should try to get his work changed often, so that his experience shall be as varied as possible. But naturally employers do not approve of altering the work, just as their employee is becoming proficient in it, so it is mostly left to the graduate himself to take the initiative in this respect.

When completing my last year at the University, our esteemed friend, Mr. G. H. Knibbs, acting professor of physics, gave us some sound advice, in which he urged us not to cease our studies at graduation, but to be students all our lives. One finds it necessary to be continually studying, so as to retain what has already been learnt, and to keep up-to-date with fresh knowledge.

The graduate may have to fight his way up the ladder against the influence of the practical miner. The Cornish miner, especially, has a large reservoir of inhospitable dislike for "theory," and everything new. But, for all the bigotry of the practical miner, the graduate has much to learn from his plain but sure methods, which are based on long experience of what he knows for certain, and he is always open-handed with information.

After the graduate has finished his course at the University, he will do well to take a second course at the mines, and study the methods of the practical miner and experienced fitter. A fitter seldom knows much about entropy of steam, but he can repair a break-down in machinery in a way that astonishes the graduate. There is so much importance in this practical component that, without it, the execution of theoretical intuitions is seldom possible. There is always a good instance of this whenever a new process for the treatment of ores is introduced. It is never complete till the practical man has banged it into shape.

The free interchange of information should be encouraged, for by publishing exclusive knowledge for the use of others, one may be sure it will induce an exchange of ideas, which, in turn, is bound to be of service to oneself, and produce a healthy effect in the industry generally. Bottled-up knowledge of methods is liable to become stagnant, and useless to the owners for want of a few details to complete it; whereas by circulation, the deficiency would be supplied by others, and the complete knowledge would be of use to many.

A graduate should establish himself on a firm professional basis, and demonstrate his indispensability to his employers before he asserts it.

DISCUSSION.

Professor DAVID, acting-dean of the Faculty of Science, in opening the discussion said that he was unable to agree with Mr. Palmer on some points. Three years being insufficient in which to teach the subjects now included in the curriculum, the Faculty of Science had decided to extend the course to four years. The Royal School of Mines, London, had a four years' course for mining and metallurgy. The extra year was not added with the object of including new subjects, but so as to allow adequate time in which to work, so that the

course would be less severe on the students than if the same amount was crowded into three years. In this connection it is to be noted that the new course will not be any more costly as regards fees. With three years, the students had not sufficient time to assimilate the information given them, so that the resulting cram led to a kind of intellectual indigestion, with its accompanying disasters in December. Additions had been made in the number of some of the lectures, those of mining having been increased, as suggested by Mr. Palmer. Workshop practice is also provided for, partly in vacations and partly in University time, a whole term in both the third and fourth years being set aside for it. With regard to points of the curriculum adversely criticised by Mr. Palmer, one very great advance recently made was the appointment of Mr. Gibson as demonstrator in mechanical drawing. Graduates could render great assistance to the Mining School by sending specimens, not necessarily the best, of ores and rocks as generally found in mines.

Mr. A. Jarman quoted the old saying that "The mine makes the manager." Sydney B.E.'s. however, did not begin their practical life by managing a mine; they first had to get some experience in subordinate positions. This was largely due to the omission of practical mining from the present curriculum. He regarded this as the chief defect of the University course, as the B.E.'s are sent out into the world with the stigma of not having necessarily done any practical mining. Quite a number of past graduates saw their first mine when on tour with the lecturer in vacation time. If mining experience was insisted upon in the University course, this stigma would be removed, and in addition the studies of the final year would be much easier, and of more benefit to the student. The best continental, American and British Schools of Mines included practical mining work, and in Sydney we were very much behindhand in omitting it. Mr. Palmer, in his paper, objected to this practical work being made compulsory, but he inconsistently advocated that after a visit to mining fields, the students should be required to write theses upon what they had seen. Such theses would not be worth the paper they were written upon; even a a trained, experienced engineer would not write a thesis from such a hurried visit, so a student's thesis would be absolutely worthless. Practical mine surveying is a subject which is very much in need of attention. It should be included at once. Field surveying is altogether insufficient, and lectures alone cannot afford adequate instruction in such a subject. Students at the Royal School of Mines do a three weeks' course of mine surveying in mines, under the immediate supervision of the instructor and two assistants. This is in addition to the ordinary surveying course. There was no reason why such an essentially practical subject as engineering should not be taught in as practical and useful a manner as possible. The benefits derived from lectures on electricity, dynamo design, machinery, and thermodynamics would be rendered much more valuable if supplimented by practical instruction in dynamo and motor running, machine shop practice, steam engine and boiler management. Such practical work was the only fitting complement to these lectures, and either without the other is halved in value. Mining lectures have already been added to, and rightly so, when one considers the vastness of the subject treated. It is generally split up into separate divisions in other schools, viz.,

