

# ENGINEERING EDUCATION IN DEVELOPING COUNTRIES: ADAPTING CURRICULUM TO THE REGIONAL NEEDS

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**Abstract** – Engineering education in developing countries is faced with many challenges. One of the key engineering education issues is the question of curriculum adaptability to the growing regional needs as the countries evolve through their developmental process. This is usually dictated by the national infrastructure program development plans. In most cases, the electrical engineering curriculum for example is usually centered on power construction given the national need and evolves to include controls and communications. The civil engineering curriculum equally revolves around structures and surveying. This paper examines how the transition from one area of concentration is made given the prevailing technological divide between the developing countries and the developed countries and proposes some solutions that can help alleviate the obstacles confronting the engineering education in these countries.

**Index Terms** – curriculum adaptability, national infrastructure, technological divide, engineering education.

## INTRODUCTION

Engineering education in developing countries is faced with many challenges in this century. These challenges cover almost every facet of the engineering education. The facilities available are generally inadequate and often obsolete. The teaching faculty members cope with several issues ranging from the lack of research facilities, opportunities and attrition of experienced members to the absence of a cohesive faculty development plan. The technical support staffs are ill prepared to give the necessary support needed in the laboratories and workshops and are therefore are ineffective. One issue that has been prominent in engineering education in the developing countries is that of the engineering curriculum developed and used in these countries. To be acceptable, the engineering curriculum often reflects the curriculum adopted in developed countries and hardly reflects the national and regional needs. The rationale here is to prepare students to be competitive with their global counterparts. The reality, however, is that these students quality education is hampered by the lack of adequate resources. Although some of the developing countries have made efforts to adapt their engineering curriculum to meet national needs, more work needs to be

done in this area so that the engineering curriculum will be comprehensively revised with the 21<sup>st</sup> century technology in mind to meet national and regional needs.

## EDUCATIONAL CHALLENGES

Education in general in developing countries is under funded. The priorities of the governments of these countries are such that while education is perceived to be important, adequate funds are generally not released to execute strong educational programs. Engineering education with specialized laboratories and workshops are capital intensive and generally feel the full impact of this under funding. This often results in laboratories and workshops being ill equipped and equipment and instruments not being routinely maintained and broken equipment not repaired or replaced. Budget constraints hamper the planning and development of engineering education. Most times, engineering education is not is differentiated from other education programs and therefore not given the special attention and treatment it deserves.

Owing to this under funding, Internet connectivity for lecturers and students is almost non-existent. General computer laboratories dedicated to student use and specialized computer laboratories with specialized software for engineering education are inadequate and in most cases non existent. This aspect of engineering education in developing countries needs urgent attention so that both students and lecturers can take advantage of the benefit of computer technology to engineering education in the 21<sup>st</sup> century.

Faculty development plans for engineering faculty members are not comprehensive and research facilities are hardly available. Faculty members are therefore handicapped in their teaching and in their upward mobility in their careers in terms of promotion. This creates a situation where lecturers are frustrated and therefore lured into leaving to take up appointment in the more lucrative and challenging engineering industry. The policy of “publish or perish” in this kind of environment is very detrimental to proper staffing of engineering programs in the developing countries. Most of the engineering programs are relatively young and they need nurturing to make them strong and productive. However, the dedicated lecturers needed to plan,

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design and grow these programs may not have much time for research. This has resulted in a situation in which the dedicated lecturers needed are hard to find.

It appears that the days that engineering education in developing countries had all the financial resources to plan and develop laboratories and workshops are over. Today engineering education stakeholders need to be very innovative and proactive in order to provide a curriculum that meets the needs of the nations and regions. Most of the funding for education in general comes from the governments. Engineering education stakeholders must join forces to provide additional revenue to boost engineering education through fund raising activities.

