technics and science which is in fact at the root of all this magnificent success.

In closing permit me to say that it is unique in the history of civilization that the honor and credit for the creation of this enormous material and spiritual wealth is unanimously and ungrudgingly accorded to Sir William Henry Perkin. It is unique that the creator of this vast industry has been so fortunate as to witness its wonderful development during fifty years. It is unique that when no longer engaged in the industrial part of our science, he undertook a series of theoretical investigations of the utmost difficulty, which only the most gifted have the courage to attempt, and that in this branch, too, he has conquered a position as lofty as his fame as a manufacturing chemist.

The world can not spare such an extraordinary man. May he live for many years to come and may his life be replete with health and happiness.

Hugo Schweitzer.

ADDRESS OF SIR WILLIAM HENRY PERKIN.[1]

It is now twenty-two years since I visited the United States. I was attending the first British Association meeting that was held at Montreal and then extended my visit to Yellowstone Park, returning by Chicago, Washington, Baltimore, Philadelphia, New York and Boston back to Montreal. At that time I certainly never anticipated that in twenty-two years' time I should be in this city at a jubilee celebration of the discovery of mauve and the foundation of the coal tar color industry. It was, indeed, quite unexpected and a matter of surprise to me when I heard that an international celebration was about to be inaugurated in my own country, which took place in July last. This included nations on both sides of the world, as you sent Dr. Baekeland as a delegate to represent America, but it was a still greater surprise to find that you were not satisfied to merely join the English jubilee, but had determined on having a jubilee celebration of your own in this city, which I should be invited to attend. I can only say how greatly honored I feel and how gratified I am at being present here to-night at this banquet, and meeting so many fellow workers in the field of science, and other friends. From the very cordial and friendly reception you have given me, I do not feel at all strange in coming amongst you, especially as I realize how closely we are related to each other by race and language, which naturally engenders a strong feeling of sympathy between us, a feeling which has been so heartily manifested this evening by the warm welcome given by the City of New York, through the Hon. Patrick McGowan, president of the Board of Aldermen, and also in a practical manner by the presentations given by Dr. Nichols, Mr. Kuttroff and Dr. Hillebrand.

The foundation of a medal bearing my name to be annually awarded to an American chemist, I feel to be a great honor, especially as I have all my life insisted on the importance of research work, and if this medal should help to encourage and stimulate some chemists to increased activity in this direction, this jubilee celebration will have accomplished a valuable result. And when we consider the advantages you fortunately have in this country by the existence of a very large research fund, we can not but believe that this will be the case. I thank you very sincerely for presenting me with this beautiful medal, the first that has been struck, which I value very highly.

With respect to the beautiful personal token you have presented to me, I scarcely know how to express myself. I am sure it will always be greatly valued not only by

[1] Given at the banquet tendered to him at Delmonico's, New York City, October 6, 1906.

myself but by Lady Perkin and my family. It has the merit of not only being beautiful but also very useful, and it is a very suitable gift for a total abstainer who is very partial to a cup of tea. Whenever we use it it will remind us of the warm-hearted hospitality which has been shown us in America.

I appreciate very much the honor the American Chemical Society has done in electing me one of its honorary fellows and presenting me with its certificate of membership this evening. I am very pleased, indeed, to have my name associated with this important society, the value of which I gauge from my knowledge of the help the London Chemical Society has been to me, and of which I have this year also completed my jubilee of membership.

I very heartily thank Dr. Nichols, Mr. Kuttroff and Dr. Hillebrand for all their kind and generous remarks in reference to myself when presenting me with these gifts.

That this jubilee should also have another important object in view, namely, the foundation of a reference and circulating library for science, is also a great satisfaction to me, as it may be the means of not only affording useful information to scientific workers, but also of stimulating research.

I am very glad that Professor Chandler is the president to-night. I have known him for a long time, and we must all admire the indomitable perseverance with which he has worked for the cause of chemistry in this city, for now over forty years without flagging. His position as chairman on this occasion is particularly fitting, because of the varied ways in which he has been connected with the coal tar industry, and his acquaintance with the great works in which the colors are made, and I also know the very hearty and active part he has taken in connection with this celebration. I thank him also most sincerely for the kind things he has said in reference to myself.

