Recent Trends in Engineering Education

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INTRODUCTION

Over the years engineering education in Malaysia has progressed and seen several changes and adaptations. The driving force behind these changes has always been mainly due to the demand of the latest technological advances, which are always developing very rapidly. Furthermore current scientific and technical thinking is becoming very much inter-disciplinary and generally more environmentally conscious. The main objective of this paper is to pick out some of these changing trends and hazards with an attempt to manage these changes.

ENGINEERING EDUCATION

Malaysia is in the middle of her efforts in becoming an industrialised country within the next two decades. Proper planning for the orderly development of human assets is of vital importance in determining the success of these efforts and engineering education assumes an important role [1]. It is also the aspiration of the leadership that Malaysia becomes the hub of higher education including engineering in the region. Much efforts and funding by the government and the private sector have been allocated towards achieving this aspiration. In the past, many Malaysian students have been sent or have chosen to go to the United States, the United Kingdom, Australia and other countries all over the world for an education including engineering. The main reasons have been the limited places available locally, the need for state-of-the-art knowledge and the comparative affluence of some that makes an overseas education more affordable. The recent past has seen various cooperative arrangements like twinning and credit transfers to make overseas education more attractive [2]. There are, however, about seventeen public and four private universities and hundreds of colleges in the country presently which offer courses covering a variety of programmes including science and engineering as well as the arts and management and business courses. It is now much easier for students to secure places in engineering programmes locally.

ACCREDITATION

All engineers desiring to practise the profession are legally required to register with the Board of Engineers, Malaysia (BEM) either as Graduate Engineers or as Professional Engineers. The first step towards registration is for the candidate to possess an accredited basic engineering degree. The process of accreditation is under the purview of the Engineering Accreditation Council (EAC), which is represented by BEM, the Institution of Engineers, Malaysia (IEM), the Public Services Department (JPA), the National Accreditation Board (LAN), the Council of Engineering Deans and the Ministry of Higher Education. All institutes of higher learning (IPTs) wishing their engineering programmes to be accredited are to request the EAC to evaluate their programmes. Several factors are examined during the evaluation process. These include the general management and education policy of the institution, the curriculum, the academic facilities as well as facilities for co-curricular activities, the staff and students, and the QA/QC aspects.

CURRICULUM

One of the important factors examined by the evaluators in the evaluation process is the curriculum in terms of structure, scope, depth, etc. The current four-year format for local engineering programmes usually faces no problems in meeting the requirement of 120 total credits to graduate with a minimum of eighty credits of engineering subjects. The IPTs have quite a wide variety of subjects to offer to satisfy the remainder of the credit requirements. In practice, each programme usually contains more than the required total of 120 credits. The choice of supporting subjects is in one way or another influenced among others by the demands of the market and the perception of prospective employers towards the graduates of a particular programme. What then are the perceptions and the expectations of employers of graduates from a particular programme? For instance, can they communicate effectively – good oral presenters as well as good report writers in Bahasa Malaysia or in English or even fluent in a particular foreign language? Can they read and analyse the Profit and Loss account and the Balance Sheet of operating companies? Are they ethical? Do they understand basic management principles, and are they adept in ICT and conversant with common engineering software? Can they be thrown into the deep end of the work place and survive? Can they work in a group and generally contribute to the wealth creation of the company without too much extra post-graduate training? All these questions need to be answered and a curriculum developed and delivered in a manner in order that the final attributes of the graduates would be relevant to the needs and requirements of the market. Apart from acquiring the necessary knowledge, skills and competency of the particular discipline, the engineering graduate has to develop certain soft skills, which may have to be acquired not directly from the curriculum but from involvement in co-curricular activities. It might be instructive here to refer to the EAC Manual where these attributes such as the following are stated:

a) ability to acquire and apply knowledge of science and engineering fundamentals;
b) ability to communicate effectively, not only with engineers but also with the community at large;
c) in-depth technical competence in a specific engineering discipline;
d) ability to undertake problem identification, formulation and solution;
e) ability to utilise a systems approach to design and evaluate operational performance;
f) understanding of the principles of sustainable design and development;
g) understanding of professional and ethical responsibilities and commitment to them;
h) ability to function effectively as an individual and in a group with the capacity to be a leader or manager as well as an effective team member;
i) understanding of the social, cultural, global and environmental responsibilities of a professional engineer, and the need for sustainable development; and
j) expectation of the need to undertake lifelong learning, and possessing/acquiring the capacity to do so [3].