### **EXISTING CURRICULUM**

The engineering curricula in developing countries are generally well designed to meet international standards. The implementation of these curricula may be partial because of the non-availability of relevant textbooks, inadequate or non-existent laboratories and workshops lack of experienced and qualified lecturers and budgetary constraints. Some general national and regional needs are met but peculiar needs to the regions are not fully addressed. Power generation and distribution, effective water supply and distribution, transportation and traffic studies, low cost housing materials and construction, contracts and contract administration are some hot areas that need more attention in developing countries. The current curriculum also needs the infusion of computer applications and the use of the Internet. Distance learning could be used to advantage by developing countries in providing study through the Internet on engineering.

The engineering curricula in developing countries are generally accredited by some national education agencies. These accreditation agencies are in general separate from the engineering professional societies that regulate the practice of engineering in these countries. Owing to this situation, engineering lecturers have no incentive to actively pursue licensure from the professional associations regulating the practice of engineering. This means that many engineering lecturers cannot be engaged in consultancy services to the engineering community, a practice that will enhance their teaching and research skills.

Until the economic and political climate in the developing countries became very unfavorable for engineering education and employment, the government jobs were readily available for engineering graduates. For several years now these jobs are no more readily available and the unemployment among engineering graduates has become quite high. The engineering curriculum in these countries must address this problem and critically revise the engineering curricula such that engineering graduates in the 21<sup>st</sup> century may be more self-reliant and should be able to generate jobs for themselves and others instead of heavily depending on government jobs.

### **REQUIRED ADAPTATIONS**

The current engineering curricula must be adapted to meet national and regional needs and trends for them to be effective. These needs have been identified in most cases and there has to be the will to make the necessary changes among engineering education planners for this to be implemented. For example, in the study of civil engineering and construction materials, in addition to the study of conventional building materials such as concrete, timber and steel, the study of the engineering properties of local materials such as bricks, adobe blocks, bamboo, agricultural fibers such as rice and corn husks, and clay could be studied with a view to developing alternative local building materials that may provide the elusive low cost housing. In the area of power generation and distribution, solar energy could be incorporated into buildings and facilities that will cut down the energy demand to a large extent. Designing curricula to meet these regional needs will make engineering education and practice more goals oriented and beneficial to the developing countries.

Engineers by virtue of their training can conceive, plan, design and direct the construction of diverse engineering projects. But this is possible only after several years of on the job experience after graduation. In the prevailing high unemployment condition, the engineering graduate should be equipped to go out into the society more prepared to contribute to the economy in a more pragmatic way than before. They should be able to run small scale businesses and become more self-reliant as quickly as possible. This will only be possible if the focus of the curriculum is changed to include more practical and hands on activities that cover the total design and construction processes.

The summer internships should be more focused. The lecturers and the company executives can discuss and come up with a comprehensive training program for students on summer internships that will cover specific areas. The internships should be closely monitored to ensure that the goals and objectives for the students are met. For effective summer internships and co-ops programs, a strong partnership must be forged between the engineering programs and the engineering industry. The industries must be made to see the need for them to be involved in the training of the engineering students. The students acquire valuable practical skills during these programs.

The problem of ill equipped workshops and laboratories may continue to plague engineering education in developing countries for some time to come and immediate steps need to be taken to alleviate this situation. One possible solution is to explore the possibility of using the Internet, web-based courses and distance learning technology to provide the much-needed training. Educational linkages can be forged with institutions in developed countries that may facilitate this and this is

encouraged for the engineering programs in the developing countries.

Engineering books are specialized, expensive, and difficult to get especially in the developing countries. Text books, codes, specifications, manuals, training videos, CD-ROMs, design softwares and tapes that are current are crucial to sound engineering education. Most of these educational materials are not available in the developing countries. The engineering programs should explore the possibility of using the Internet and the virtual library to meet some of these needs.

