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Industrially and technologically, Pakistan is still not completely out of the initial stage of its development. It has still to become an economically self-sufficient nation capable of providing a rising standard of living for its growing population in terms of a greater abundance of better and cheaper food, clothing and shelter, of better and more efficient transportation, utilities and services of all those things which spell contentment and well-being. To do this, in turn, means increased reliance on its own resources and freedom from dependence on imported goods, which do not of themselves increase a nation's wealth. There is one way ; and one way only, for the country to generate wealth in our soil, our water and the products of our land and by discovering and developing processess for utilizing those materials and resources to the full. Science and Technology have made such rapid strides during the present age that, before long, man will discover yet further riches of power and products from sun, sand and sea water. It would be necessary for the Pakistan scientists and engineers to develop technologies to exploit the power and wealth of those agencies. The locating, exploiting and processing of our natural wealth are engineering functions, and our success achieving self-sufficiency will be largely a measure of our success in developing an engineering education which meets this great challenge.

Gentlemen, Pakistan is known to possess a vast manpower and is rich in a great variety of raw materials. Both the human and natural resources remain largely unexploited. This situation, therefore, calls for producing and mobilising the high-quality engineers and technicians who are fully capable of handling projects of national importance designed to achieve economic development and prosperity. Why do we need engineers and technologists ? A glance through the 4th Five Year Plan of Pakistan shows that atleast 60% of the total allocation on development relates to the works which engineers and technologists alone can handle.

Contrary to the needs of the country, however, Pakistan has been producing simple graduates in large proportions who have neither the technical know-how nor the skill to be of much use to the country. The present Goverment's Education Policy document points out that more than sixty percent or our University graduates being produced today belong to this category. Can Pakistan really afford such a wastage of manpower in view of some of the established facts in the more advanced and developed countries ? Who is not familiar with the rapid progress of Japan ? One of the main reasons of her rapid develoment in the large-scale employment and utilization of its trained engineers and technical personnel. In America it is a firmly-held belief that industrial and technological organizations manned by engineers almost invariably show more progress than otherwise. So why should Pakistan go on producing graduates who ultimately have to become a liability for the Government and the Society ?

QUALITY OF ENGINEERING EDUCATION

Gentlemen, whenever there are needs to be met, there are problems associated with it and when a solution to these problems is sought ; it gives rise to additional needs. Engineering education is no exception to this. However, let me begin by emphasising a few elementary but fundamental ideas regarding engineering education. First there ought to be a continued and uncompromising emphasis on the high quality of educational experience to which the student is exposed. Our commitments as human beings and as educationists and engineers spur us to do the finest job we can in helping and inspiring young people to grow and develop. Anything less seems unworthy.

Secondly, in any country, the important decisions concerning its educational programmes 'can' and 'should' be made by its own nationals. The 'should' signifies the growing recognition of the sovereign right of a people to be the final judges in their own affairs. Education seems, in many of its important aspects, particularly susceptible to and dependent upon the culture in which it occurs. Hence the 'can' affirms that knowledgeable and wise decisions can be made only through a profound awareness of the character, temper and traditions of the people. Pakistan has been rather unlucky in this respect in the past. At the time of independence there was an acute shortage of experienced and trained technical personnel and the few institutions impart-

ing engineering education were very poorly equipped. The country was, therefore, dependent upon foreign technical assistance both in terms of men and materials. As the time passed, this dependence on foreign countries was reduced but not wholly eliminated. An end had to be put to this practice and I sincerely congratulate the present Government for putting maximum reliance on the engineering talent available in Pakistan and assigning to it some of the top jobs of national and international importance.

Lastly the total programme in engineering education at all levels should have relevance and be responsive to the needs of the country. Three aspects of relevance seem worth particular attention. Let us look at each of these in turn.

ROLES OF TECHNICIANS AND ENGINEERING AIDES

The first aspect concerns the relative emphasis on the various levels of engineering education. Through-out the world in general and in a developing country like Pakistan in particular, the need for engineering technicians is acute, much greater than the need for professional engineers. The trouble is that everyone wants the prestige of a College or University degree even though his aptitudes and abilities are much better suited to the technicians' role. One of our great problems in engineering education, therefore, is to help prospective students fit their aspirations better to their aptitudes. Good counselling by well-informed people at the secondary school level can do a great deal to help students in self-assessment and in planning their areas on a sound and realistic basis. Equally important is the promotion of understanding among the public of the nature, opportunities, rewards and satisfaction available in the work of engineering aides and technicians. I realise that changing the widely-held popular notions and values is a difficult task but the urgent need for many more able technicians demands our best efforts. With this object in view, the Engineering University at Lahore has taken upon itself the responsibility of organising the Bachelor of Technology courses for the diploma holders from our Polytechnics. The syllabi of these courses will be proposed by the University and the examinations will also be conducted by it. It is hoped that this programme will provide more scientific insight to the students completing their education at the polytechnic Institutes.

