

Revamping Engineering Education

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Abstract

Engineer's responsibility in fulfilling the requirements of human society, has increased by many folds during the current century. In recent years, additional responsibilities towards conservation of resources, development of substitutes for rare materials and management of wastes and environment, have also been assigned to him. In this context, reforming engineering education in order to produce new generation of engineers, has been felt very essential. This can be greatly achieved by reorganising the courses of studies, adopting more effective and application oriented system of teaching, making aptitude assessments and developing better evaluation processes. These efforts can be further strengthened by implementing international partnership in engineering education. Sharing the knowledge and expertise will benefit both the developed and developing nations while saving the 'good earth'. A modest beginning in this direction can be made on a bilateral level.

Introduction

Human civilization has developed progressively mainly with the application of scientific knowledge through engineering skill and perfection. To meet the growing demands of the increasing population on this earth, engineers in different disciplines are put in to the job for developing various types of industries, roads, transport and other communication systems, generation of power from different possible sources and making provisions for the supply of essential items like building materials, food and food products, drinking water etc. However, in the process of rapid industrial development and urbanisation, depletion of most of the natural resources including oil, coal, ores and minerals, forest etc. are taking place at a very fast rate and at the same time, the environmental pollution has started threatening the very existence of the human-beings on this

earth. In this critical situation, the responsibilities of the engineer have further increased. Besides providing the necessities of the human society, he has to now take the additional burden to find out ways and means to judiciously utilize and conserve the fast depleting natural resources and also to tackle the environmental pollution problems. In this context, a fresh look to our system of engineering education, needs to be given in order to produce the next generation of engineers, who can confidently meet the challenges posed today to the human society and the earth's environment.

Present Situation

During the last three to four decades, all over the world, there has been an increasing demand for engineers and technologists in different areas of human activities including newer areas like electronics, computer technology, nuclear energy, space programme, etc. The requirements of engineers have been comparatively more in the developing countries because of faster rate of industrialization and also due to rapid urbanisation. In order to provide technical personnel for all these, a large number of engineering schools and colleges, both in government and private sectors have come up in recent years. In most cases, due to lack of adequate teaching and allied infrastructural facilities and dearth of well trained teachers, the standard of engineering education has been found to be deteriorating in many parts of the world. In most cases, the courses of studies as well as the method of teaching, are found to be very out dated. In certain cases, it is observed that the engineer, after completion of his courses of studies, does not possess adequate practical experience in his area of specialisation and also the required background in some of the allied areas. Further, due to lack of proper guidance and suitable teaching programme, he fails to be analytical and innovative. Due to insufficient knowledge on the recent advances made in his area of specialisation, the young engineer finds it difficult to work

in a team, particularly in a multinational project. These stand very much in his way to plan and execute field projects successfully.

Scope for Improvements

The above mentioned situation in general, prevailing in the present system of engineering education is directly or indirectly due to the flaws existing in our courses of studies, the teaching system and the methods of evaluation. Therefore, in these areas, some reforms and improvements are very necessary.

1. Courses of studies:

Due to various developments taking place in different areas of science and technology, the engineering disciplines in the educational institutions should modify and recast the courses of studies time to time, in order to meet the needs of the human society. In the academic programme, besides giving due importance for imparting sufficient basic knowledge in the allied disciplines, enough stress should be given on certain important areas like resource conservation, substitution and waste management, in their respective disciplines. At all levels of engineering education, the student should have the required knowledge and training in the areas like quality control and environmental protection. The students should be exposed to various modern techniques, equipments and analysis facilities. These will greatly help in developing his skill and efficiency in handling various assignments in a shorter period in his profession.

For an engineer, the courses of studies should be such that, he should be able to put the theory in to practice in a proper manner. This can be achieved by adopting 'sandwich courses' of studies where theory is blended proportionately with practice. This sandwich system of education will bring the university and the industry closer. In this system, the total study period can be proportionately divided in to classroom studies and field trainings. In this system, the student besides getting more applied education, the industry as well as the educational institution, would derive a lot of benefits. During this period, the industry besides getting the technical services of the student, can get an opportunity to asses him properly for possible future employment. In addition, during this process, the teaching staff of the university and the engineers in the industry can work effectively on certain projects of mutual interest in a team, by involving the students fully.

2. Teaching system:

Like the urgency in reforming the curriculum of studies, it is also equally important to bring various improvements in the teaching system. The teaching method should be reviewed periodically. The teaching programme in general should be such that the student can be trained to be more analytical, inovative and productive in his profession. Engineering teaching in the classroom should be done in a more illustrative manner and can be made further interesting to the student if it is aided by models, samples, slides, movies, etc. Particularly, at the entrance level, the student can be better motivated and become more interested if the subject is taught by experienced professors rather than those freshers in the profession.

Every theoretical topic taught, should be followed by solution of some related problems so that the student understands better and becomes capable for the application of the concerned theory. For example, the important topics like thermodynamics and kinetics or the mathematical modelling taught with solution of certain practical problems, can be more interesting and useful rather than being abstract and dry to the student.

