

a student, for it generally determines the special line of his future career. The 'theme' is usually taken from the particular branch of the subject at which the professor himself is working; but, as the scientific name and position of the professor depends, not only on his own work, but, to a large extent, on the work issuing from his laboratory, he is careful not to limit himself to too narrow a range of his science. Of course it is the best for all if the student selects for himself a suitable 'theme,' suggested to him by his lectures or practical work, or from his private study of the literature of the science. But this seldom happens, for the young student is not yet able to discern the bearing of special questions, and lacks knowledge how to work them out. Sometimes (but not very often, indeed,) he points out to his professor in a general way the kind of problems he would like to work at, and the professor suggests to him a special problem out of this range of subjects. During the working out of his chosen subject the student learns generally much more than he has heard at lectures. Every part of the investigation forces him to revise the scientific foundations of the operations he performs. During this time the incidental short lectures given by the professor on his daily round from one to another of the advanced students are most effective in deepening and strengthening the student's knowledge. As these explanatory remarks are generally heard not only by the student whose work has caused them, but also by a number of fellow-students working near, a fairly wide range of scientific questions are dealt with in their hearing. Often these small lectures develop themselves into discussions, and, as for myself, I judge from the frequency of such discussions between the students whether the session will turn out a good one or not.

"If the professor thinks the work sufficiently complete to be used as a dissertation, the student proceeds to the close of his studies. He prepares himself for the examination, which is conducted by the very professors whose lectures he has heard and in whose laboratories he has worked. This examination varies somewhat in different universities, but in no case is it either very long or extensive; indeed, it is not considered as very important. For we are all aware what an uncertain means of determining a man's knowledge and capabilities an examination is, and how much its issue depends upon accidental circumstances. Part of this uncertainty is removed by the fact that the professor and the pupil know each other, are acquainted with one another's modes of expression and scientific views. The main purpose of the examination is to induce the student to widen his knowledge to a greater extent than is covered by the subject of his dissertation, but indeed it happens very seldom that a student whose work is considered sufficient does not pass the examination.

"We have no great fear that this system may induce a professor to treat his own pupils in too lenient a way, and so lower the standard of the doctor's degree. There was a time when such abuses used to occur, but there very soon arose such public indignation that the

abuses ceased to occur. Even at the present day similar instances occasionally occur, but, as before remarked, the position of the professor depends in such degree upon the value of the dissertations worked out under his supervision that such deviations from the right way correct themselves in the course of time. The most effective instrument for that purpose is the publication of all dissertations and the consequent public control over them; and for this reason publication is, I believe, compulsorily prescribed in all German universities. When the student has finished his course he is still entirely free to choose between a scientific and a technical career. This is a very important point in our educational system; it is made possible by the circumstance that the occupation of a technical chemist in works is very often almost as scientific in its character as in a university laboratory. This is connected with a remarkable feature in the development of technical chemistry in Germany—the very point upon which the important position of chemical manufacture in this country depends. The organization of the power of invention in manufactures and on a large scale is, as far as I know, unique in the world's history, and it is the very marrow of our splendid development. Each large work has the greater part of its scientific staff—and there are often more than 100 doctores phil. in a single manufactory—occupied not in the management of the manufactory, but in making inventions. The research laboratory in such a work is only different from one in a university by its being more splendidly and sumptuously fitted than the latter. I have heard from the business managers of such works that they have not unfrequently men who have worked for four years without practical success; but if they know them to possess ability they keep them notwithstanding, and in most cases with ultimate success sufficient to pay the expenses of the former resultless years.

"It seems to me a point of the greatest importance that the conviction of the practical usefulness of a theoretical or purely scientific training is fully understood in Germany by the leaders of great manufactories. When, some years ago, I had occasion to preside at a meeting, consisting of about two-thirds practical men and one-third teachers, I was much surprised to observe the unhesitating belief of the former in the usefulness of entirely theoretical investigations. And I know a case where, quite recently, an 'extraordinary' professor of a university has been offered a very large salary to induce him to enter a works, only for the purpose of undertaking researches regarding the practical use of some scientific methods which he has been working at with considerable success. No special instructions are given to him, for it is taken for granted that he himself will find the most promising methods; only, in order to increase his interest in the business, part of his remuneration has been made proportional to the commercial success of his future inventions. From this clear understanding of the commercial importance of science by the directors of industrial establishments, there science itself gains another advantage. A scientific man can