## **RELEVANCE TO NATIONAL/REGIONAL ECONOMY**

Decades of engineering education in developing countries have resulted in the graduation of many engineers. These engineers have played some prominent roles in the planning and construction of these countries' physical infrastructures, such as roads, buildings, bridges, petrochemicals, hydropower plants, dams, Liquid Natural Gas projects and petroleum refineries. In spite of the moderate investment in engineering education over the years, many engineers have been produced and many indigenous engineering companies have been formed. However these governments continue to use foreign firms from developed countries to execute the huge construction projects. In some of these countries, the indigenous engineers have protested this action and yet the engineering contracts continue to be awarded to foreign companies. Although it could be said that this action of the governments is political, but what is generally sensed is that these governments do not have confidence in their indigenous engineers to perform the tasks contracted out. What ever is at the root course of this problem, this situation must be arrested if the engineering education in the developing countries must be improved. The engineering curricula must be redesigned to reflect and meet national and regional needs. The engineering programs must be in the forefront of helping to formulate ways and means of meeting these needs. They must be proactive and aggressive in showing that indigenous expertise is available to meet these needs. This involvement will bring many opportunities for engineering students to learn real-life engineering. It will also help to remove the stigma of "producing engineering graduates that have to be retrained by employers" before they can confidently enter the workforce.

## **THE ROLE OF TECHNOLOGY IN ADVANCING THE CURRICULUM CHANGE**

Engineering education in the 21st century has been highly influenced by advances in technology. Available technology has influenced the way presentations are made, courses are taught, and materials are available on the Internet, CD-

ROMs, videos, tapes, spreadsheets, and several application softwares. Courses are offered outside the traditional classrooms and students can meet with their lectures and fellow students in chat rooms on the Internet. Web-based courses and distance learning course offerings have raised the opportunities for students to enroll in courses or programs that are engineering related. This opens up a lot of opportunities for engineering education in developing countries. There are a lot of potentials of technology being used for engineering education and they need to be explored by engineering programs in the developing countries. This may help to bridge the gap of lack of laboratories and workshops and unavailability of textbooks to large degree. The basic infrastructure needed to take full advantage of current technology for engineering education in developing countries may be largely in place already. Classrooms, lecture halls and laboratories must be wired for Internet connection. The engineering education curricula must be thoroughly reviewed with the aim of identifying areas where technology could be incorporated to provide access to resources available on the World Wide Web. The Virtual Library, Distance Learning, and Web-based courses are important aspects of the 21<sup>st</sup> technology that need careful study for the purpose of identifying areas that will be of great use to engineering education in the developing countries. Linkages with engineering programs in other parts of the world should be explored further. There is the possibility of using various systems already available through distance learning to beam classes via satellite to many campuses in the world. This means that a class being taught in the United States of America or the United Kingdom may be received via satellite in studios wired for this purpose in developing countries. Owing to different time zones, the courses could be taped and then aired later at a more convenient time. This may be possible at a fraction of the cost of teaching such course in house.

Virtual laboratories and workshops may be areas to look at also. Is it possible through distance learning to provide laboratories where students can perform laboratories and go through workshop procedures on the Internet? Many corporations use videos to train personnel on complex procedures by performing all the necessary tasks on the computer. This is possible and could be used to provide training for students in areas were either the expertise and/or facilities are not locally available.

## **CONCLUSION**

Engineering education in developing countries faces many challenges. While the curricula for engineering education in these countries are comprehensive by international standards, they fail to fully address national and regional needs. The result is that the developing countries continue to look to the western countries for the execution of their major construction projects. To this end, the engineering curricula in the developing countries should be revisited with a view

to building into them, aspects that address national and regional needs. Many areas that could be looked into include, power generation and distribution, solar energy, local building materials, project management and control, traffic and transportation studies, facility management and operation and maintenance of public facilities.

The curriculum adaptation can be made possible by using advances in technology to provide training in those areas that need strengthening. The World Wide Web and distance learning capabilities can be used to provide this training through linkages with other institutions and organizations.

To overcome budgetary constraints, the engineering programs in the developing countries must forge viable partnerships with the local engineering industry to provide assistance in training the next generation workforce. Apart from the mutual benefits such partnerships produce, they help to provide a feedback on the needs of the engineering industry. When the programs respond to feedback received, the programs are able to produce graduates who are prepared to address national and regional issues.

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