mining, ore dressing, concentrating machinery, surveying, and ore deposits. Assaying is already treated quite fully enough, much more fully than in most schools, but ore dressing and treatment are confined to sampling lots up to two or three tons, stamp battery work, concentration on a Frue vanner, cyanide, hyposulphite and chlorination-leaching, in 3½ cwt. vats, and roasting in a furnace, taking about 8 cwt. of concentrates. He agreed with Mr. Palmer's suggestion to widen this course, but pointed out the necessity for more funds and a larger staff. The recent gift by Mr. P. N. Russell might enable something to be done in this direction. The battery should be removed from its present site, which is adjacent to two lecture rooms; its work in consequence had to be very intermittent. With all the subjects included, it is not surprising that the Faculty of Science had decided to make the course one of four years. Most kindred institutions required four years, and in addition have a compulsory science matriculation, whereas in Sydney, the matriculation examination is the same old-time compulsory Latin—one long ago discarded by the up-to-date Universities as being only suitable for those proceeding to a degree in arts. The unfavourable treatment accorded to graduates of the Mining Schools by old-time managers is a matter of concern, but one which will pass away. It can best be removed by the graduate going forth and showing, as many have already done, that they can start at the bottom rung of the ladder and climb to the top.

Mr. Barraclough deprecated the idea that the course should be made more technical in character. Mr. Jarman had advocated the teaching of boiler, engine and dynamo running in order to make the degree of more value to the student, but that was not what the University was for. He contended their duty was to teach the principles of the subjects concerned, but, certainly, if a student desired in addition to get such practical experience, he thought the opportunity should be given him. The University did not aim at producing a man highly specialised along one line; breadth of vision and thought was the ideal. A short course on trades and business methods would be of advantage to all. He drew attention to the enormous cost of equipping a professional school. Even the P. N. Russell gift of £50,000 would not go very far at present rates of interest.

Mr. T. M. Owen commended the increase in mining lectures, and would much like to see the running of machines, both steam and electrical, put into their practical courses, as a supplement to the lectures which, however admirable, did not fit the student to run these machines. He though that it was out of place to require graduates to pass the theoretical part of the Government examination for mine manager's certificates, considering that the Government subsidised the University to the extent of £10,000 annually, and that the examinations at the University were much stiffer than those of the Government. He expressed much surprise that the University authorities had not made representations to the New South Wales Government on this matter, so that those who had obtained a B.E. degree should be exempt from this theoretical examination.

Mr. F. Danvers Power said that it must not be forgotten that at a mining school only the groundwork and principles of the profession were taught; the details on which success depended came after the

foundation had been laid. A graduate was not a full-fledged mining engineer, by any means, on leaving the University; his degree only guaranteed that he had passed certain examinations; he still had his practical experience to gain. While learning anything new, progress is slow; but when that knowledge had to be applied in business, time is often a more important factor than accuracy. One might learn to adjust machinery at the University, and how to conduct experiments, but one could not expect to have an extensive plant capable of covering all contingencies, neither were the conditions at the University the same as one would meet with in practice, but that was not necessary. A student, not knowing what his future might be, must have a general grounding; that is advisable even should he decide to specialise from the first. A man was often selected as superintendent of a mine on account of his special knowledge; if ore treatment was more important than ore extraction, then a metallurgist would be chosen, if the other way about, a miner would be given preference. Probably, a good deal of what was learned at the University would be forgotten, but the subjects were so selected and taught as to lead up to the main subject, and after all, it would not take long to pick up the information when it was known where to find it. We learnt more by failures than by successes; men with most practice made most mistakes, as they had most opportunities. It was not a question of the number of mistakes, so much as the nature of them. Men who passed examinations brilliantly, often proved failures in after life, while apparently dull or idle men turned out successes. This was because the brilliant scholar frequently lacked the necessary qualification for applying his knowledge, and was unable to manage men, while the dull man was often more practical. Some graduates were disappointed when they found they had to take a lower position than uneducated men of their own age at first. Mine owners did not want people to learn at their expense. It generally paid better to give a fair wage to a man who knew his business than to engage an inexperienced man at a lower figure. A beginner, naturally, did inferior work to one accustomed to it; tools got broken, time of one's mate was taken up in teaching him how to work, and then, just as a graduate began to get useful, he wanted to leave, and get experience elsewhere. It was really the workman that paid the boss, for the less bossing a man required, the higher the rate of pay he could command. A manager received higher pay than his men on account of his ability; the excess might be looked upon as interest on the time and money spent on his education. Economical management was not always illustrated by dividends; the cost of work in £ s. d. was not always proof of good work, one must take conditions into consideration. It is not work that kills the young engineer, it is worry, and it is advisable for his own sake that he accepts a subordinate position at the commencement of his career. We could never expect to have an ideal curriculum, for what is up-to-date to-day, is out of date to-morrow, and frequent alterations have to be made, according to the additions made to our knowledge. The two years' course schools, on the mining fields, were equivalent to the German Mining Schools for under-officers. The four-year schools were equivalent to the German Mining Academies, where mining engineers were trained. Graduates from techinal schools often found themselves in awkward positions for want of business knowledge. In German