We have all listened with interest to the remarks of Dr. Schweitzer, who is not only practically connected with the coal tar coloring matters, but has also done good scientific work in connection with them. I thank him also for all the kind references he has made to me. And I take this opportunity of thanking him and all other members of the committee for the pains they have taken to make my visit to this country so extremely pleasant and enjoyable, not only to myself, but also to Lady Perkin and my daughters. It is a landmark in our lives to which we shall always look back with pleasure.

I have no doubt that some of you will have read the particulars of the London celebration and what I said on that occasion, and this makes it difficult for me to address you, and if I repeat much of what I said then, I must claim your indulgence, because one can not but state the things which have occurred in one's lifetime; they can not be varied. As I expect that many of you, however, may not be so well acquainted with the history of the coal tar color industry and the mauve dye which was its starting-point, as people are in the old country, I thought that you might like me to give a brief account of it, especially of its early days, but even to do this is difficult in the time at my disposal, and, moreover, as I shall have to speak about myself, it would have been more agreeable to me if some one else could tell the tale. To begin, it may perhaps first of all interest you to know something of my early days and how I became a chemist.

As long as I can remember, the kind of pursuit I should follow during my life was a subject that occupied my thoughts very much. My father being a builder, the first idea was that I should follow in his footsteps, and I used to watch the carpenters

at work and also tried my hand at carpentering myself. Other things I noticed led me to take an interest in mechanics and engineering, and I used to pore over an old book called the 'Artisan,' which referred to these subjects and also described some of the steam engines then in use, and I tried to make an engine myself and got as far as making the patterns for casting, but I was unable to go any further for want of appliances. I had always been fond of drawing and sometimes copied plans for my father, whose ambition was that I might be an architect. This led me on to painting and made me think I should like to be an artist, and I worked away at oil painting for some time. All these subjects I pursued earnestly and not as amusements, and the information I obtained, though very elementary, was of much value to me afterwards. But when I was between twelve and thirteen years of age a young friend showed me some chemical experiments, and the wonderful power of substances to crystallize in definite forms, and the latter, especially, struck me very much, with the result that I saw there was in chemistry something far beyond the other pursuits with which I had previously been occupied. The possibility also of making new discoveries impressed me very much. My choice was fixed, and I determined if possible to become a chemist, and I immediately commenced to accumulate bottles of chemicals and make experiments. About this time I changed my school and was sent to the City of London School, and to my delight found that lectures on chemistry and natural philosophy were given there twice a week during the dinner interval. These I attended, and not long afterwards the lecturer, seeing the great interest I took in science, made me one of his lecture assistants, my duties being to prepare the experiments, arrange the table and assist at the lectures. This was a great lift to me, and I daily used most of the interval for dinner and not infrequently all, but the abstinence from food this caused did me no harm, as nearly all of us eat far too much. This interval was the only time I had for fitting up apparatus and preparing for these lectures. The lecturer was Mr. Thomas Hall, B.A., one of the class masters, and he was very kind to me and helped me in every way. My father was disappointed at my choice, and the outlook for chemists was, indeed, very poor in those days, and naturally that was a matter that weighed with my father, but Mr. Hall had several interviews with him and eventually I was allowed to follow my bent, and at the age of fifteen I left school and entered the Royal College of Chemistry in London, where Dr. Hofmann was professor.

Under Dr. Hofmann's able instruction I soon got through the ordinary course of qualitative and quantitative analysis and also gas analysis; this I looked upon only as a preliminary part of my chemical acquirements and not, as many used to and some still do, as a full equipment. Research was my ambition and under the professor's guidance this was entered upon and the first investigation completed when I was seventeen. I then became honorary assistant in Dr. Hofmann's research laboratory and helped to carry on his scientific enquiries, and in this way I quickly acquired a considerable insight into the chemical science of that day, as well as experimental experience. My time being much occupied with the professor's work, I had little opportunity of carrying on research on my own account. I, therefore, fitted up part of a room in my father's house and made a rough laboratory, a very different place from the laboratories of the present day. Spirit lamps and charcoal, for combustion, had to be used as sources of heat, as there was no gas. In this labora-

