Full Paper

Abstract

This paper describes the importance and significance of industrial engagement or placement for ensuring the engineering education standards are achieved and the role of industry to continue the industrial engagement from the view point of developing countries. Introducing policy by the university and government to support industrial engagement in developing countries is suggested. It is believed that through this publication, general awareness of standards of engineering education in developing countries will be created which might help plan a longer industrial training/engagement and industry based final year project.

Introduction

In developed countries, industry involvement with engineering education is a common approach for teaching and learning. For example in Australia, the John Holland Group has developed a strong relationship with Central Queensland University (CQUniversity) through their involvement in the university's engineering co-op program (Devenish et al., 2010). This program requires engineering students to undertake two paid, 6 months periods each, of work placement in their 3rd and 4th year study. John Holland is a consistent employer of CQUniversity.

But in most of the developing countries (such as Bangladesh, India, China), universities have little interaction with industries regarding students' placement in industry. In those developing countries, industry mainly interacts with engineering university for consultancy or evaluation of technical concepts. Generally industries are reluctant to disclose or discuss their practical/operational issues with universities. For ensuring engineering education standards are achieved, engineering education institutions should take initiative to engage industry through, for examples co-placement, developing industrial project for research, research seminar, workshops, project based learning, incorporation of students' evaluation, feedback and recommendation into curricula, etc (Devenish et. al., 2010). Moreover, students should be introduced to the concept of inherently safer design to maintain safety in industries (Perrin and Laurent, 2008).

In the developing countries, to provide quality engineering education, universities or educational institutions realises the importance of implementing practical engagement of final year engineering students into different engineering industries. In most of the developing countries it is a part of short training scheme and students used to attend the training scheme but there was no option to earn credit from this training. Nowadays, a long time practical engagement with industry, alternatively it is called industrial attachment/placement, is seen necessary as a requirement of the award of degree and students be given credit in their study program. In future a diverse engineering workforce will be needed, so they will need to have critical thinking and problem solving skills beyond those of previous generations (Sunthonkanokpong, 2011). For this reason, interaction with industries isneeded. In this paper the importance of industrial engagement for ensuring engineering education standards are achieved for developing countries is presented and discussed.

Challenges and Approaches

Today's engineers need more than just a sound technical background to be successful. It is very important to provide a real connection between theory and laboratory experiment (Stefanovic, 2013). In course of solving engineering problems they will need to interact effectively with people of various backgrounds, races, and religions. Therefore, engineering education must offer the students a compelling context for engineering design, a multi- disciplinary team experience, and enough time to learn and practice professional skills, personalized mentoring and exciting technical challenges. At present

engineering education in developing countries are facing many challenges in teaching and learning processes and approaches. Engineering education of the developing countries is always behind from the developed countries. Following issues/challenges can be noted for that;

- Lack of modern laboratory equipment
- Minimum engagement between industry and university
- No standard guideline for teaching in engineering education
- No initiative for professional development of academic staff
- Lack of postgraduate research
- Absence of quality assurance authority (Like AQF or TEQSA in Australia) in engineering education
- Lack of expertise in specific field
- Not maintaining proper process of accreditation of engineering degrees
- Institution of engineer's functional dilemma

The importance and significance of industrial engagement and revision of curricula for implementing project based learning, industrial engagement/training, incorporation of students' evaluation, feedback and recommendation into curricula, etc, are described and explained in detailed in this paper with the aim of addressing above noted issues.

Result and Discussion

There are several ways for improving the standard of engineering education in developing countries. Some of them are outlined below.

Revision of Curriculum

Engineering programs/courses should be designed in a way that graduates can survive with the challenges of technology change and can avail the opportunity globally. Like any programs, the engineering program must ensure that its course structure is responsive to market needs and students' demand (Chowdhury et al, 2008; Rasul, 2012). The curricula for engineering education in developing countries are not up to date, even not revised regularly to cater for industry needs due to lack of resources and limited linkages with developed countries like Australia (University Grant Commission (http://www.ugc.gov.bd); Bourne et al., 2005). The courses and programs need to be designed in such a way that it reflects the stage 1 competency (EA Stage 1 competency, RMIT 2010). The programs/courses should reflect issues such as below, amongst many;

- Understanding of the social, cultural, global and environmental responsibilities of the Professional engineer and the need to employ principles for sustainable development.
- Understanding of professional and ethical responsibilities and commitment to them.
- Ability to function effectively as an individual and in multi-disciplinary and multicultural teams, with the capacity to be a leader or manager as well as an effective team member.
- Ability to utilise a systems approach to complex problems and design and operational performance
- Ability to communicate effectively with engineering counterparts and the community at large
- Capacity for creativity and innovation, and proficiency in engineering design, ability to conduct an engineering project & understanding the business environment
- Capacity for lifelong learning and professional development & professional attitudes
- Graduates have an international perspective, and are global in outlook and competence
- Graduates should have an awareness of occupational health and safety issues.

