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# Education of Mining Engineers.

PROFESSOR N. W. LORD.

The development of technical schools for the training of young men for entering the various professions, such as mining and civil engineering, or metallurgy, has been due to the rapid growth of scientific knowledge and its generally recognized value as the only true basis for these arts as practiced to-day. The recent action of the mining society in regard to the improvement of this department of the State University justifies my asking their attention to a few points in regard to the nature and limitations of this kind of school work.

The constant criticism of college courses is that they are not "practical." Let us consider the demands covered by this complaint, and how far the school can meet them.

All schools of the kind under discussion are largely devoted to the teaching of the sciences, of chemistry, geology, physics and mathematics, it being universally admitted that no proper special education, in mining engineering at least, can be given which does not rest upon these subjects as its foundation. Now, it has long been seen that the only way to give thorough instruction of this kind was by laboratory work, or as it would be popularly called, making the course practical. The chemical laboratory, for instance, is always a prominent feature of an engineering school and only by practice in the actual manipulations of analysis combined with the lectures and text book instruction can that intimate acquaintance with the facts and laws of the science be obtained which will be of real service in the professional life of the engineer.

Physics and geology are taught in the same way, the latter by "field work," the actual practice serving to make the students practical, that is able to do the observing and experimenting for themselves and draw the right conclusions unassisted.

All this is well understood. Schools can and do graduate men who are fair practical chemists, physicists and geologists. The laboratories of steel works and smelting works can be supplied with properly trained men directly from the class, who, while lacking, of course, business experience and judgment, yet are good workmen in these branches. A school can and should similarly train draughtsmen fit for immediate employment, and the fact that probably the majority of the young men who graduate from the technical schools of the country find employment in these directions shows that this feature of the course can be and is made "practical."

Now, this work is of a nature especially adapted to school

teaching. These arts are largely dependent upon personal skill, which fact, with their market value to the young graduate seeking employment, accounts for the amount of time usually allotted them in the curriculum of most colleges.

How far can a similar practical course in the higher and more difficult branches of mining and metallurgy be formed for students in these subjects?

It is evident that even if the only good the school course could do the young engineer was to teach him "practically" and well the sciences upon which his future business was based, it would not have been in vain, but it assumes to do more and includes the special study of their applications to the problems of engineering and the teaching of the actual business of the engineer.

The usual plan is to discuss in lectures and recitations the various methods of smelting ores, opening, ventilating and draining mines and all the other subjects connected with this business of mining. After such study the young man finally graduates with the engineer's degree, and unless he has been very carefully and continuously repressed, imagines himself an engineer *de facto*.

It is against this part of the work of the mining schools that the charge of impracticability is most frequently brought, and so great is the prejudice aroused by the confessedly inexperienced character of many of the young men when they first start out that the whole course is by some condemned and regarded as superfluous, while the real and substantial good that has been accomplished in giving the graduate a mind trained to the scientific study of things and stored with a knowledge of the sources of information and the history of the experience of men is altogether lost sight of.

Much of this wholesale and flippant criticism of mining schools and their graduates is unjust and wrong. I am not infrequently treated to statements of the incapacity and unpracticality of some young man who, just from college, "can't do anything"; but when I look over the list of graduates from our own or other mining schools I see that in a very short time many of them rise in their profession and attain positions of trust and responsibility, gaining practical knowledge of the details of their business with a rapidity which is an index of the value of the mental drill acquired in their course of so-called "theory." Still it is true that most graduates must learn their business after leaving the college, and this fact acts as a hindrance to them and is quoted as a reflection upon the schools.

Let us inquire, then, as to the nature of the practical instruction sought for, how and to what extent it can be given during the college course.

Analyzed down to its lowest terms much of the real trouble and fault found with students just after graduation comes from

their not being workmen with the handiness and experience of the "craft." Is it right to suppose that this sort of skill and experience can or should be given them at an institution of the kind we are considering? A school course is not, it seems to me, to take the place of the actual apprenticeship to a business, though it may shorten the time necessary for that part of the man's training. Numerous attempts have been made to make it this, but always with more or less failure, as might have been foreseen; and the reason is simply that a man must learn the actual business in the business itself. Small work shops, smelting furnaces and other expedients of a like nature have been advocated and tried, but while they have proved of great value in other ways, have left the student much where he was before, as far as his position as a beginner in his profession was concerned.

In arts like drawing, chemical analysis and even to some extent the details of surveying, where young men can be taught and required to do the actual work in the college, as has been seen a certain amount of facility can be given in the more special and elementary parts of this subject, but beyond this simpler practice comes the experience and judgment, only gained by constant employment in the work, together with the element of personal responsibility for results which gives the chief value of the man who has been "in the field" over the raw student. Now, this cannot be conferred by any process of instruction, as it only comes by direct experience, and the school which gave it would have to build railroads, develop mines and employ workmen, or in other words become a money making business, and could not afford to teach, but merely to employ men.

This idea that a trade or art can be well taught in a school often finds expression, but is, it appears to me, at fault. The truth in the old motto, that only "by working we become workmen" stands forever nearer the truth, and it is to fit men the better and more speedily to thus "become workmen," that is the true object of the modern system of technical education. The school time is too valuable to devote entirely to this "practice" while the other and higher things with which it deals would be neglected. If, then, this kind of "practical" instruction is not the proper function of the school, what is the real lack that is to be supplied? It seems to me that this will readily appear if we consider a little in detail the actual state of instruction. Take as an illustration the lectures on mining engineering.

