DISCUSSION.

Mr. JAMES VICARS, M.E. (Consulting Engineer), said that he was in thorough accord with the bulk of Mr. Poole's views as expressed in the paper. He thought the question of apprenticeship was on a very good footing, and he could find no objection to teaching methods of to-day, save to their very limited scope. He did not see why, at Technical Colleges, men should be debarred because at sixteen they had not made up their minds what callings to adopt. Through circumstances, men might not have been able to go through apprenticeship to congenial employments, and it was a pity technical training was not available to such. To the syllabus of subjects recommended by Mr. Poole he agreed. The perspective drawing, however, should be practical. In the selection of men, the unwritten law that professors and teachers, when appointed, should not be over 35 or 40 years of age, may permit of getting highly qualified men by examination, and well read; but practical attainments, as well as good training, should be required. In America the professors were not wanted unless they were engaged in private practice as well. It was a common experience that the best qualified men in practical work might be five or ten years over the age previously fixed for such a position. Generally speaking, a man's practical judgment and technical knowledge is highest probably when he is 50, the most vigorous was at 40, and the most daring man about 30. The man between 40 and 50 was one who had probably seen more pitfalls, and the young man was therefore not so well fitted to take the chair in the Engineering Course.

Mr. W. E. COOK, M.E. (District Engineer, Metropolitan Board of Water Supply and Sewerage): In the first place, he might say that generally he agreed with almost the whole of what Mr. Poole said, and in particular he agreed with the paragraph re compulsory school training at night, or otherwise for boys between 14 and 16, when they are generally apprenticed. He also agreed with the contention that full recognition should be given by our Universities to students of Technical Colleges and Schools of Mines for work done by them at the colleges and schools, if they wish afterwards to obtain a Degree in Engineering.

He did not agree with the extreme specialisation at the University to anything like the extent suggested by the Address. There are now separate courses for Mining, Mechanical and Electrical, and Civil Engineering, which is for the present quite enough. A graduate will naturally follow his own bent, and with the knowledge now necessary to obtain a degree, his scien-

tific training should render him quite competent to perfect himself in any particular branch which inclination or circumstances dictated.

It is most difficult to exactly balance the exact proportions of practical work and theoretical work in an Engineering Course. He would insist, however, that the course be so arranged that the graduate may do well the early work he is likely to be called upon to do at the very beginning of his career.

In connection with Civil Engineering, he thought Surveying and Levelling came first. A young man will generally aim at field work in the first instance, and therefore he must be quite confident of his ability to do this work, both the field work and the necessary office work, with accuracy. Naturally he cannot expect to get sufficient practice at the University to do the field work as fast as an old surveyor, but to the ordinary graduate average speed would easily come with a little regular practice. He might spend a year at this class of work, and then have, say, two years in the drawing office, lest he begins to forget his University training in design.

He had no hesitation in recommending railway work as giving the best all-round training for something of almost every class of engineering required.

Thus he would recommend a year on railway survey and permanent survey for choice, two or perhaps three years on railway construction, as three years is about an average length of time taken up in a railway contract; then two years in drawing office.

By this time the Engineer would presumably be 26 or 27 years of age, and he would be then quite young enough to specialise on one particular branch of engineering, and at the same time he would be sure of his own mind and well equipped for his chosen special line.

He felt that all present were indebted to Mr. Poole for his valuable and comprehensive paper.

Acting-Professor O. U. VONWILLER, B.Sc., said that he was particularly interested in the preliminary science training of the engineering student.

In such subjects work was done which had little apparent relation to the needs of the Engineer. It would in some cases be profitable to substitute other matter. In the Department of Physics, owing to the smallness of the teaching staff, First Year Courses had to be common for students of all faculties.

With additional lecturers, some changes would be made in the direction of special preliminary courses, which, however, would differ only slightly from the common course now given, as preliminary training should be wide and general.

The work of the University is not only to give the training needed by the average student in his work, but also to give the general scientific knowledge which may be needed by some destined to become pioneers and leaders in new practical application of scientific research. It is a mistake too early to insist on limiting a student's studies to those branches of a subject which he is certain to use in his profession.