Curriculum revision committee (CRC) should consist of both internal and external members. Internal members are generally academics of their own university and external members are from another university and highly experienced professionals from renowned industries (both public and private) and senior members of various professional organisations (such as Engineers Australia, Members of discipline based society, etc). For the revision of curriculum, a rigorous discussion is needed and the curriculum design of universities of developed countries should be considered for adaptation.

Project based learning and industry based final year thesis

Project based learning is relatively a recent concept of teaching and learning. This is a comprehensive instructional approach in which students are engaged in a sustained and cooperative way for research on a given project. Students acquire and apply new knowledge and find out possible solutions. Here teachers act as a facilitator to reach the goal. In developing countries, the engineering education system can adopt the project based learning method, which will build the students to be more creative and independent (Rasul, 2012).

In general, all final year engineering students need to complete a research project or thesis as a requirement of their degree. In a developing nation, most of the Engineering Universities are lagging behind in the use of this modern and sophisticated instrument for their final year projects and theses. There are many brilliant students who have innovative ideas and who sometimes are successful in stimulating their thoughts by undertaking research or using simulation software. However, due to the shortage of experimental facilities, those research findings cannot be validated and proposed for marketing. Most of the students complete their project using their own funding. In many cases, the project is the literature review type and only proposes ideas. In the earlier days, industries were reluctant to express their practical problems to a university, most probably due to having virtually no idea on the value of research and development (R&D) activities. Nowadays, fortunately, industries are familiar with engineering degree students due to improved communication between industry and universities through short industrial training and attachment. Final year projects should now be more related to the local industry's activities or problems, similar to what many of the Australian universities are doing. In this way both students and industry get benefits through exchanging thoughts with each other. Another advantage is that, after graduation, students could be employed in the same industry, as CQUniversity is having in their co-op program. Of course, they will be able to quickly grasp the operation of that industry. Therefore, choosing research projects more on applied topics focusing on local or national industry needs is recommended for developing countries.

Cultural interaction with developed countries

Culture and customs are part of human blood. They cannot be changed in a day or month. Some cultural fusions are needed with developed countries, especially in the sector of education, such as requiring that an education tour abroad be arranged from university as a part of their study program. In that case, parents cannot deny that and, moreover, students can acquaint themselves with other cultures which can enrich their knowledge as well as their attitude towards their engineering education. Different conferences or seminars can be arranged where students from everywhere can be welcomed cordially.

Practical visits to industry

Most of the undergraduate engineering courses deal with theory to solve practical problems. If we consider some specific courses like manufacturing processes or automobile engineering in our discussion, we found that both subjects explain theory and its applications differently. For example, manufacturing processes deals with various methods for production of different products and preparation or arrangement of things for final outputs. On the other hand, automobile engineering deals with the description of different parts and their function and drive system, etc. It is believed that it will be very easy to learn

the topics when students physically observe the model of related matter. The developing countries should arrange more short (i.e., a day or two) visits to local industries related to their current study, so that the learning and teaching would be more attractive and the students' learning process will be more interactive and joyful. Nowadays most of the engineering education systems implement real life onsite training as a mandatory requirement of the degree. The program is called industrial training/attachment. Final year students need to take onsite training in relevant industry placements. An example from Bangladesh is presented here for understanding the need for appropriate work placement or industrial engagement. In 2013, the final year students of the department of mechanical engineering of Chittagong University of Engineering and technology (CUET) each completed an industrial attachment for 2 weeks in nineteen different industrial organisations in Bangladesh. The number of students who participated in various industrial organisations for their industrial training program is shown in Figure 1.

Figure 2 shows the distribution of students in different categories of organisations/industries. About 10 different organisations were identified where students were placed. It can be seen from Figure 2 that the highest number of students were placed for industrial training purposes in production organisations and the lowest number in the energy sector. From this analysis, it can be concluded that, for a developing nation like Bangladesh, firstly a clear concept on how much workforce will be needed in future for a particular sector is needed, after that universities can train their graduates according to the demand in the respective sectors. Otherwise, there will be an imbalance of work force creating job uncertainty and will suffer from skilled workforce. Having said this, two weeks industrial training is not enough. An understanding should be developed within the policy/decision makers of the importance and significance of longer industrial training/placement.

In India at this moment industry placement is only opened for faculty. Student can manage industrial training by their own communication and no credit is added in the learning process (Strategic plan 2014- 2020, IIT Madras; Saeki and Imaizumi, 2013).