PLANNING FOR FUTURE :

The second aspect of relevance relates to timing. Too often, the education of engineers for their utilization, a decade in the future is better suited to the needs of a decade in the past. Suppose we establish today an undergraduate programme in engineering. Before the students graduate from such a programme, five to eight years will have passed. But this is not all. Too often the experienced engineer and even the engineering educator thinks of the needs of the field and especially of the education required to meet these needs in terms, not of today's engineering but of his own experience which may be outdated by ten to twenty years. Thus we tend to fall into the trap of designing the education of students, who will begin his work in the 70's, on the basis of engineering know-how and practice of the 50's. A simple but effective way of obviating such a situation is to keep reviving the curricular of courses at the engineering institutions so as to enable our graduates to remain abreast with the rapid pace of advancement in tne technical knowledge. Also, a regular and unrestricted inflow of the latest books and research journals is an essential requirement for this and it is a matter of great satisfaction that the present Government is doing all it can to remove the shortage of the books and journals on engineering by waiving off the copyright of the Publishers.

FACILITIES FOR RESEARCH AND ITS ACCOUNTABILITY

The third aspect of relevance is of special importance to a developing country like Pakistan. A Professor who has earned his doctorate in an atmosphere of advanced science and technology naturally wants to continue his efforts in the same field when he returns home to a different level of technology. He may for example have fallen in love with research in nuclear physics or with some exotic aspect of space sciences. He may, therefore, find it distasteful or even difficult to attack some of the fundamental problems in Pakistan like transportation, communication, agriculture or basic industry. However, if his advanced training and education are really good, they would have given him that most valuable skill—the ability to tackle an entirely new problem successfully and to find it fully as challenging and exciting as his specialized field. Those responsible for education and for support of research and development surely have the power as well as the duty to provide able young graduates and Ph.D's with attractive incentives to tackle vigorously the pressing problems of his own country. Both moral and material inducement should be used to

encourage creative work by the ablest people on vital and immediate problems of our society. Encouragement to research must always be accompanied by accountability. It is rather unfortunate that apart from the teaching institutions where research and creative work are a part of the education system, there are very few research organisations or industrial concerns which give due thought to producing something new—something more feasible, more economical and more suited to the needs of Pakistan. I am convinced that certain amount of 'taking to task' will be required before things really begin to happen.

OBJECTIVES OF ENGINEERING EDUCATION

Let me now turn to the question ; what are the objectives of engineering education. The general answer is, to prepare students to practice the profession usefully and competently. How can we best prepare students for these future responsibilities ? As teachers we, therefore, ask, what do the engineering students need to learn to contribute directly to the development of Pakistan, to be relevant to the needs of the country. The obvious first answer is that they need competence in certain kinds of subject matter. The second, and I believe much more important, is the acquisition of an engineer's pragmatic and problem-solving attitude of mind directed towards producing results.

In the subject matter, stated briefly, we ask of the engineering student reasonable understanding of and performance in the sciences, the engineering sciences and engineering technology. Equally important is the interest of the engineering student in experiences which lie outside science, pure and applied and which I would like to call General Education. May I propose, as worthy for our consideration, the idea that the engineer, if he is to serve his society, his profession and his country well, should be an educated man. By an educated man, I mean one with appreciation for and at least some knowledge of the important features of his own culture and preferably other cultures as well. Today in the vast area of interaction between human beings and between diverse societies and culture, the engineer is playing an increasing role and to my mind any engineering education would be deficient that fails to expose the students to some of the humanities and social sciences and the modes of thought peculiar to them. Particularly significant for the engineer is some understanding of the impact of science and engineering on economic, social and political life of societies. Some understanding of the effects of the scientific and technological explosion in the Western World can give an insight into what may happen in Pakistan

tomorrow which is now going through the earlier stages of technological revolution. Our engineers can benefit from the mistakes that have been made elsewhere and indeed try to avoid at least some of them entirely. I refer to such areas as the material responsibilities of labour and industry, their regulation and control by Government, the wise use of natural resources, the disrupting as well as the beneficial effects of industrial development on society, and especially the ways to maximise, the beneficial effects while minimising the disrupting effects. All of these are, it seems to me, matters with which the responsible engineer must be concerned professionally. Not to be concerned with them is to lower his standing and influence as an engineer and as a responsible member of society.

ENGINEERS AS CREATIVE THINKERS :

I return now to the second objective of engineering education—learning to think and act as an engineer. Here is where the greatest responsibility of the teacher lies and where the teacher faces his biggest challenge.

Two characteristics of engineers seem to me of prime importance in considering how we can help students to develop skill in thinking and acting as engineers. First the engineer's primary role is to produce something new-something not done before. Second an engineer maintains his competence only through a life of continuing study. Both of these characteristics of engineers, producing something new and keeping up to date are active, creative processes above and beyond factual knowledge which is pre-supposed.