schools there were lectures on business, including book-keeping. The proposed trades course was also good, for the young mining engineer found in his work that it was necessary to specify for and pass certain work at times, about which he knew next to nothing. A course of lectures pointing out main features of the commoner trades he is likely to come in contact with, would be of great assistance to him, and would be better than picking up the information in a haphazard manner. Mr. Palmer objected to class certificates being issued in their present form, for fear the public should think the holder of one had gone through the complete engineering course. The certificates state distinctly that they are only class certificates; if the public thought otherwise they were just as likely to confuse the diploma of an inferior school with one of a superior. Perfectly competent men, for various reasons, may not go through the regular course, and still be as good or better than those who do. A man may enter as an unmatriculated student, and pass all the other examinations, yet not be qualified for his diploma according to the rules; or a man may prefer to divide his time between two or more schools. It was probably a slip of Mr. Palmer's pen when he wrote that the mining course consisted of thirty lectures, and recommended that they be increased to sixty. The present number is sixty, though he (Mr. Power) actually gave eighty, and in addition to these there were class examinations and time taken up in excursions. The lectures, however, in the future will be increased to one hundred. The calendar can of necessity give but an outline of the subjects treated; in the synopsis given to the class, the subjects are mentioned more fully. The present mining lectures included economic geology, mining proper, and ore dressing. In Germany, these subjects are treated separately; mine surveying is a separate course to land surveying; there are also classes on mining laws, business, etc. Mr. Power did not agree with Mr. Palmer that ore dressing should be coupled with metallurgy. It had nothing to do with the extraction of metal, except in the case of gold. Ore dressing was a mechanical, not a chemical, operation for separating different associated minerals prior to metallurgical treatment. Such work was generally carried out near the mine, so as to save transport, while metallurgical works might be miles away in some more central place near fuel or other ores. With regard to mineral specimens, fairly pure and crystallised minerals were necessary for teaching purposes, and it would be a pity to send rare specimens to the furnace. The collection Mr. Power had presented to the Mining School contained examples of deposits of the ordinary ores and wall rocks of gold, silver, lead, zinc, nickle, cobalt, mercury, copper, tin, chromium, antimony, phosphate of lime, tripolite, magnesite, asbestos, etc., and were found useful to illustrate the lectures on economic geology. He did not agree with Mr. Palmer's views of the worthlessness of a practical course prior to lectures; he himself had found such a course most useful, and it helped him to appreciate the lectures better, as it gave a basis on which to work, and was something with which other mines could be compared. A certain amount of manual labor was advisable, so as to give an idea of what men were capable of doing; besides, mixing with men gave one an insight into their views of things, and proved of value later on, when it was necessary to handle them. Otherwise, he agreed that visiting various mines worked under

different conditions was likely to be more productive of good to a future manager.

Mr. A. J. GIBSON agreed that more work in designing was necessary, but did not approve of the course in applied mechanics being cut short; mining men especially were wanting in this subject, which was so necessary when it was required to design plants—in fact, such designs should be made by mechanical engineers of no mean order. Practical knowledge was a *sine qua non* in such a profession as engineering, but it was not necessary that an engineer should be an artisan, though he must know enough to be able to direct the men under him. It was impossible to obtain a good mechanical training in three years, and a man must have mechanical knowledge before he commenced to design. Engine instruction should include the locating of defects, and the effecting of repairs in break-downs.

Mr. C. A. SUESSMILCH referred to the relative importance that metallurgy bears to mining. Exceptional men might be sufficiently expert in both subjects, but it was usual to specialise in one or the other. Sufficient importance was often not given to ore dressing. The difficulty was to decide what to teach, and what not to teach. In Germany, the training in mining and metallurgy ran on parallel lines at first, but diverged during the last years. He, however, did not quite agree with that. One reason why there were so many failures in mining was the want of technical knowledge; another reason was the want of business knowledge. One not only had to get out ore, but to win it at a profit. He inclined to a four years' course rather than one of three years. The extra year, even if a big slice out of one's professional life, was advisable, as it enabled the training to be as complete as possible. Some of his students at the Technical College were men who had had mining experience, and who came to Sydney to receive a technical training. Such men appreciated the lectures far more than those who had never been below.