The subject of ventilation is, for example, being discussed. Maps are shown of different mines, the direction of air-ways, the amount of air required, the velocity, the composition of the gases considered, the machinery for establishing the draft, furnaces, fans, etc. Now, this sort of thing would be called by any one who had had experience in mines, eminently practical instruction, and yet to many, or most students, it is pure theory, is learned

with a half understanding, and quickly forgotten; so of other branches taught. The young men are studying things about which they do not understand the needs and applications. They have no proper comprehension of the bearing and importance of what they hear, and the result is that, instead of drawing practical conclusions, they absorb "theoretical" ideas. To make instruction of this sort practical, it must be addressed to "practical men." In this direction there lies the great need of our mining school. How can we secure a class of students who know the bearing of what they learn, or how can we supply the lack of this to the students who come without it? To illustrate, I had recently a student in metallurgy who had worked for years in a rolling-mill. The lectures on iron and steel were to him of a most practical nature. Every point discussed, as he informed me, was of direct importance to his work, and yet to a considerable part at least of the class the whole matter was merely dry detail, to be forgotten, until possibly recalled by future needs, when "cornered" by some practical difficulty. How, then, can the training be given to the students, which is needed to put the average undergraduates in shape to receive this instruction "practically?" The matter was fully discussed at an early session of the American Institute of Mining Engineers. The outcome was that actual work was the only proper school where this experience could be gained, and that it must come either before, during, or after the college course itself.

But can this kind of practice be made an integral part of the college requirements? The answer is furnished by the experience of the famous schools at Freiburg, Germany, and more recently by the summer schools in connection with Columbia Schools of Mines in our own country.

The prominent advantage which the great German school enjoys has always been its immediate connection with the mining and smelting works in its vicinity. The students are allowed to work a part of their time as apprentices in these establishments. This is not playing at work, or mere visiting of the locality to see how things look, but actual employment, under regular foreman and overseers. This part of the course is not only allowed but required for all those native students who expect employment as Government engineers, as without it their degrees cannot be obtained. The value of this work can hardly be overestimated. It makes the students "practical" through work, and the mind, aroused to see the needs of the scientific discussion of the points met in practice, grasps the "theory" with a firm insight. I have talked with gentlemen who had taken this "practical" German course, and am told that the work done in the mines and shops is the true secret of the thoroughness and completeness of the school. Many efforts have been made, as before stated, to supplant this actual work by small workshops, furnaces, etc., at

the school, but these do not secure this contact with the actual, that is the great feature of the former method.

The Columbia College method differs somewhat from the German. The experiment was first tried some years ago by Prof. Monroe, who organized a summer school of mining upon which the attendance was voluntary. The success was so great that now such work is a regularly required condition of graduation, students spending part of their vacations in the mines and shops, and being required upon their return to College to give written accounts of their summer work, in the shape of memoirs and theses.

Now it seems to me that this is the one great need of our course in the State University. We have thus far been trying to train young men who expected to get their real experience after their College course was done, this has led to a difficulty of obtaining employment through lack of experience and acquaintance, and again to the necessity of waiting too long between the theoretical study of the more advanced branches, and the practical demonstration of their value and application.

The very central location of the University and the extensive mining operations of the State ought to make an arrangement possible to bring the two into more immediate contact.

A plan similar to the German scheme would be to require each student in the regular course for the degree of Engineer of Mines to spend, say three or four weeks of his summer vacation at work in some mine or at a furnace. To accomplish this would need the co-operation of the gentlemen in charge of such works. Can they be persuaded to give it? Can I say to them, "I have several students whom I wish to get a little personal experience with actual work during their College course so that I may make their instructions more practical. Can you put one or two to work? of course salary is no object, their time is at your disposal, I merely wish them to 'rub up' against the difficulties of the business." Will this bring the opportunity? if so I can secure the attendance of the students. It is said that visiting works in company with a Professor will take the place of this, but it seems to me that while such visits are undoubtedly valuable they will not secure the same results as the plan considered. Of course the inspection of actual operations should not be, nor is it neglected. We always make such trips to all available points, but after all, what is seen in this way like the illustrations of a lecture is most serviceable to the man who, by actual work, has learned to see the working of new plants intelligently.

In conclusion let me say that I believe it will pay to work with our school in this direction. The real reason for the maintenance of technical schools is the need of well taught men in the profession. The business of the country wants them, and if this is generally appreciated so that by the co-operation of this and similar societies the right grade of men can be developed for the

various branches of the great mining and manufacturing interests of the State, it will result in an increased revenue from these sources, and more important, still, better utilization of our natural wealth. I hope the interest in our school will grow, our defects be discovered and corrected, and above all, that our students will be looked after and encouraged. Remember they are young men trying to make themselves valuable for the State. They are taking the first steps, do not expect them to be old hands with old heads at first, and I am sure that they can prove in a short time that their school course has been worth while, and the years spent at "theories" have not been wasted.

#### DISCUSSION.

Mr. Roy: The address of Professor Lord is very valuable, and it would be well to follow, as far as possible, the advice given in it in regard to the education of mining engineers. The one prominent object that this Committee had in view, I believe, in wishing to see the department of mining liberalized, is to have provision made for theoretical and practical instruction, and as far as practicable make the education of these young men such that it will fit them for engineers in the State of Ohio. In regard to the instruction at Freiburg, I do not understand it as Professor Lord does. I know the students are required to visit the mines, but not to work there. As I understand, they are taken there by the professors during the vacations, and some of them do work; but it is not popular. I would not regard it as a waste of time for any one to be required to go down into the Hocking Valley, and to take a pick and dig in a room, or to lay track; but I think he would receive valuable practical instruction, if he were taken down there to study the geology of the coal measures, to study the rocks, to study the way the mines are opened, and the various machinery used, and all the various steel and iron industries. Having seen how those things are done—with the theory he would get in the schools—he ought to be fitted when he graduates to take an engineer's position.