Similarly, in the practical class, the experiments to be conducted by the student, should be carefully selected and programmed, so that he applies his theoretical knowledge and learns more with pleasure. For example, a mineral engineering student when conducts experiments on beneficiation of an ore by flotation, he should apply his theoretical knowledge to conduct the experiments and should learn the techniques for utilising his results. Based on this laboratory scale studies, he should be able to develop a tentative flowsheet, calculate the economics of the proposed process, and also learn to identify the related environmental problems and find out their possible solutions. The student in engineering field, should also get enough scope to be exposed to case studies. With these background, when he goes to work in a mineral processing industry, he will be more confident and also productive.

These are a few examples of many possible orientations needed in our present style of imparting engineering education. In order to implement various reforms in the teaching programme, the students to teachers ratio should not exceed about ten to one, particularly in the undergraduate level. This will help the teacher to closely interact with the students and to know the apitude of each of the students.

3. Proper Evaluation:

The proper evaluation of the student's knowledge and engineering skill, is also an important aspect of good engineering education. The evaluation should be done in a continuous and objective manner so that the student is not strained rather gets interested and takes initiative to learn more about the subject taught. Due to advancement of

knowledge, the amount of study materials in a particular discipline as well as those in the inter-disciplinary areas are increasing. Therefore, except certain basic subjects, the student should be allowed for 'open book examination' as far as possible. In this type of evaluation system, the required answers should be brief, objective and more problem - solution oriented.

In the sandwich type of teaching programme, it would be much easier to assess the students theoretical as well as practical abilities. However, in general, the evaluation procedure should be aimed at testing the three important aspects namely, (a) basic knowledge and understanding of the subject, (b) analytical approach and (c) application orientation.

The above mentioned approach towards revamping the engineering education with respect to the courses of studies, the teaching system and the evaluation procedure are a few broad outlines of a detail scheme. However, in order to maintain an uniform national standard, an universal programme should be followed in these three areas, by all the educational institutions in the country. This will go a long way in improving the standard of the engineering education and also facilitating proper assessments and recruitment of the new engineers in various industrial and other engineering sectors.

International Partnership

We are practically at the door step of the Twenty First Century. The developed countries have almost reached the pick of the industrialisation. The developing nations are trying to pickup at a faster rate in this race. However, all are approaching 'the cross road' where the nations of the world should collectively choose the path of prosperity and coexistence, otherwise the acute resource scarcity and the environmental pollution will soon destroy the very foundation of human society. It is therefore, very essential for all the nations to plan and undertake some viable programmes to evade such an unfortunate situation. In this regard, one of the important steps is to initiate international partnership in engineering education in order to produce the new generation of engineers for meeting the challenges confronting us. Sharing the knowledge and expertise will benefit all the nations while saving this 'good earth'. By the way, most of the developing countries have got much more natural resources compared to many developed ones. In view of this, international partnership in improving the engineering education will benefit both the groups while sharing and conserving the natural resources, developing substitutes, utilising the engineering manpower and also fighting out the environmental pollution problems. In this regard, a world body like UNIDO may initiate a model

programme on international partnership in engineering education.

Bilateral Programme

However, a modest beginning in this direction, can be made on a bilateral level. As an example, such a programme can be initiated between countries like India and Brazil. Just like India, Brazil is endowed with rich mineral, forest, marine and agricultural resources. The aspirations of the peoples and the governments as well as the industrialisation programmes and projects are very similar in many respects for both the nations. In view of many common objectives and programmes, the technological cooperation between these two countries is expected to be more effective. This process can start with proper planning and implementation of programmes of mutual interest in different disciplines of engineering education. This will immensely help in speedy development of trained engineers in areas of interest for both the countries for proper utilisation and conservation of their resources. At different levels, there should be programmes for preparing courses of studies, exchange of students, organising short courses and training programmes in special areas for both students and teachers. Joint projects for the preparation of teaching materials including writing text books and also exchange of research materials and information, will be highly beneficial. Associating concerned industries of both the countries in various joint projects, the educational institutions as well as the industries will benefit to a great extent. However, in the whole process, the governments of India and Brazil should take initiative and set up an effective machinery to properly implement various joint programmes and projects. Such bilateral programmes should also be taken up by other nations.

Concluding Remarks

At the present time, the human society needs very much a new generation of highly trained engineers for fulfilling its needs while doing the needful to conserve the resources and also to save the environment of this planet.

To produce the new generation of engineers, it is felt essential to drastically modify the courses of studies as per the needs of the society, to bring radical reforms in the methods of teaching and to develop more effective evaluation systems and also the aptitude tests of the students. Every country should have an uniform national programme for revamping the engineering education so that nearly same standard is maintained in all the concerned educational institutions.

Another important step in this direction is to urgently initiate the programme of international partnership

in engineering education in the interest of both the developing and developed nations. The implementation of this vital programme can be carried out successfully under the auspices of an organisation like UNIDO. A modest beginning in this regard can be made on a bilateral level.