Contributing to the development of creative productivity are a variety of educational activities. These would include, for example, problem-solving working up from simple ones to those demanding intense mental struggle, projects in the laboratory directed toward solving some new even though minor problem ; small research problems and design problems. Each of these in its way can develop what we may call "mental muscle, coordination and skill". Coupled with these theoretical educational exercises within the campus, the students ought to be provided with opportunities to see for themselves the 'engineering in operation'. Engineering institutions in Pakistan, by and large, do not have all the industrial equipment to afford adequate practical experience. Conseqnently training of students has been suffering from an incompleteness and unbalance. Only a coordinated effort of the engineering institutions and various industrial organlzations can improve this situation. It is only when education is patterned by good coordination of theoretical knowledge and practical training that our

engineering graduates can be equal to the enormous national responsibilities. I am glad to say that Engineering University, Lahore, has envisaged a 'Training with Industries' scheme and during the current summer vacations, many students of third and final years of different engineering departments are acquiring invaluable practical and field experience.

Let us now consider the second characteristic of an engineer, namely, the requirement that he continually updates his competence. If an engineer is to remain useful, such updating is vital. Today it is often said that in engineering the half-life of the usefulness of much of engineering knowledge is ten to fifteen years. In all fields so many new concepts, methods and materials continually come into being that the engineer who does not develop competence in the new areas is banned from participation in them. In order to avoid stagnation of the engineering talent already available in Pakistan, we at the Engineering University, have been making constant efforts to revise our courses regularly and to offer the most advanced syllabus to our students. The revision of the existing courses must always be supplemented by introducing new subjects as demanded by the needs of the day. I may go even this far in saying that no engineering education is complete which does not feed its engineers with information on fields like System Analysis, Operational Research, Economics/ Personnel Management, Work-Study Techniques and Computer Science. Any engineer who feels at home with these subjects will never fall prey to the routines of obsolete engineering practices now prevalent in Pakistan. I am happy to announce here that the Engineering University has felt the importance of dissemination of such information and has already started offering courses of this nature to its students. In addition to this, short-term refresher courses are also arranged for practicing engineers to acquaint them with the recent developments in their respective fields. However, I feel that the organizations employing engineers should show more concern over the updating of technical knowledge of their staff. They ought to provide facilities to their engineers to join our post-graduate courses on the "pay-and-learn" basis. This, I believe, will have a direct bearing on the development of Pakistan, because on the one hand, latest information will be imparted to the engineers joining the post-graduate classes and, on the other, the reserach projects assigned to them will be on the problems faced by Pakistan's own industry.

The implications of all this are even more important for the teacher than for

the practicing engineer. For it seems self-evident that only the teacher who continues to learn actively himself can help his students to develop this passion and inspire them with the continuing desire to learn.

CONGENIAL ATMOSPHERE VITAL

Gentlemen, may I state here that to have able students and able faculty in an engineering institution is not enough to produce competent engineers. A congenial atmosphere at the University campus, close and friendly relations between the teachers and the taught and better facilities in the hostels are some of the vital factors which need particular attention. It may be pertinent here to point out that since independence our educational system has been subjected to paralysing tensions between the demands for quality and the demands for quantity. There has been and continues to be, a phenomenal rise in the educational population of the country at all levels. Invariably the increase in essential facilities has been far outstripped by the increase in number of students. This has meant woeful shortage library or laboratory facilities, of classrooms, of teachers—fact of all that goes into maintaining quality of education. It has also perforce brought on the campuses large sections of both students and teachers who lack abilities or attitudes essential for higher learning. Educational institutions, in most cases, are caving in under the sheer pressure of numbers. And the better part of the time and energies of teachers and administrators is consumed in coping with these pressures rather than attending to requirements of quality. Obviously an urgent national need is to find a feasible balance between educational demands and educational resources of our society. The present Government, it is gratifying to observe, is making a break-through in this direction by, on the one hand, increasing immensely the resources allocated to education, and, on the other, by providing trade and profession-oriented education at the school and pre-university levels. Of special consideration is the present system of examination which has been the bane of our educational system. The necessity of revising it was recognised long time ago but no concrete step has been taken so far. Now the time is ripe to concentrate upon the problem for some feasible solution. We at the Engineering University are deliberating on the system of internal evaluation of the progress of the students. This, in some respects, is close to but not identical with the semester system now in vogue in the more advanced technical universities. We hope that the new system that we

are endeavouring to design and implement would provide incentive to the students for genuine learning and development of critical and creative faculties, rather than more cramming ; would ensure a closer and stimulating intellectual companionship between the teacher and the taught ; and would have built-in arrangement for more reliable self assessment, both on the part of the students and the teachers.

Gentlemen, I feel I have taken a lot of your time already, so I will end by saying just this that the countries which dominate the world scene have always had the abundance of honest and dedicated engineers in their soils.

I thank you.