in the laboratories of a manufacturing company a strict masonic secrecy is imposed.

The Masonic Secrecy of the Laboratory.

It is even said that the director of one part of a great chemical works is not permitted to enter another part, and that the exact salary of an important man may not be known even to his own wife. So far is secrecy carried that a chemist in one laboratory is frequently totally ignorant of the work done in another laboratory in the same building. He is not allowed, with rare exceptions, to read papers before learned scientific societies, at least not without the consent of the firm. Buried away in the files of the great companies are probably the records of countless experiments which, if made public, would unquestionably advance the whole cause of science. The individual steps, already taken, must be painfully retraced by university professors who are working for no commercial object. At Essen, for example, I was told that the problem of gun erosion had been so far studied in the laboratory that the Krupps considered themselves ten years in advance of America on that point, but when I asked a chemist if he could refer me to any scientific publication in which the Krupp experiments are discussed, I was informed that they had not been published and probably would not be published; that they were, indeed, in the nature of trade secrets.

The Business Management of a German Manufacturing Company.

A German company is usually managed by a board, at least one member of which is a scientifically trained man, thoroughly conversant with the technical operations of the plant. One of the directors may be a lineal descendant of the original founder of the factory. He bears the name of his ancestors and continues the traditions of the old factory so long as they meet modern requirements. Another director is a glorified salesman. He is a man who has traveled much, who knows government officers, who may ultimately win the title of *Kommerzienrat* and who may even win a seat in the Reichstag. All of these men speak four or five languages and speak them well. With them on the board sit men who have represented the company in foreign countries and who travel six months in the year establishing agencies all over the world.

As a result of this partition of labor it is difficult for one man on the board to overawe the others. The purely business men know nothing of science; they must rely upon the technically informed member of the board. On the other hand, the technical director knows little of business and must accept the views on finance uttered by those members of the board who are better informed on such subjects than he. As a rule the directors are all men between thirty-five and fifty. Keen, alert, thoroughly informed of business conditions in foreign countries as well as their own, students of international politics, they are, in a word, broad-minded, cultured business men of the finest type. Even the chemists and engineers on the board of directors are essentially commercial men—commercial in the sense that they meet the mechanical requirements of the world. More, however, is required in that respect of the German than of the American engineer. The German enters into direct competition with French, German and Austrian technologists, who have at their command labor just as cheap as his and just as plentiful. We find him, therefore, thoroughly conversant with every phase of the industry in which he is employed. Nothing escapes him. He knows the source of raw material, its price both to him and to his foreign competitors, the manufacturing processes adopted in foreign countries and their efficiency as compared with his own. He studies the idiosyncrasies of the foreign market, and seeks to adapt himself to them. He knows the transportation facilities as well as any shipping agent. He makes a study of tariff schedules and customs laws of foreign countries.

These men usually have at their command a huge capital, represented by bonds and stocks valued at anywhere from five million to ten million dollars. The dye stuff industry of Germany as a whole represents an investment of about seven hundred and fifty million dollars. There are surpluses and reserve funds that amount in several cases to over two million dollars. Dividends of thirty-five per cent are occasionally allotted.

Because there is more science in German than in American industry there is less audacity. The offhand way in which many American business men will sink a hundred thousand dollars in an enterprise about which they know absolutely nothing, simply on the strength of a friend's well-meant advice, is without a counterpart in Germany. But when the board of directors of a German company has thoroughly studied a problem with the aid of competent men, when, as a result of that study, they have become thoroughly convinced that in the solution of the problem there lies a commercial possibility, money is spent freely in researches that may extend over years before it is possible to erect the first manufacturing plant. Thus the Badische Anilin und Soda Fabrik spent about four million dollars, it is said, to develop the present method of making synthetic indigo on an industrial scale. But the pecuniary sacrifices thus made were not risked for work that might or might not succeed. The result was foreseen and inevitable. The company knew that, given time, money and brains, the problem could be solved. Every path was explored, every chemical reaction that could possibly be employed was tried, with the result that every chemist now knows.

Millions for Research.

So, too, the Badische spent thousands and thousands of dollars in developing the Schoenherr process for the reduction of atmospheric nitrogen. The late Heinrich von Brunck, who did much to bring the company to its present eminence, realized how important was the solution of the problem. He placed ample funds at the disposal of Dr. Schoenherr. The Badische Company needed sodium nitrite for the production of anilin dyes. Previously, sodium nitrite had been made by the reduction of Chile nitrate with lead; but this method of production was costly. On every acre of the earth atmospheric nitrogen to the amount 31,000 tons presses; for eighty per cent of the air we breathe is composed of nitrogen. At that rate the air over every nine acres contains about two hundred and eighty thousand tons, equivalent to the amount of Chile saltpeter used in 1907. It is no easy matter to utilize the nitrogen of the atmosphere, simply because it is inert, in other words, because it refuses to combine very readily with other elements. Schoenherr devised an electrical method of fixing the nitrogen of the air, which is now familiar to the readers of this journal. As a result of the Schoenherr process, sodium nitrite is no longer reduced from Chile nitrate. Practically the entire supply of the world, valued at about one million dollars, is now obtained electrically.

So, too, the contact process of manufacturing sulphuric acid was developed by the Badische Company because of the demand of the indigo and alizarin manufacturer for a cheap concentrated sulphuric acid and sulphuric anhydrid. The demand for cheap sodium and chlorine induced the company to develop the electrolytic soda process. In a word, even the raw materials of a great industry are now made by cheap and efficient processes, scientifically developed.

The amount of work that must be done in systematically developing an industrial process along scientific lines is herculean. New methods must be worked out before a way is at last discovered of attacking the problem in hand. The work is slow because the investigator must follow an unblazed path. To spend two hundred thousand dollars a year and have nothing to show at the end of that period may seem sheer madness. Yet the German chemist knows that given time, money and brains, he must eventually succeed, knows that the commercial returns from a single great discovery are enormous. Of seventy-five research chemists whose collective salaries may vary from $75,000 to $200,000 a year, seventy may discover nothing, while the other five may discover products that mean a net return of a hundred thousand dollars a year for at least the life of an ordinary patent. That explains why some of the German chemical products notably drugs, seem inordinately high in price. Dr. Eberhardt of the Badische Company put the matter thus: "If capitalists are to employ inventors or to take up the exploiting of inventions as their business, as a means of earning their dividends, they must be recouped from successful inventions for the losses which they inevitably will incur from unsuccessful ones. Success can be made certain only by taking a large number of chances. A firm employs, let us say, one hundred chemists and engineers for the purpose of making and working out inventions. Some of these will never make an invention, but their salaries have to be paid. Few can be relied upon to deliver a paying invention every year, but the expense of their laboratories and their income has to be assured. If these conditions, essential for the establishment of chemical industry, were better realized, there would be less talk of the exorbitant prices charged by patentees for their product, and the ideas of many people as to fair terms for licenses—compulsory or otherwise—would have to be re-arranged."

(*To be concluded.*)