tory work was carried on in the evenings and vacation time. In those days one of the problems was the artificial production of vegetable and animal products, and amongst other subjects I was ambitious enough to try and produce quinine artificially, of course from purely scientific motives, but, as is frequently the case, the research took an unexpected turn; no quinine was formed, but only a dirty reddish-brown precipitate. Unpromising though this result was, I was interested in it and thought it more desirable to experiment with an analogous but more simple material than I had previously used. *Aniline* was, therefore, taken, but in this case I obtained a black and more unpromising product, but on submitting this to investigation found it contained, besides other things, a beautiful purple coloring matter which was found to be capable of dyeing silk and other materials, and it was in fact the product we now know as the 'mauve dye.' This discovery was made in the Easter vacation of 1856. I showed this dye to some of my chemical friends, who thought it might be valuable, but its evident costliness and the difficulties of preparing aniline for its production on a large scale made the probability of its proving of practical value very doubtful. At this time aniline was a very rare product, only found in a few research laboratories, and could not be purchased. Having obtained an introduction to Messrs. Pullar of Perth, the well-known dyers, some pieces of dyed silk were sent to them, and they reported: "*If* your discovery does not make the goods too expensive it is decidedly the most valuable that has come out for a long time." This report was very satisfactory except the '*if*' it commenced with. During the summer vacation, and with the help of my brother, Mr. T. D. Perkin, larger experiments were made and consequently larger quantities of coloring matter obtained, and it was then decided to patent the process, but a difficulty arose. I was but eighteen years of age, and it was questionable whether a patent could be granted to any one under twenty-one (a minor). Counsel's opinion had, therefore, to be obtained, and this was to the effect that, a patent being a gift from the crown, the matter of age did not affect the grant. Further experiments were then made on dyeing and calico printing, and although the colors were admired, that terrible *if* respecting the cost was always brought forward, besides other questions. Nevertheless, I became persuaded in my own mind of the importance of the dye, and as a consequence I gave up my position as assistant to Dr. Hofmann that I might follow up the subject, but at this he was annoyed, probably thinking I was taking a false step. I was also much afraid that by entering into this technical pursuit my research work might be prevented, but I determined that so far as in me lay this should not be the case.

But the difficulty in starting this new industry was that no one was willing to come forward with the requisite capital, because they were not ready to risk it on such a new and untried product as this dye. My father, however, although he had been disappointed at my becoming a chemist instead of an architect, nevertheless, had so much confidence in my judgment that he very nobly risked most of the capital he had accumulated by a life of great industry by building and starting works for the production of this mauve dye. Had it not been for this generosity on his part, for which I have always felt very grateful, probably I should not have been able to start this industry. My father and brother joined me in this undertaking, and I feel that my success was largely due to their collaboration. Time would fail me to enter into all the difficulties that beset the

establishment of this unique industry, not only in having to invent a suitable plant, but also to obtain even the raw material, which was not then made of a definite quality. The processes were quite different in character from those in existing chemical industries. The coloring matter also when made was quite different from ordinary dyes in its properties, and methods for its application as a dye had to be discovered, and this consumed much time. In fact, it was all pioneering work. Nevertheless, the mauve was supplied for silk dyeing as early as December, 1857.

I have mentioned these particulars because the production of this new color and the practical proof of the possibility of manufacturing it commercially was the foundation of the coal tar color industry. When the mauve was seen to be a success, of course every one commenced experimenting with aniline, and three years after its discovery magenta was discovered by M. Verguin in France. None of the difficulties I have mentioned were encountered in the manufacture of this dye; the way was clear and all the processes for the application of the mauve were equally suitable for the magenta, and, moreover, none of the first prejudices in reference to such an innovation as the mauve any longer existed.

Other coloring matters were then discovered by myself and in France by Messrs. Girard and Delaire and then by Dr. Hofmann in England, many of which were derivatives of magenta. These were produced not only in France but largely in England by Messrs. Simpson, Maule and Nicholson; they were also made to some extent in Germany and Switzerland, and very soon dyes of all the colors of the rainbow were obtained from commercial aniline, and the industry made very rapid progress.

