REVIEWING ENGINEERING CURRICULA TO MEET INDUSTRIAL AND SOCIETAL NEEDS

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Abstract— The present state of engineering practices in our country has called for review of engineering curricula to make it more proactive and relevant to the industrial and societal needs. It is imperative that students be shown the difference between studying engineering and becoming an engineer. There is need for strong industrial interaction in our education for the students to know the types of problems engineers face, the concepts, processes, and tools they use to solve those problems, and the personal and professional attributes essential to be a team player in solving engineering problems. An attempt was made to evaluate all this variables in this paper.

Keywords— Engineering practice, education, curricula, industry, problem solving

1. Introduction

Nothing is more important to the future of any nation's engineering enterprise than attracting talented young men and women to the pursuit of an engineering degree and providing them with an education relevant for the 21st century. Engineering graduates are key to providing the higher level skills that are required for economic recovery and long-term prosperity in Nigeria. Hence, their education and curriculum must be given optimum priority. But, presently in our country, engineering education is in a turbulent period. Industries complain about skill deficiencies in engineering graduates. High attrition rates of engineering students with good academic performance records have all provoked calls for changes in how engineering curricula are structured, delivered, and assessed. The fact is that the "content" of engineering practice other than basic principles is changing far too rapidly for engineering curricula to keep pace with. It is therefore imperative that students need to be shown the difference between studying engineering and becoming an engineer. The exclusive use of straight lecturing and the posing of questions for which there is only one correct answer must be replaced by discovery learning and learning with understanding [1]. Hence, there is need for strong industrial interaction in our education for the students to know the types of real-life problems engineers face, the concepts, processes, and tools needed to solve such problems. The personal and professional attributes essential to be a team player and also to lead a team as an engineer leader – not a follower – but an independent-thinking leader in our technological society is also highly essential for today's engineering graduates. Modern engineering systems are multidisciplinary involving adequate understanding of the design process, integration and simultaneous optimization of the physical system, sensors, actuators, electronics, computers, and controls. This requires a new type of engineer, one with in-depth knowledge of the engineering discipline with multidisciplinary approach to engineering issues and a balance between theory and practice [1]. Also, questions such as "how can we enhance a sustainable world-class higher education engineering sector that meets the graduate recruitment needs of industry", need to be answer in order to improve engineering education in this country.

Take for example, the Nigerian Content policy, which was initiated in 2006 by the Olusegun Obasanjo administration, was aimed at developing local capacity building in the

Nigerian oil and gas sector, with a view to ensuring that Nigerians participate actively in the operations in the sector [3]. The Federal Government's aspiration to achieve 70 per cent local content in the oil and gas sector by 2010 has not been achieved, due to poor compliance with the guidelines governing the Local Content policy by most International Oil Companies (IOCs) operating in the country [3]. This is also partly due to decadence in our engineering curricula. If we are to compete in the new global economy, we will require an adequate supply of high-quality, flexible engineering skills at all levels, developed through a range of routes including, apprenticeships, foundation degrees, undergraduate degrees and postgraduate qualifications. Engineering degrees should aim at providing a firm grounding in the principles of engineering science and technology, while inculcating an engineering methods and approach that enable graduates to enter the world of work and tackle "real world" problems with creative yet practical results. It is important that our education is relevant to the industry and pragmatic in nature, focusing on aspects important for practice in order for it to be useful. Our curriculum should also be market driven. The market-driven, product-centered requirements engineering should not be a substitute, but rather a variant meant for market-driven environments [4]. Lecturers should also be encouraged to give industry based assignments, and also go for industrial experience through sabbaticals and other relevant means.

2.0 Current Change Activities in Engineering Education

We live in a time of revolutionary change. Within technological context, engineers play an ever more significant role. Engineering colleges throughout the world are experimenting with new approaches to curricula, rethinking traditional teaching modes, and developing innovative ways to recruit and retain students with the best brain [5,6]. Many universities and their engineering colleges now aspired to be model of "research-intensive" university. This model focused on developing research excellence in scientific and engineering fields, and on creating research-oriented doctoral degrees. While not all universities and engineering colleges adopted the research-intensive model, many have viewed it as a standard of excellence. This shift creates new opportunities for redesigning curricula and programs, expanding relationships with industry and educating students who are both technically capable and broadly sophisticated. In addition, some models of innovation and curricular change are typically small-scale; 'stand-alone' and most of the time do not impact on Departmental, institutional or national practice [7]. Therefore, these innovations are typically lost when the faculty member or lecturer initiating the change moves on [8], because their colleagues are unwilling "to invest the time to teach the course in the new manner in part because the time commitment was greater than for traditional lectures" [9]. Examples of ambitious department- or School-wide innovation most commonly cited in the literature – such as Olin College of Engineering in the US [10] or Aalborg University in Denmark [11] – tend to have been designed from a blank slate rather being the product of an educational transformation from a more traditional curriculum. As such, they do not offer insights into the change process at the systemic level.