Another matter of importance in this address is the question of the recognition to be given at the University to work done by students in Technical Colleges or Schools of Mines. Undoubtedly in some of these the work done is of a very high standard, and in many cases exemption from attendances at lectures and examinations in the University should be given to students who have done corresponding courses elsewhere. It would be bad to extend these exemptions too far, because students ought to get something more from the University than the technical knowledge of their profession. By entering into the various activities of University life, mixing with men qualifying for different professions (of varied views), a man had opportunities of developing qualities which might count for more than his professional knowledge in making him of value to the community. Time properly spent in the Union might turn out to be of more value than that spent in a science laboratory. No scheme for recognition of work done outside the University should allow a man to graduate unless he spent at least two complete years in the University.

Mr. W. H. MYERS, B.E. (Government Tramways), said that he quite agreed that the course at the University should be as general as possible. The University lecturers, in his opinion, should be men of practical experience, not necessarily in one branch, but in various phases of engineering. A lecturer who had had eight or ten years of practical experience, and had held positions of responsibility, would carry more weight with the students. The question of apprenticeship was very important, but it was really a political one. He hoped that legislation would remove the existing abuses and anomalies.

Mr. P. BOARD, C.M.G., M.A. (Director of Education), said that while he could speak with some experience in the organisation of various forms of education, he could not profess any knowledge of engineering. Mr. Poole, in his comprehensive and valuable address, had presented a great store of information about existing means of technical training that could be relied on for its accuracy.

He (the speaker) had been investigating the question of apprenticeship. He considered that a mistake had been made in regarding the apprentice as an industrial unit, and appren-

ticeship simply as a factor in the organisation of industry. The apprentice was dealt with by Wages Boards, who were mainly concerned with the apprentice in his relation to the adult worker and the labour market, and only in a secondary degree with his training. This was a weakness in our apprenticeship system, and would remain so until the apprentice was regarded primarily as a person to be trained and educated for efficient craftsmanship.

The apprentice's first business was to learn, and in his early years the service he renders was only a means to his learning.

Again, the extension of preparatory technical schools made it very questionable whether a term of five years should be required in all forms of apprenticeship. At present a boy passes through a four years' course in the Technical High School, and completing it at the age of 17, finds that he cannot then be apprenticed in any engineering workshop on account of his age; whereas he has in those four years received a preparatory training much in advance of what he would have received if he had left school and become apprenticed two years earlier. There was very great need for some provision for shorter terms of apprenticeship according to the degree of preparatory technical school training which the boy had acquired before being apprenticed.

Other cases arise where a boy seeks apprenticeship late, at the age of 17 or 18, and is debarred because at the age of 21 he would not be qualified to earn the adult worker's wage. The adult wage for the adult worker was a perfectly sound principle, but the application of it in a hard and fast way shut the door of a skilled trade to many a promising boy who is a year or two late in determining his future occupation. In order to obviate this difficulty, and at the same time preserve the general principle that journeymen's wages should be paid to the adult worker, there was need for some authority to determine the individual cases in which the period of training might be extended beyond the age of 21. Such an authority would prevent such a concession from being abused.

Reference had been made by previous speakers to the linking up of the Engineering Department of the Technical College with the University. This was already partly arranged for by the provision that a student of the Technical College might, on the completion of the engineering course, be admitted after matriculation to the University Engineering School, and the Technical College work count as one year of the University course. He thought that now, since the Engineering Department of the College was under highly efficient instruc-

tors, the principle might be extended and the College course made equivalent to two years of the University course. He would not advocate more than that, since this would leave the student only two years' attendance at the University to get his degree in engineering. Less than two years would not be advisable, since there were other things in University life that the prospective professional engineer could not afford to do without, but which he could gain in his two years' attendance there.

H. E. BARFF, M.A. (Warden and Registrar, Sydney University), mentioned that some time ago the Senate of the Sydney University fixed an age-limit in the appointment of professors and lecturers, but in practice it had not been adhered to. Also, it was being recognised that outside practice by the teacher tended to greater efficiency, as instanced in the case of the Medical School, where lecturers were selected from the leading medical practitioners. He did not think that the student in four years at the University could afford to specialise, but there was another kind—the specialisation of teachers. The tendency was to divide the work of the departments, and in the evolution of the University this specialisation should be increased. There was a loss to the State of the services of graduates, due to the inadequate remuneration offered and the lack of business training. They were not able to step into commercial positions without learning the rudimentary principles of business practice; but this was being remedied by the establishment of a course of instruction in connection with the chair of economics and commerce.

