THE TRAINING OF THE MINING ENGINEER.*

We are interested in the management of thirty-two mines, of gold, silver, copper, lead and tin. These mines are situated in Australia, New Zealand and elsewhere. In addition, we act for several exploration and development companies, which are engaged in other portions of the world. The thirty-two mines mentioned employ about 9,000 white men, and produce minerals of a gross value of 6,000,000 pounds sterling annually.

In the organization of these enterprises, each single mine is a unit of administration. The head of each unit is 'the manager,' who is not only necessarily a mining engineer, but he is also the commercial head of the enterprise, and, therefore, the dual capacity of technical and commercial execution is combined in one hand. This form of administration of mines causes mining engineering to differ in the requirements of training and experience from most other forms of enterprise where technical skill is required. Under the 'manager,' who has general charge of the mine, is a staff in charge of various departments. These men comprise a mechanical engineer, surveyor, electrician, metallurgist, chemist, foreman, accountants, etc., and, as in the case of the manager of the mine himself, these men are, except the accountants, of technical and semi-technical character, and have, as in his case, executive control of their departments, combining thus again the commercial and the technical administration into one hand. The number of 'superior' men employed varies with the size of the mine, from two technical subordinates, up to as many as fifteen or twenty on large mines. As said above, all of the staff except the accountant are necessarily men of more or less technical training. This technical training has been derived in foundation either from technical schools, or by self-education within the actual field of practise.

In addition to this organization of each unit, these mines are combined into administrative groups under a still superior organization, over which preside engineers of greater distinction and capacity. These men are themselves assisted by a staff of specialists in various departments, and who preside in a general way over all of the mines of their group and their particular departments, in reinforcement of the actual organization of each mine.

As the men thus employed in capacities superior to workmen are paid salaries varying with the importance of their position and their personal qualifications and experience, an easy method of discussion of the results of technical training can be arrived at by dividing them into classes according to their salaries. There are a total of 272 employees of this technical and semi-technical character (omitting accountants and purely commercial agents) in our employ.

The following table shows the number of men, arranged upon this basis, the character and origin of their training:

Class.	Trained in Technical Schools.				Trained in Practise.	Total.
	America.	Australia.	England.	Total.		
Salaries over £4,000.....	5	nil	nil	5		5
Salaries £1,200 to £4,000.....	9	1	2	12	5	17
Salaries £800 to £1,200.....	4	8	1	13	6	19
Salaries £480 to £800.....	3	19	3	25	37	62
Salaries £240 to £480.....	1	18	2	21	148	169
Total.....	22	46	8	76	196	272

In connection with the above, it may be observed that among men of the lower

* This essay is an extract from a private letter. It is published by permission of the author.

ranks, technical education is not so essential for the requirements to the position of assayer, cyanide man, mill man mechanical engineer, foreman, etc., are more of a skilled artisan than that of an engineer. A large portion of the men who fill these ranks are of this type, and have secured their training practically by way of apprenticeship through the actual work. These ranks, however, form the stepping stones from which all men must rise to the leading positions. It would be desirable if, except for some cases as foreman, all of this rank and file were men of the highest technical attainments, as, obviously, the men qualified to occupy superior positions are more advantageous in an inferior position than the man who has at that point reached his limitations.

From our experience and as indicated by practise shown in the table above, there can be no question as to our belief in the value of technical education. Given men of equal qualifications, the man of technical training is bound to rise to the higher position, because of his greater value to his employer.

A side issue in connection with the value of technical training lies in the fact that we have found, as a rule, men who have been technically trained are men by virtue of their education who are endowed with a professional feeling which does not to the same extent exist among those men who have risen from the rank and file. They are, therefore, more trustworthy and, especially in mining work, where such premium for dishonesty exists, for this qualification alone, they are bound to have precedence. We do not by any means wish to disparage the qualifications of many men who have risen from the ranks to eminent positions, but our opinion may be concentrated in the statement that even these men would be better men had they received a thorough technical training.

As to the character of the training which we should desire for men whom we would employ, we can make the following observations:

1. These men should receive a thoroughly broad groundwork of education in the humanities, as well as the sciences, prior to their entrance to technical schools.

2. Their technical training should extend over a period of at least four years, as we believe that any period less than this is quite insufficient in which to embrace the purely theoretical groundwork of the engineering profession which we should desire in our employees.

3. The character of this training should be altogether theoretical, subject to the intercalation of experience set out in paragraph 5. Four years is too short a time in which to embrace any 'practical' training within the working days of a technical institution. Mining engineering requires a broader training than any other engineering branch, as it must embrace mechanical, electrical and civil engineering, as well as applied chemistry and mineralogy.

4. The theoretical training during this period should cover a thorough training in pure science of mathematics, chemistry, physics, geology and mineralogy and mechanics, with special instruction in the applied branches of these sciences, as bearing upon this special branch of engineering. It is our belief that especial stress should be laid upon the purely scientific portion of this training, as under the varied conditions of each new problem this portion is of more use than any knowledge of special application.