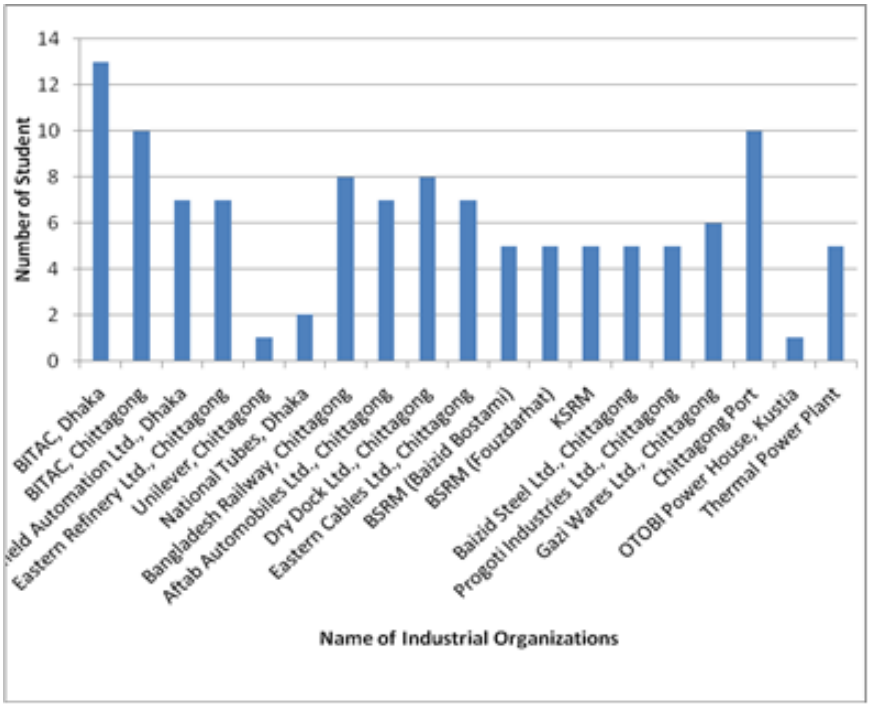

Figure 1: Industrial training of Mechanical students CUET 2013

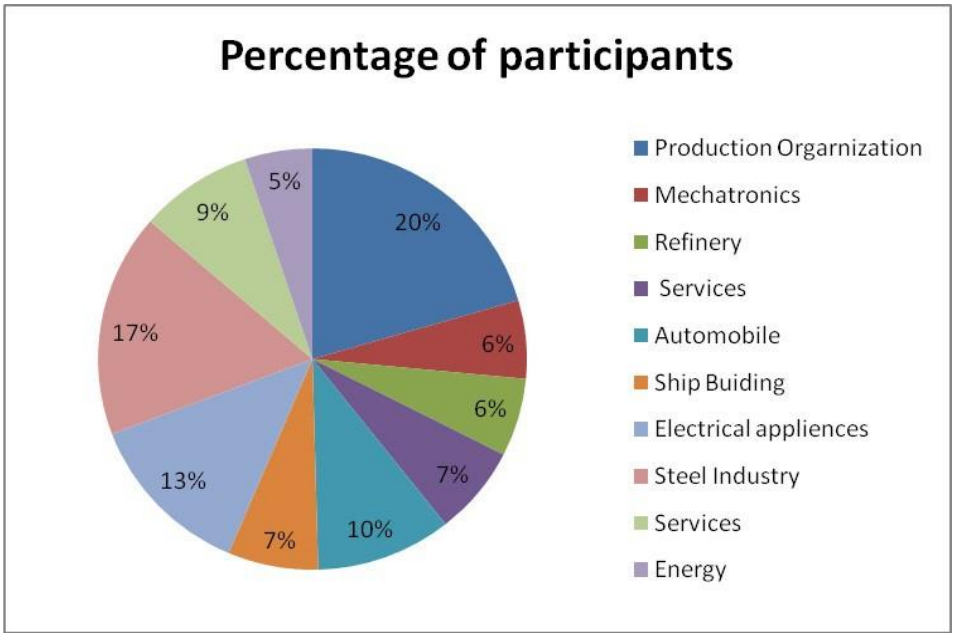

Figure 2: Distribution of students in different engineering sectors

Student evaluation and feedback

The teaching and learning environment is greatly influenced by a student evaluation and feedback process. Frequent student evaluation and adding their feedback into course improvement will make the learning process more informative and interactive. In developed nations it is widely applied in higher education, but in developing countries it is generally overlooked due to less freedom of students. The main reason is that, in developing countries, most of the public universities are run and funded by government and student tuition fees are negligible. But in developed countries like Australia, universities earn major revenue from student tuition fees, and, in this context, students are also

careful about their quality of education. The systems of higher education in developed countries provide periodic feedback from students and evaluate teacher's performance. Sometimes they invite industrial experts to deliver lectures for particular topics. In this way, the quality of engineering education can be significantly improved and can be maintained in developing countries.

Conclusions

Engineering education system in developing countries can be improved through collaboration between higher education institutions and industrial organizations. To achieve this, developing countries should take initiative to engage local industries more with universities. Arranging more seminars, symposiums on engineering education and openness is needed. Another outcome of industrial engagement is that student become familiar with work environment before they graduate, even they get job before their graduation due to presence of industrial engagement with engineering education. Interaction between students with students, academic with students, industry with students and industry with academics can give a remarkable dimension and improvement in engineering education standards.

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