Education and Training in Engineering Colleges.

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More progress has been made in the first 60 years of the 20th century than in the previous 5,000 years. Startling inventions have resulted in tremendous increase in the use of power, in the use of communications and also in the improvement of the destructive power that man has developed to destory his ownself ultimately if good sense does not prevail. It may not be long before the man lands himself in the Moon. All this rapid and phenomenal development has been to a great extent made possible by the Engineers. The future development of any country is, no doubt, linked up with the training of its engineers. It is for this reason that our popular Government has directed its special attention towards the development of technical education in our country. The structure of technical education, as it has emerged out of Education Commission's report, is known to you all. Briefly stated, at the lowest level we shall have the technical training centres whrre skilled workmen will be trained in the various trades. Then we shall have the techicians who have to work as Supervisors, and are a connecting link between the artisans and the professional engineers. Our discussion today will centre round the eduеation and training of professional engineers.

The role of a professional engineer as distinct from the sphere of work of the technician, must be clearly understood. This will enable us to properly plan out training schemes for either of them. The education imparted to a professional engineer in the early stages is comparatively remote from industrial techniques, though references to practical applications may well be a feature of the teaching methods. Their studies will be academic in character and designed to stimulate and train the students' powers of abstract as well as to equip them with a sound knowledge of basic facts and methods. For the technician, on the other

hand, the teaching of science should be by a more descriptive and less abstract method and applications through the commoner techniques will come into the foreground from the earliest stages. It will thus be seen that the training of the professional engineer is quite different from that of the technician in its general aim although there may be some over-lapping at places.

Let us consider the condition in the present day Engineering Colleges and then think of the ways and means to improve the existing conditions. It must be realised that the most important factor in the complicated engineering education and training is the individual himself. He must have the basic qualities and natural aptitude to become an engineer. The first point which arises, therefore, is the method of selection of the new entrants in the college. The present method of admitting students on their academic merit alone is far from satisfactory. Admitting all types of funny eccentrics on their academic results into what is mainly a Practical Science is a great national loss. The academic position of a student merely indicates one of the many qualities that a student possesses, and therefore, to base the selection only on one quality irrespective of the large number of other qualities which are essential to make a successful engineer, is totally wrong. It will, therefore, be essential to adopt a more scientific and systematic method of selecting new entrants in the Engineering Colleges. Intelligence tests and aptitude tests must necessarily form a part of the system of testing students for admission.

Teaching Methods in the College.

Having selected the right type of boys, it is now the responsibility of the teachers to make a success of them. Their success even if they are of an outstanding quality does not necessarily rest with them alone. The general atmosphere in college, the teachers, and the extra-mural activities in the college can be of great assistance. All can contribute greatly to a rapid development of the overall personality of the young men and thus can help to turn out good engineers for the future progress of our country. Each factor involved in their proper training has a specific responsibility. The college must provide a free friendly atmosphere. The teachers should be efficient, sympathetic, helpful and firm. Extra-mural activities should be selected so as to accelerate the proper development of the overall personality of the young men.

The most important factor is the teaching done at the college. No engineering progress can be derived from a stereo-typed repetitive teaching of standardised engineering subject matter. This type of teaching has been defined as a way of imparting knowledge which passes from the

notes of the teacher to the note book of the student without passing through the brain of the either. A genuine engineering spirit, a desire for learning and growth can be imparted to students only by enthusiastic teachers inspired by their own studies and projects for developing and disclosing new knowledge in the profession. The lecture type teaching should be minimised and a more active participation of the students should be encouraged in the class teaching. In other words, the students should be encouraged to develop their own knowledge with their own personal efforts and the teachers should provide the necessary guidance and lend a helping hand wherever required. Tutorial system should be introduced on a more dynamic and live basis so that the teachers know about the working progress of the students in their group and are able to refer their students to another teacher if any student is found deficient in a particular subject. Introduction of weekly tests, monthly tests and home assignments is absolutely essential. Note taking in class rooms should be minimised and working sheets already prepared by the teacher giving a broad skeleton of the course work to be covered in a particular class meeting should be given in advance and the students should themselves come prepared to the class and then discuss their difficulties and problems with the teacher. Extensive use should be made of models, diagrams, charts and slides. The whole affair should be an active and live teacher-student participation rather than a stereo-typed lecture by the teacher which some boys take down faithfully and others who slip out of the class, may copy it afterwards, without feeling the least necessity of attending the class lecture. This attitude on the part of a student may be due to his gross negligence but quite often it is due to the defective teaching system. The student does not feel any poorer by not attending a particular class lecture. This, in a way, is a reflection on the teacher himself. Such active student participation in class work should be planned by the teacher and a regular record of his performance and grades maintained that he should find it very difficult to miss a class even if no attendance is marked in the class.

Degree Engineering Students and Practical Skill.