The IPTs must be sensitive to the state of marketability and employability of their graduates. They will endeavour to "dance to the ever-changing tune" as required by the industry as far as possible, but there are technical as well as financial constraints; and any new changes to a programme need at least five years to establish and bear fruit.

A noticeable trend that is slowly creeping nowadays is the apparent decline in the standard of mathematical skills among engineering undergraduates. If it is true to say that mathematics is the language of engineering then it would seem that engineering graduates are not speaking engineering very well nowadays. Can one imagine engineering without mathematics? There was a short scare recently when it was reported that it was possible for students to get an equivalent of an engineering qualification without ever taking mathematics as a subject in the examinations. Maybe there is now too much engineering software doing the necessary manipulations that engineers no longer need to slog and do any more tedious mathematics. It doesn't seem very long ago when every engineering undergraduate had to take Engineering Mathematics I, Engineering Mathematics II and so on. Now a student is offered Mathematics for Electrical Engineers, Mathematics for Chemical Engineers, Mathematics for Civil Engineers and other shades of mathematics to cater for the specialised requirements of each engineering discipline.

FACILITIES

Another important factor looked at during the evaluation process is the facilities, such as lecture halls and seminar rooms, the library and resource centre including computers and laboratories that are available. One of the trends that can be seen in relation to facilities is the seemingly reduced emphasis on laboratory work. In the early sixties, a Chemical Engineering programme at most of the leading universities in the United Kingdom required that undergraduates take supplementary subjects like Introduction to Electrical Engineering, Introduction to Mechanical Engineering, Strength of Materials, and Chemistry. The depth of coverage of these subjects varied from one university to another, but generally all of these subjects would have included laboratory work. In the early seventies, most technical subjects even at the local IPTs maintained laboratory work to complement each lectured subject. Now it is not uncommon to have engineering programmes offering laboratory work as a separate subject and not tied to any one individual subject. It can also be seen that the IEM/BEM graduate examinations do not require any laboratory work to be done by the candidates. This is perhaps a special case where the working engineering environment of the candidates is more real than any kind of laboratory work to be imposed. The IEM is fully conscious of this so much so that as one of the requirements of entry is that the candidate must be currently fully employed in the relevant industry of the candidate's discipline. It is also interesting to note that one of the questions (Q 15) from the current list of Code of Ethics questions in a Professional Interview reads, "With the rapid development in IT, would virtual laboratories be a good substitute for real ones in engineering? Elaborate on the merits and demerits of the issue." Perhaps the point is that there is a need to answer the basic question as to why do we need to have or what are the objectives of having laboratories in an engineering programme. Are the current methods effective in satisfying this need or achieving these objectives? Are there any other better or perhaps cheaper alternatives? It is a well-known fact that one of the reasons why a number of the private IPTs do not offer engineering courses is that it is costly to provide the necessary infrastructure, including laboratories, required by an engineering programme. Would a virtual laboratory be sufficient to achieve the objectives? Then again, can you imagine an engineering programme for civil, mechanical, electrical or chemical engineering without laboratories?

STAFF AND STUDENTS

As mentioned earlier, there are now more than twenty IPTs in the country and the majority of them have been established only fairly recently. This explosion in the number of IPTs means an increase in demand for appropriately qualified and experienced lecturers and support staff. The requirement of the EAC of a staff/student ratio of fifteen or better for engineering and a minimum of relevant teaching staff in the discipline for each programme of eight put a lot of pressure on the resources to be made available by the IPT. For a basic degree programme, the teaching staff must also possess at least a post-graduate qualification. A teaching staff must also be fairly active professionally and facilities must be provided to enable the person to conduct research work

and to publish the work in journals. There may be a need to look again into ways to optimise the utilisation of these limited assets. Cooperation among and integration of smaller operators may become advisable or necessary.

With the embrace of the meritocracy system, the standard of students entering the IPTs is generally higher. Many science students, however, choose to take up medicine, dentistry and the related medical and dental courses instead of having engineering courses as their first choices.

QUALITY ASSURANCE / QUALITY CONTROL

The trend towards more transparency in the examination process and less dependence on the final examinations is also evident. Increased course work and the open-book system have been introduced. The need for the External Examiner is still very much emphasised; and the requirement for a minimum period of Industrial Training is now made compulsory. It is interesting to note that one of the leading local private IPTs insist that their students undergo an extended period of Industrial Training, and this has been very well received by all including parents, prospective employers, as well as the students themselves. One is reminded of the UK 'sandwich' courses of the sixties and seventies; but then this approach was seen as not being so elegant and had a somewhat negative stigma about it. Along similar lines, there is another perception that is interesting to note. There is this perception that graduates from overseas somehow find it easier to secure a job when they return. So what seems to be the common underlying factors that determine this apparent greater degree of employability? Maybe it is confidence through exposure and independence in real life situations, and the need to possess keen survival instincts; there is greater opportunity for a student to experience them overseas.