Mr. J. NANGLE, F.R.A.S. (Superintendent of Technical Education, N.S.W.), said he had to congratulate Mr. Poole on the preparation of such an exhaustive account of what was being done in Australia to train men for all branches of engineering. He particularly appreciated the excellent descriptions which Mr. Poole had given of the work carried on by the Department of Technical Education in New South Wales.

Mr. Poole, however, had expressed a fear that too much of the instructors' time was taken in attending to the job cards. He could assure Mr. Poole that the time necessary to make the job cards was not wasted and was not interfering with the results aimed at in the teaching. The job cards were used to record (scientifically) the progress of the students and form the link between the teachers' assessment of values for work done and the departmental recording office. At the end of the year the marks on these records form the major percentage of the marks necessary to gain a pass for the year's work. The system thus is really an examination, commencing

on the day the student enters the class. Annual examinations are still held, because it is advisable to have external expert opinion on the work of the students; but the maximum of marks gained in the annual examinations, as compared with the maximum marks gained for the year's work, is in the proportion of 40 to 60. This system, which was introduced at the commencement of 1914, is working very satisfactorily.

Mr. Poole raises an objection to the occupation qualification for entrance to the Diploma Courses. Those Diploma Courses, for which an occupation qualification is required, are not designed to prepare students for entry to a calling. The Diploma Course in Mechanical Engineering, for example, is intended to enable persons in any branch of Mechanical Engineering to gain knowledge beyond that of a journeyman, to enable them to qualify for positions such as foreman or works manager.

Mr. Poole discusses in his address the important question as to how those being trained as professional engineers shall best receive the practical training that is indispensable to the fully qualified professional man. Mr. Nangle said he stood firm for the principle that the practical training should go before a diploma or a University course. To his mind the best way to make a fully qualified Mechanical Engineer was to begin with a good high school education, then apprenticeship, concurrent with supplementary technical education, and finish up with the University course. The Senate of the University of Sydney had generously provided for the recognition of portion of certain of the diploma courses under the Department of Technical Education in New South Wales, and the Government had provided scholarships whereby the best of those who proceeded through the Diploma Courses could take advantage of this recognition, and by attending for three years at the University could obtain a degree in any of the branches of engineering.

Mr. Nangle said that the engineering profession in Australia, and Technical Institutions generally, had been placed under a debt of gratitude by the very fine address delivered by Mr. Poole.

Mr. J. J. KING-SALTER (General Manager, Commonwealth Naval Dockyard, Cockatoo Island): He congratulated Mr. Poole on the comprehensive way in which he had detailed Technical Education. It appeared to him that the chief point of argument about the education of engineers was, to what extent practical training is necessary. Another point is how much allied specialised engineering should be learnt by the specialist. In these days of strenuous competition the num-

ber of men with practical experience in more than one specialised subject is becoming less and less.

He thoroughly endorsed the necessity for a boy continuing his school work after the age of fourteen. Some form of compulsory schooling is necessary after the age of 14, even if it is only by night classes; but three or more afternoons a week would be preferable. In the special province of shipbuilding, the system of technical training which has been adopted for H.M. Naval Establishment in this country is based on that of H.M. Dockyards at home. This has stood the test of time, and has produced very many eminent men, among others Sir W. White, Sir Philip Watts, Professor Biles, Professor Elgar, Sir A. Denny, Samuel Thearle, Professor Welch, Mr. W. T. Luke, and many thousands of highly-skilled workmen, chargemen, inspectors, foremen, and last, but not least, draughtsmen.

The Admiralty System of combining concurrently practical and theoretical training is eminently satisfactory. No amount of book work or laboratory work, unless this is carried out on thoroughly practical lines, only possible with certain branches of engineering, can replace experience gained in handling actual materials and seeing them used in work. Without this training a draughtsman or controlling officer makes silly mistakes. A year only at practical work is nothing like sufficient to acquire a thoroughly practical knowledge of the trade.