5. During the course of theoretical training, in which there must obviously, in any educational institution, be certain vacations, as is done in American universities, in the actual employment of going concerns. Such employment should not be undertaken with a view to the actual ex-

perience gained, as fitting men for final employment on the expiration of the four years, but with a view to rooting in the minds of the men the use and application of the theoretical training which they are undergoing.

6. In the instruction of the applied features of these sciences, we do not believe in any attempt to reproduce actual working conditions, but that all laboratory work should be of a purely theoretical and investigatory character. As this is a disputed point, we may set out our reasons fully. They are:

(*a*) The time of young men in technical institutions can be more usefully employed in theoretical training than practical demonstration, and lack of such theoretical training can seldom be made up in after life.

(*b*) In mining engineering, as we have set out above, the qualifications necessary for our requirements are not only technical, but are also commercial. Men must take on administrative functions. It is impossible to reproduce commercial conditions in any training institution. It has been our universal experience with young men who have come from technical colleges where an attempt was made to give so-called practical instruction, that these men came to us in the thorough belief that they were fully fitted to occupy important positions. The conditions under which so-called practical instruction can be given in technical institutions, reduces them to purely play-house value and gives to the mind of the individual an exaggerated idea of his attainments.

7. Given the student having had four years of theoretical training, which has been founded on a preliminary entrance requirement of broad character, and a certain amount of vacation time spent in works, then this student should, for a period of at least two years, go into active employment of the nature of an apprenticeship. With this period, it should not be the ambition of the student to place himself in a fixed position, but rather to work through the various departments of such section of the industry as he intends to devote himself to, and to undergo this work as an actual workman. An opportunity of this character we are offering to students from the school of mines.

Upon receiving the men from technical institutions, we require them to spend two years or to have had two years' experience in the actual operation of the various departments of mining. In other words, to serve an actual apprenticeship as actual workmen in the various departments, as it is only by this that the youth can get an adequate balance of what constitutes commercial *vs.* theoretical conditions. In questioning the technically trained men employed in the most important positions on our staff, we find that in every single instance these men have served such an apprenticeship, yet we regret to say that in throwing our mines open to young men fresh from technical institutions, that not one out of ten have been content to go through this period of apprenticeship. A great majority has drifted entirely out of the profession. A few have secured positions beyond their capacities and come to worse grief.

In general, we may sum up the position that for our business what we desire are young men of good natural qualifications, thoroughly trained theoretically, without any so-called practical knowledge, unless this knowledge has been gained by employment in actual works, for, as expressed by one of the leading members of our staff, we have not the time nor the inclination to knock out of the heads of these men misimpressions which they have gained by so-called practical training in the technical school.

There are other matters in connection with this question which appear to be of more importance than the pure questions of technical training, and which are deeply rooted in English custom and feeling.

In the first instance, engineers have from time immemorial in this country (England) been educated by an apprenticeship to other engineers. The result has been more or less hand-to-thumb methods. This, of course, can be improved by direct technical training of the character given in America to engineers.

English industries, however, are conducted under two bureaus of administration—commercial and technical. The attitude of the commercial direction always tends towards the greatest immediate result, which usually takes the form of the least outlay of capital. The tendency of the engineer is to get the minimum production cost per unit, which involves large outlays of capital. Neither side is entirely right, and in America this has been successfully overcome by educating the commercial bureau as engineers. In other words, our engineers are administrators instead of consulting men, so that any improvement in English industries must come by a reorganization of their method of administration, as much as by superior education of their men, and this is a matter which can not be accomplished by technical education, and, in any event, would be of very slow growth. There are many hundreds of American engineers in the employ of English concerns, and almost universally they are in executive positions. The whole of the gold mining industry practically is under the direction of American engineers, and England owns mines yielding fully seventy-five per cent. of the gold output of the world, and the American form of administration has been introduced into this industry almost universally.

Another matter which enters into the great English question is that social dignity does not attach to the position of engineer. In the English social mind, the engineer is still an artisan or a tradesman, and the distinction of the engineer as a professional man of equal rank and personal attainments to any other profession has but few advocates in this country. The consequence is that the young men of better families, looking about for a profession, must choose either the law, the church, the army, the navy, medicine or the civil service if they hope to attain social dignity. The result is that it would be very difficult to draw the average brains of the country into the technical branches, whereas I think the feeling in America is quite to the contrary.

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RECHERCHES SUR LES SUBSTANCES RADIOACTIVES.

OF the half dozen books which have recently appeared on radioactivity, two are of commanding importance, for they contain the records of the epoch-making work of the two investigators to whom we are most largely indebted for our present knowledge of the phenomena in question, E. Rutherford and Mme. Curie. Of these two wholly dissimilar treatments the former is the more comprehensive and perhaps the more suggestive; for, from beginning to end, it is a presentation of a well-developed theory of the cause and nature of radioactivity. Facts are everywhere grouped about, and fitted into, and interpreted in the light of this theory. On the other hand, Mme. Curie's 'Researches sur les Substances Radioactives,' now appearing in its second revised and corrected edition, deals very sparingly and very conservatively with theory. It is primarily a record of the experimental researches which have been made by herself and her husband during the past five years. Nevertheless, the work of other experimenters is given ample attention, so that the book constitutes a very complete and concise résumé of the present