The IPTs are also required now to have Industrial Advisors for their programmes. This is definitely a move in the right direction since these advisors will be able to give very useful inputs into the curriculum design and delivery, making it easier for engineering programmes to be more relevant to the industry. These same people will create the network for closer university-industry linkage which will lead to more collaboration among the parties.

OUTCOME-BASED EDUCATION

One of the more newly-introduced factors in the engineering programme evaluation process is the Outcome-based Education (OBE) approach. The IPT must be able to show evidence that it is fully committed to embrace the OBE approach and show progress towards this direction. There have been several lectures, workshops, seminars and discussions organised by several organisations on OBE. It is understood that this approach towards engineering education has been endorsed and blessed by the Ministry of Higher Education. What is the driving force behind the OBE approach to curriculum design? Is it the realisation that this approach is the one which will answer the dire need to satisfy one of the main stake-holders – the employers? Or is it business-driven giving rise to the aspiration to be a permanent signatory of the Washington Accord? The current permanent signatory countries to the accord are the United States, the United Kingdom, Canada, Ireland, Australia, New Zealand, South Africa, Hong Kong and Japan. It is definitely strategic for Malaysia to become a permanent signatory to the accord. It would mean that graduates from accredited engineering programmes in Malaysia are recognised by the other signatory countries as having the necessary qualification for possible employment as engineers in those countries without further examinations. This is a plus point towards the efforts in establishing Malaysia as the regional hub of engineering education. It is one of the conditions or requirements of the accord that in order to be signed onto the accord, the education system has to be adopting the OBE approach.

DIVERSITY OF DISCIPLINES

Another trend that is noticeable in engineering education is that the disciplines are becoming so diversified and specialised. This is all the more so for graduates coming back from the United States but local IPTs are also showing evidence of such a trend. So we see that concurrent with the rapid increase in the number of IPTs, there is also a rapid increase in the number of different programmes offered. We now have several programmes belonging to sub-sets and sub-sub-sets of the traditional disciplines of civil, mechanical, electrical and chemical engineering offered at the first degree level. There are, for example, biomedical engineering, mechatronics engineering, instrumentation and control engineering, to cite a few, offered by local IPTs to cater for the fast-expanding specialised fields of engineering. One still remembers the days when an IPT has to be really creative in coming up with names of programmes to be offered because there was a condition or understanding where a new programme cannot be offered by an IPT if there was one similar-named programme already being offered by and running at another IPT. The proverbial rose took up several interesting names to circumvent this condition, and these names have survived until today.

JOB MARKET

There are published reports which say that there are plenty of unemployed engineers around. There have also been several cases of companies applying for their foreign engineers to be given temporary registration as Professional Engineers to enable them to be engaged in projects in Malaysia. Have there been an over-production of engineers causing the unemployment situation or have there been production of the wrong type of engineers with not quite the right attributes thus affecting and reducing their employability and perpetuating the need for the temporary registration and renewals of foreign engineers? Some say engineering education is very good and it prepares the graduates not only to be

able to work in an engineering environment but it is also flexible enough to adapt to other types of work environments. While it is fairly easy for an engineering graduate to convert to non-engineering type of work, it is relatively much more difficult for non-engineering graduates to adapt and be effective in an engineering work environment. However, engineering education is very expensive and if over-production is actually planned and done on purpose then perhaps the production of more of the four basic disciplines of civil, mechanical, electrical and chemical engineering, where the degree of flexibility would be much higher, would be worth considering. But then again, the case of engineering graduate unemployment could also be due to personal preference and choosy engineers. The difference in take-home pay between engineers and sub-professionals is also a factor that influence the type of courses offered by an IPT. University colleges established to produce technologists see their role as having to go beyond just their original intentions, to get EAC accredited status in order that their graduates are also registerable with BEM.

CONCLUSION

Our engineering education system is in sync with the current trends and developments happening around the world and is seen to be sensitive to the changing demands of the market. Since it takes time to get a system properly in place and going, we have to look for the optimum approach with regards to curriculum content, installation of infrastructure, training of staff and the entire approach towards delivery and post-graduate training and tutelage. ■

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