The method of training at Newport Railway Workshops, referred to in the address, is very similar to the system in Admiralty Dockyards, which is as follows:—

Boys between 14 and 16 years of age enter the dockyards by examination as apprentices. They place themselves on a list by the results of that examination, and each boy, according to his position on that list, selects his trade, filling the vacancies available in each trade. They serve five years. Each boy is attached to a trade instructor for three years, to get a thorough practical knowledge of the trade. On two afternoons and three evenings a week at the Dock School he is taught mathematics, physics, chemistry, mechanics, drawing, etc. Those boys who show special abilities at the end of the third year are allowed to continue their studies for a fourth year, and a few at the end of the fourth year pass into the Royal Naval College at Greenwich, to undergo the course of three years for entry into the Royal Corps of Naval Constructors. During the three months' summer vacation they gain further practical experience in the dockyard to supplement their college work. Those who fail to get to the college complete their fifth year and become tradesmen in the dockyard; but may qualify

by examination for the rank of Inspection Draughtsman, and from there, that of foreman. If shipbuilding is to flourish in this country there should be some place which imparts the necessary higher technical instruction, and hence there should be a Chair of Naval Architecture at the University of Sydney.

Instruction in scientific management, organisation, costs, wages, systems, etc., was imperatively necessary. Hitherto this has been very largely neglected, with sad results from the lack of this knowledge by men in responsible positions.

It was desirable that the Naval Architect, the Naval Engineer, and the Electrical Engineer in a minor degree, should have a sound knowledge in the other special work. The French system, where the Naval Architect and Naval Engineer are combined in one man, was not desirable, as no man has the time to be a specialist in both capacities.

Mr. C. T. STEPHENS, B.E., Assoc.M.Inst.C.E., said that, as one of last century's graduates, he received very little practical training at the University. It was hard to say how the students were to get practical training at the University unless they were to specialise. The best experience was to be got as a timekeeper on a big job, as most of the work going on would be seen. Surveying could not be fully taught at a University. Practical training on leaving school had the objection that the student might get out of the habit of studying, and so be greatly handicapped in going on with the deferred University work.

Public Works Departments did not at present provide all-round experience. The Roads Board of Victoria was an exception. Their pupils did tracing and preliminary office work, and under-supervising engineers assisted in the survey and preparation of plans and specifications, and the construction of the work for which the plans were prepared. The pupils so trained, though of limited scope of experience, would likely make better shire engineers than University trained men. State departments should follow a similar system of training.

Mr. J. J. C. BRADFIELD, M.E., M.I.C.E. (Chief Engineer, Metropolitan Railway Construction), said that Mr. Poole should be congratulated on the excellent address. Mr. Poole, of all our graduates, was (by unique past experience) specially qualified to write such an address.

As the first engineering graduate from this University to take up work in Queensland, he (Mr. Bradfield) remembered well the hesitancy there was to accept the fact that a University could train an engineer.

As the success of engineers depends mainly on themselves, their University training should be general. No attempt should

be made to specialise: to expect grey heads on green shoulders is to ask too much of the student.

As a class, Professors and Lecturers have not the necessary knowledge and experience to inculcate practical business methods into their students. Engineers might be excellent from the point of view of design and method of carrying out work, but if they had not the capacity to handle men and get work done economically, they might be outclassed by less competent men.

Teachers should not only know the theory, but should have been engaged (outside a University) in the practice of that theory for some years; in order to see things in their true proportion, to be able to sift the chaff from the corn, and to turn out well-trained men. The success or otherwise of students depends mainly on themselves. The headmaster of the North Ipswich Public School, which he (Mr. Bradfield) attended over 30 years ago, used to impress on the pupils that there were only two classes of men in this world—donkeys and donkey-drivers—and that it rested with themselves to which they were to belong.

With regard to graduates, he had helped to better their prospects in the Government service.

Last year a system was elaborated which aimed at giving every trained man—whether in the workshops, the field, or the University—better opportunities. The University man with a degree was exempt from all further examination. The intention was to bring the Public Service, the Harbour Trust, Water Board, Railway Department, and other bodies into line, to standardise (as far as possible) the qualifications of the engineering profession, and insist that in all appointments the standard should be maintained. Having obtained this in New South Wales, the formation of an Australian Society of Engineers, embracing Civil, Mechanical and Electrical, would be practicable, and would ensure that all engineers practising in Australia had at least passed through a pre-determined course of training.