Most of the students enter the Engineering College after passing their F. Sc. examination and a considerable number among them are such who have never handled a wrench and quite a number of them do not even know as to how a brick is made. Students with such poor background should not be admitted to an engineering course but since such students are being admitted at present, something has got to be done to upgrade them. Such students must necessarily be provided greater familiarity with tools and must acquire some skill in their use. Before dealing with this problem, we should know just how competant a graduate

engineer must be in the use of tools. There can be no two opinions about the fact that an engineer should know how to use tools for the adjustment and setting up of measuring instruments but that he is not concerned with the use of tools for the commercial fabrication of material for production or construction. The engineer uses measuring instruments in order to collect technological data which he needs but it is rare that he himself makes the things he designs. The engineer must have an elementary facility with tools but it is not necessary for him to acquire a high degree of skill with tools. The engineer's competence with tools should always be inferior to the competence with tools of the artisan or the technician. The engineer, however, must understand manufacturing and construction processes. He must know how the machines and structures he design shall be made. It follows, therefore, that the typical engineer should know how to use hand tools and that he should be able to do accurate work with them but he should not waste his time acquiring superior skill with tools because he will normally very seldom apply this skill in his career. The students should therefore, be given experience in using tools in the college shops and laboratories during their college session and also during a portion of the summer vacations. Some sort of co-ordination may have to be developed with the industries to persuade them to employ students in summer periods to acquire some workshop experience. The students should be taught the use of tools by means of stimulating exercises. The exercises must have an apparant purpose of their own or at least the students must be made to feel that they are performing useful tasks, Furthermore, the exercises should be so designed that the students will learn other matters while they acquire competence with tools. Vacation exercises in the shops and laboratories should be arranged so that students help in re-conditioning or repairing the shop or laboratory machines. Industrial employment of the students should also be arranged as far as possible during summer vacations. When a group of students are assigned for summer training, a teacher should also be deputed to work there during vacations, who will thus not only be adding to his own practical experience but would also supervise the students' work. Weekend trips should be arranged to important engineering works and other constructions going on in the neighbourhood. It must, however, be borne in mind that a graduate engineer must not spend much time on acquiring skill with the tools but he must be taught the basic engineering sciences to a high standard, especially Mathematics, Hydraulics, Structures, Thermo-dynamics and Electricity, more emphasis being laid on the subject of his speciality. A sound basic knowledge of Engineering Sciences to a high standard is absolutely essential for a Professional Engineer.

Examination system.

The present day examination system is very unsatisfactory. It is hardly necessary for me to go into detail of this matter as the issue has been so often discussed. More emphasis must be laid on the day-to-day work of the students and the cumulative effect of their performance should determine whether or not they qualify to go to the next stage. The Education Commission's Report has recommended a combination of the existing examination system and the one that advocates complete dependence on the day-to-day performance of the boy, which I believe, is a good beginning.

Post-graduate teaching and research work.

It is absolutely essential to initiate Post-graduate classes at the colleges. The post-graduate courses should consist partly of some advanced lecture work and partly of a research project. The teachers of the colleges should have their own research projects. This is absolutely essential if engineering education is to make satisfactory progress in Pakistan. As has already been pointed out, no engineering progress can be derived from stereo-typed repetitive teaching of standardised engineering subject-matter. A desire for learning and growth can be imparted to students only by enthusiastic teachers inspired by their own research projects for developing and disclosing new knowledge in their fields. I am quite aware that members of the teaching staff do wsth to undertake engineering research projects but have been prevented by lack of suitable assistance and necessary facilities. If the Engineering Colleges have to be active and live organizations, necessary facilities for research work to the staff members should be provided. Senior students of the degree courses should be attached with staff members and also with the post-graduate students for building and operating certain types of simpler research apparatus. They will thus not only be of assistance to the research workers but will themselves develop a linking for research work. Projects of applied research should be taken to begin with and later on basic research problems may also be tackled. There should be some sort of co-operation and co-ordination between the colleges and the industry. Both the colleges and the industry stand to benefit from an active relationship on research, as both are likely to be benefitted from research work on live problems in all branches of engineering and other fields in which the colleges may be engaged.

Further Training of Fresh Graduate Engineers.

An Engineering College can provide proper training for professional engineers upto the point at which industrial training begins. It can go further in the case of those trained for research work but it cannot turn out fully trained engineers of any type. This must be realised not only by the students themselves, but also by those who are to employ them after

graduation. The employers must realise that the students just after graduation, are merely trained to become engineers and that rest of the job is yet to be done. There is no direct teaching method that can do the entire job of developing the young engineer to a full professional status. It is only through good training, proper guidance and continuous encouragement that the graduate engineer can build up his professional status. The employer, therefore, has a responsibility in this respect and the colleges should not be blamed for not imparting the type of training which actually is not their sphere or responsibility. The college education is a journey and not a destination. There is much still to learn. It is for this reason that engineering firms in advanced countries, having fully realised this aspect of the young engineers' training, have set up very comprehensive and advanced post-graduate training organizations within the industry itself. It is, therefore, the responsibility of the industrialists of our country to ungrudgingly make whatever contributions they can in this direction. The B & R, Irrigation, Electricity, Water and Power Development Authority and other big engineering concerns must set up training organizations for fresh engineering graduates, so that they are introdued to the practice of engineering in a systematic manner and are not left to themselves in which case they will learn by making costly mistakes. It would be cheaper to set up training organizations than to let them learn in an expensive way.