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THE MAKING OF AN ENGINEER

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A professional engineer is an ideal blend of theory and practice. He combines in a single person the role of a scientist, a planner and a builder. But he does not attain this stature only by spending a few years at an engineering institution. Through his academic education, he acquires a broad and general appreciation of the engineering sciences and also gains some familiarity with the application of the scientific method and outlook to the analysis and solution of the engineering problems. But when is he ready to assume personal responsibility for research and development, design construction, manufacture, engineering management or even education of engineers? Attempt is made here to answer this question.

2. It may be mentioned at the very outset that, strictly speaking, even the theoretical education of an engineer is not complete when he has passed his final year examination. At an engineering institution, he is exposed to a very broad spectrum of knowledge in many disciplines and rarely gets an opportunity to specialise in any particular field belonging to his branch of engineering. This is, in a way, a blessing in disguise because it keeps several options open to him depending upon the market demand for his services. But then this deficiency in his education should be fully known to his potential employers who will have to arrange for more intensive knowledge of their own fields of interest.

3. The training of an engineer is carried out both within an educational institution and outside in an industrial or an engineering establishment. The practical training within the engineering course comprises workshop practice, laboratory exercise, design work and project thesis. The level and scope of this training depend upon the physical facilities available to the institution, the relations developed by it with the outside industrial organizations and the initiative and the practical experience of the teaching staff. The manner of training in the industry and the importance attached to it too vary from country to country.

4. In the continental European countries, it is obligatory upon the students to undergo practical training in industry during the course or at the end of their studies, before a degree is awarded. The manner and quantum

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of this training are usually agreed upon in advance between the engineering colleges and the relevant industry. This practical training combined with engineering education is considered sufficiently complete that an engineer can legally embark upon professional practice on the award of the degree.

5. In the United Kingdom, no specific requirements have been laid down for training in industry during the engineering studies or even afterwards. Moreover, the courses provided for the first degree cover mainly the fundamental sciences with only a minor emphasis on one branch of engineering without any attempt at specialization. Whille there is no legal restriction on a newly qualified engineer commencing independent practice, he is unlikely to be fully accepted as a professional engineer until he becomes a corporate member of one of the engineering Institutions or Societies. The young engineer, therefore, expects that his first appointment will be as a graduate trainee during which he will receive specialised training while engaged in industry for two to three years. Only then is he considered to be really qualified to practise on his own as a professional engineer.

6. In U.S.A., the position is similar to that in U.K. but in some of the states, a graduate engineer cannot start practice until he has been awarded a special diploma of Professional Engineer on the basis of an examination conducted by the State. Such an examination is designed to test the candidate's familiarity with the state regulations and codes.

7. In Pakistan, any person who has obtained a degree in engineering is eligible to start functioning as a professional engineer and there is neither any tradition nor any legal stipulation of prior experience in industry as a pre-requisite for the degree. This practice, unfortunately, generates a sense of satisfaction at the adequacy of the training that a graduate engineer has received at the engineering institution which has awarded him the degree with the result that, by and large, no conscious effort is made for his further training on an organized basis to bring it to a level which his position as a professional engineer demands. The tendency to freely import technological know-how from the developed countries acts as another disincentive to the proper training of our graduate engineers. In the case of the Public Works and several other Departments, a complaint is often voiced about the shortage of funds which prevents them from undertaking orderly and planned training of newly employed engineers. This complaint betrays, in fact, a distortion in the allocation of financial resources rather than their quantitative limitation and reflects an incorrect appreciation of the ultimate benefits of in-service training of the engineers. Apart from raising a demand for the creation of engineering academies, the professional engineering societies in Pakistan have not made

any concrete proposals for meeting this deficiency in the training of the graduate engineers.

8. The prevailing situation of inadequate and unorganized professional training of the engineers must be remedied if they have to be prepared to shoulder the responsibilities of which they are potentially capable. Concerted efforts in this direction can maximise their contribution to the process of accelerating the social and economic development of the country. Improvements must be sought in the quality not only of training imparted at the engineering colleges but also of the post-degree practical experience to be arranged in operational engineering establishments.