Dr. MACKENZIE quite agreed with the former speaker that mining and metallurgy should be treated separately; the tendency of the present day was to specialise. At least four years should be occupied in training. Chemistry was the foundation of metallurgy; the structures used, *i.e.*, furnaces, were simply means to an end One had to deal with business men in practice, who wanted 21s., to the pound. The question asked was, "Is there any profit in it?"

Mr. J. A. SCHOFIELD remarked that when students first joined a school of mines they did not always know which subject they would take up eventually—mining or metallurgy, so studied both.

Mr. H. G. FOXALL said a man might feel that he was better suited for a special kind of work, but if he put in extra time on any particular metal, he might find that at the examination he would not have a single question on it. He considered that special research should be taken into consideration when passing a man, as it would show whether he had done good work, and the time taken up in special research, would otherwise be put in on more general subjects, possibly of less ultimate value to the student. Much had been said against descriptive geometry, but he considered it was necessary for the understanding of surveying and the proper appreciation of geological maps. Because an engineer may not have occasion to apply the shadow of a cone thrown by light

from a certain angle, it does not follow that the subject should not be taught any more than plane geometry.

Mr. J. P. TIVEY mentioned that he had put in sixty hours at fitting, and then was told that he knew absolutely nothing about it, so he did not know what benefit would be obtained from the ten hours proposed by Mr. Palmer. A man with ten hours experience might be placed over experts at fitting, when he would simply become the laughing stock of those under him. He would like to see more work done in engine testing and repairing. He did not think examinations were fair tests of a man's knowledge. One might be a first-rate practical man, and still be no good at answering theoretical questions.

Mr. CRAIG said that the object of the Engineering School was to teach a profession, so the course had to apply as much as possible to suit the case. The school really replaced the old apprentice system.

Mr. E. J. LEES was not in favor of a four years' course. It was all very well for those born with silver spoons in their mouths, but those who had to earn the necessary money to keep them at the University would find the extra year hard.

Mr. H. S. MORT considered it a great pity that the electrical lectures had been cut out of the mining course, as electricity was used so much now in connection with mining. Some of the speakers had objected to the trade lectures proposed by Mr. Palmer, but, as he understood it, the proposition was not that trades should be taught so that a man would be able to build a house, but so that he could tell whether it was built properly.

Mr. H. J. WRIGHT said that the handy practical man had held the reins of mining work so long that the change in management to the trained engineer was necessarily a slow one. There lurked in the mind of the non-technical man a contempt for the "theoretical man," and and the opinion was still widely held that the product of mining schools were simply theoretical. We had all met graduates who were anything but handy practical men, but it was the man, rather than the course he had gone through that was at fault. The school career and preliminary training all tended to make a student approach his course from a too theoretical standpoint; he had an unlimited capacity for assimilating knowledge, but had somewhat undeveloped powers for discriminating between useful and interesting information; he did not know the reason for learning this or that subject, and probably never having been on a mine did not appreciate all he was taught. Students should be compelled to put in, say, one year on certain underground mines before starting on the mining course proper. Mixing with miners, he would learn how to handle them, and they would teach him many things not put down in any syllabus. He would also learn confidence and decision, and he would be constantly on the look-out for short methods and labor-saving devices. The commercial side of mining engineering ought to be dealt with more fully than is usually the case. He would even go so far as to advocate the inclusion of mining bookkeeping as a separate subject, but for the fact that the course was long enough as it is. Arrangements should be made with the principal mines and metallurgical works in Australasia, whereby students could spend considerable time going through the various

departments, and be given every opportunity to gain an insight into the methods in vogue. This is done in some cases, and the best interests of the State were thereby secured by giving such men an all-round experience.

The president, Mr. T. P. STRICKLAND, remarked that once before a paper of this nature had been read before this society, and the question was asked, "What is the good of all this talk?" He, however, considered it was very important just at this time, when a change was about to be made in the curriculum, and he was sure any pertinent suggestions would be appreciated. He thought it advisable that students should be able to turn a lathe, but they should learn how to do this in the shop, not at the University. In some Universities, especially in America, the students had to forge chains, which they afterwards hung up in their bedrooms; but that did not constitute them smiths. He did not believe in a four-years' course. If the marticulation examination was made more severe, and schools were obliged to teach physics, etc., a three-years' course would be quite sufficient. A man who confined his studies to a narrow line is apt to consider his branch to the detriment of the general scheme. It would be advantageous to have practical work through the course, but in this school there was not time. In America and Canada, the practical work was done during the summer course. American students were turned out better practical and business men, though perhaps their grounding was not so good as out here, but they had more *nous* than the Australians.