When such a state of affairs exists, the engineering profession will be on a somewhat similar status to the medical profession, and will be able to command higher emoluments for work performed.

A brief outline of the scheme agreed to last year by the Public Service Board is as follows, but the salaries cannot be published:—

DEPARTMENT OF PUBLIC WORKS, N.S.W.

.....Branch.

Chief Engineer.

Deputy Chief Engineer.

Office Staff.	Field Staff.
Principal Designing Engineer.	Female Tracers.
Designing Engineers.	Inspecting Engineers.
Engineering Draftsmen, 1st Grade.	Supervising Engineers, 1st Grade
Engineering Draftsmen, 2nd Grade.	Supervising Engineers, 2nd Grade
Cadets.	Field Assistants, 1st Grade.
	Field Assistants, 2nd Grade.

Qualifications of Engineering Draftsmen and Engineers.

Female Tracers.—Shall enter the Department by examination as at present.

Engineering Draftsmen, Second Grade.—Shall have completed the Departmental Cadet Course or similar course elsewhere, or shall have served an apprenticeship in workshops or field of four years, and qualified for ordinary drafting work by completing the drafting course at the Technical College or similar institutions, and shall be capable of passing, or shall have passed an examination of standard equal to that set for student members of the Institute of Civil Engineers.

Engineering Draftsmen, First Grade.—Shall have been promoted from Second Grade Draftsmen; shall hold a University degree in Engineering, or shall be associate members of the Institute of Civil Engineers, the Institute of Mechanical Engineers, the Institute of Electrical Engineers, or be capable of passing the examination for Associate Membership of one of these Societies.

Designing Engineers.—Shall be promoted from First Grade Draftsmen or shall have similar qualifications.

Field Assistants, Second Grade.—To be cadets with not less than three years' office experience, transferred to the field, or officers whose training outside the Department gives them qualifications equal to a cadet of three years' standing. Such qualifications to be tested by examination.

Field Assistants, First Grade.—Shall have been promoted from Engineering Assistants, or shall be second-grade draftsmen transferred to the field, or have qualifications similar to these for a second-grade draftsman.

Supervising Engineers, Second Grade.—Shall be promoted from 1st Grade Field Assistants or 1st Grade Draftsmen, who have had the necessary field or workshop experience. They shall hold a University degree in Engineering, or shall be Associate Members of the Institute of Civil Engineers, the Institute of Mechanical Engineers, the Institute of Electrical Engineers, or be capable of passing the examination for Associate Membership of one of these Societies.

Supervising Engineers, First Grade.—Shall be promoted from 2nd Grade Supervising Engineers, or designing engineers who have had the necessary field or workshop experience.

Inspecting Engineers.—Shall be promoted from 1st Grade Supervising Engineers or principal designing engineers, receiving the maximum salary for their class, who have had workshop or field experience.

Mr. D. F. J. HARRICKS (President of the Engineering Association of N.S.W.) said that the Engineering Association had realised some time ago the necessity for a central reference library of technical literature, and were devoting considerable attention to the matter. They had decided to use the interest from the P. N. Russell bequest to the further strengthening of their library, which they hoped in the near future to make available to other institutions. The possibilities of greater fraternisation from the meeting of engineers of different associations in such a library would be good.

He much appreciated the frank way in which Mr. Poole had handled the subject of the address. The old controversy as to the relative values of the theoretical and practical training is disappearing, and it is becoming accepted that an intelligent system of sandwiching these two essential factors is what is wanted.

The apprenticeship question is being seriously tackled by the Government, and engineering associations should help to build up a good system of training. Means to enable the exceptional boy to emerge from the general class to become a leader in his profession should be provided by employers or by the Government. The education of young engineers should be broad rather than deep. The Chairman of the firm of Cammel Laird, Great Britain, recently declared that young men should be taught "how to live and how to learn," not how to earn a living.

Mr. A. D. CRAIG, B.E. (Lecturer in Surveying, Sydney University), had listened with interest to what had been said, and in particular to the remarks of Mr. Bradfield. The system now adopted by the Public Works Department appeared to be the best method possible for providing practical experience for men whose training had been mainly theoretical. Those