9. The practical training offered at the engineering colleges is through a final-year project work which, as stated earlier, could be a design exercise, an experimental investigation, construction of an experimental rig, a feasibility study or a minor research problem. Its utility can be increased manifold if the projects undertaken for study have a direct bearing on the economic problems faced by the country. It would greatly help a better choice of the topics from this point of view if the teachers of engineering colleges/universities are associated with the actual working of the industry and the engineering corporations or departments by appointing them as consultants and nominating them on the various committees on planning, development and design which may be set up from time to time. Such a relationship between the teaching community and our development organizations would not only ensure that the latest theories and techniques are brought to bear on the problems entrusted to the Committees but also provide a proper bias in the thinking of the professors concerned and therefore, lend realism to the guidance they would, in turn, offer to their students. For the same reasons, it would be most desirable if the facilities available to the teaching organizations are extended by allowing the engineering students access to the laboratories and research centres set up by Government or the public sector corporations dealing with engineering subjects. The libraries of the engineering colleges too need to be expanded so as to stock all non-classified reports and engineering memoranda prepared by and for the engineering ing organizations of the country.

10. The responsibility for training the young engineer is not commonly accepted by the managers of our industrial and engineering organizations. More often, managers are heard to complain that the educational institutions have not given to the graduate engineer all the practical training necessary to practise the profession of engineering. It is totally unrealistic to expect an engineering college/university to possess practical training facilities in the multifarious and diverse technologies that constitute a modern industrial economy. Industry and engineering establishments must, therefore, be made

to accept responsibility for the training of graduate engineers, as has been done in the developed countries, in their own interest, by viewing such expenditure on training as an investment that assures increase of productivity and provides safeguards against obsolescence of their technological processes and products. Legislative measures have been tried by some countries but the advantages of a voluntary effort based on proper publicity of the impact of such training can hardly be overstressed.

11. The training of the graduate engineer in industry must be carefully and systematically planned and supervised. The training programme must be built upon the young engineer's theoretical knowledge and fulfill certain requirements *viz.* (*i*) train the engineer in the specialised technology he has to practise; (*b*) acquaint him with the functions of the different units in the organizations; (*c*) familiarise him with the general policies of management, rules of administration, accounting procedures and the communication system. The large industrial organizations must each set up a department headed by education officers to supervise the training programme. For the smaller industrial firms, the professional societies and educational institutions have a role to play in planning and organizing satisfactory training programmes. Engineering academies can fill the bill for the government agencies engaged in engineering activities.

12. In the modern technological world, the new frontiers of knowledge are being pushed back so rapidly that the effectiveness of an engineer drops by about 50 percent in 7 years unless arrangements are made for his continuing education throughout his career. This need for continuing education can be met in several ways, such as special meetings of the professional societies, preparation of special educational issues of the engineering literature, tailor-made courses organized by universities and specialised institutes like the engineering academies. The Engineering Universities in Pakistan offer post-graduate courses which should be availed of by the young engineers with aptitude and ability in the areas of design and development research. For the other engineers, the courses to be offered by the university should aim at keeping them abreast of the latest technological developments in, for example, control system, operations, research systems, engineering, computer programming. These courses would not necessarily be of the type designed to give credit towards a post-graduate for the practising engineer. Collaboration between the engineering academies and the engineering universities in this matter could be most fruitful.

13. The training in administration and engineering management should not be overlooked to enable the engineers to fill up higher positions of executive

and policy-making responsibility for which they as a class are better suited generally than the persons with non-engineering background. There are many organizations and institutes offering management courses in the country and advantages should be taken of them. However, the type of management training to be provided must take account of the responsibilities which the engineer concerned is required to shoulder later on. This training must lay a comparatively greater stress on case studies approach.

14. Engineers are one of the greatest assets that a country can have. Any attention paid to their proper training and extending to them facilities for broadening their grasp of practical problems will pay rich dividends. Shortage of resources should not stand in the way as the returns would be much larger in comparison to the small investments required in this venture. A change in attitude on to the entire question is all that is required.