In 1868 Graebe and Liebermann commenced an investigation on alizarine, the natural coloring matter of the madder-root, from a purely scientific point of view; this led to the remarkable discovery that this coloring matter is related to a coal-tar product called anthracene, and they also succeeded in producing it from this product. This was the first natural coloring matter which had been produced artificially. Their process, however, was not suitable for the production of this coloring matter technically. Having in my research work studied anthracene and some of its products, I endeavored to find a practical process for the formation of alizarine, and after a time succeeded in finding two suitable methods for its production on the large scale. Caro, Graebe and Liebermann quite independently also discovered one of them. I and my brother then took up its production at our works (my father having died previously), but many difficulties were encountered, one being that of obtaining anthracene, which was not then a commercial product, but after visiting most of the tar works in England and instructing the tar distillers and agreeing to take what they could make, a supply was soon obtained in all different states of purity, which quickly increased. In the meantime the difficulties of the manufacture were overcome and we were soon able to commence supplying alizarine to the turkey-red dyers. Our output rapidly increased, and this artificial coloring matter has now become one of the most important of the coal tar colors and has superseded the natural dye, so that the cultivation of the madder root has practically ceased. In the year 1873 the demand for alizarine had so increased that we felt that it would be necessary to enlarge our works two or three times to meet the demand. My brother and I, however, did not care to undertake this great responsibility; we, therefore, sold our works, hoping our successors would follow up the matter.

This ended my connection with the color

industry from a manufacturing point of view. After this I occupied myself with scientific research, some of which was connected with coal-tar coloring matter, but mostly with other subjects. Some of these are still occupying my attention. But I must not enter into details, as time would fail me.

One of the most remarkable developments of the industry has been the artificial production of indigo, and, curiously, the first process for its manufacture, discovered by Professor v. Baeyer, was dependent for its success on the method of producing cinnamic acid, discovered in my purely scientific investigations, and this dye is now manufactured so cheaply that the cultivation of the indigo plant has been discontinued in many parts of India.

As I mentioned, when I started this industry I was determined not to give up scientific research, and so long as I had to do with it the part I took in its development resulted from the union of industry and scientific research. This has been followed up by others, especially in Germany, and owing to the work of an army of chemists, many of them men of great eminence and most of them engaged in the works and their laboratories, this wonderful development, unequaled in the history of industry, has taken place. This industry has also had a marvelous influence on the development of science itself. Its wonderful growth has also, as a matter of course, created not only directly but indirectly an immense amount of employment for men of all classes, especially the working classes, which can not be gauged, and although America has not become a manufacturing center for the production of these dyes, no doubt many thousands of American workers are engaged in the applications. That this industry which I was permitted to found should have led to this result is a source of pleasure to me, because the final result of our work should be the benefit of mankind.

You have been so good as to honor me by having this jubilee in remembrance of the part I have taken in connection with this coal tar color industry, and whilst I am thankful that I had to do with its foundation and early development, yet I feel that the part I have taken is indeed small when compared with the labors of the army of scientific men and others, both inside and outside the color works, who have advanced it to its present condition. At the same time it is very gratifying to me to receive all the generous and kindly expression of feeling you are manifesting, and I thank you very heartily. But what have I that I have not received? It is not, therefore, for me to boast (and I also feel that I have but imperfectly used my opportunities). I, therefore, can only say in reference to the success which has attended my efforts, Not unto me, O Lord, not unto me, but unto thy great name be all the praise.

REFORM IN MATHEMATICAL INSTRUCTION.

THE principal mathematical reforms recommended by the commission appointed by the Gesellschaft Deutscher Naturforscher und Aerzte is that more emphasis should be laid on the development of the concepts of *function* and *space*.[1] As the commission realized that such fundamental changes are not likely to be accomplished by a mere publication of the results of its deliberations, it appointed two of its members—Professor Klein, of Göttingen, and Professor Chun, of Leipzig—to try to interest secondary teachers in the subject, and, if possible, to bring them to discuss it very freely.

[1] 'Bericht der Unterrichtskommission der Gesellschaft Deutscher Naturforscher und Arzte über ihre bisherige Tätigkeit,' Leipzig, F. C. Vogel, 1905.