3.0 Suggestive Models and Strategies for Change in Engineering Education

In light with current trend, the following model and strategies are suggested for change in engineering education. Engineering colleges may choose to become more like "professional" schools, preparing students for professional engineering practice through the master's level. Such programs would model themselves after schools of law and medicine, in which engineering practitioners from industry would work on-site, providing clinical training and assistance. Unlike the other models, however, that of the engineering professional school would continue to incorporate undergraduate as well as graduate education.

Some universities may opt to combine elements of traditional technology-based engineering education with a strong emphasis on broader skills such as written and oral communication, management, economics and international relations. This type of program would aim to prepare individuals for technological decision-making and policy-setting as well as for non-engineering professions.

Still other engineering universities may decide to focus on Ph.D. related research and preparing graduates for research and teaching careers. This decision must be taken with the full understanding, however, that the nation's support system for research is limited, and there will likely be few research positions available through industry, the federal government and perhaps the university.

Exchanging faculty, graduate students, and engineers from industry and government is an effective ways of promoting technology transfer, and ensuring that faculty and students are exposed to engineering practice. The federal government, in partnership with engineering colleges and industry, should develop a national program to foster creation of "industrial professorships" in engineering colleges.

4.0 Need for Creativity in Engineering Education

"The need to be right all the time is the biggest bar to new ideas. It is better to have enough ideas for some of them to be wrong than to be always right by having no ideas at all". ***Edward de Bono***.

In recent years, there has been call on the need for creativity in engineering profession and the associated need in engineering education. Unlike industrial problems, most of the time engineering education problems usually involves problems with single correct answers. Throughout their stay in the University, we rarely give the students the impression that there are:

- Some problems which do not have unique solutions,
- Some problems which may not have solutions at all,
- Problems in life, unlike problems in school, which do not come packaged with the precise amount of information needed to solve them—some are over-defined, and most are under-defined,
- Problems in life, unlike problems in school, which are open-ended: there is no single correct solution and any realistic answer invariably begins with, "It depends",
- Sometimes a solution that at first sounds foolish, may be the best solution,
- Circumstances when to be wrong is not synonymous to failure.

If we are to produce engineers who can solve society's most pressing technological problems, we must somehow convey these messages in our instruction to students in our institutions. We must provide our students with opportunities to exercise and augment their natural creative abilities and we must create classroom environments that make these exercises effective.

Many techniques have been suggested for exercising creativity and developing problem-solving skills in the classroom [12, 13]. The following suggestions are worthy of note among others:

- In every course some open-ended and under-defined problems should be assigned, and more information than is needed should be provided for problems with unique solutions.
- Problems should be assigned that call for the generation of possible alternative solutions, and when the solutions are evaluated credit should be given for fluency (number of solutions generated), flexibility (variety of approaches adopted), and originality. If the generation of possible solutions is to be done effectively, it is essential that the critical facility be suspended in the initial stages of the process. The problem-solver must feel free to advance any idea that occurs, regardless of its apparent practicality or lack of it.
- A number of techniques should be adopted to facilitate the uncritical generation of ideas. The following are several techniques that have been found particularly effective in industrial settings:

1. A series or questions are used to stimulate new ways of thinking about a process, plan, or device.

2. List attributes or specifications of the entity to be improved, and systematically try modifications or variations. Proposed by Robert Crawford (cited in [13]).

3. Morphological Analysis, proposed by Fritz Zwicky (cited in [13]). Set up axes for principal attributes of the entity, with entries for each variable.

4. Brainstorming

CONCLUSIONS

Engineers will play a crucial role in emerging economic sectors of this country. Therefore, researches are done all over the world with the aim to identify the options for encouraging and enabling universities to develop engineering courses that better meet the needs of industry and to identify the opportunities, barriers and costs involved.

It is important that requirements and curriculum of engineering education be based on best-practices and techniques. Engineering education must take into account the social, economic, and political contexts of engineering practice; help students develop teamwork and communication skills; and motivate them to acquire new knowledge and capabilities on their own. Because many modern engineering projects require a combination of several disciplines, students also need exposure to the integrative field of systems engineering. In essence, engineering education today should aim to prepare an engineer to be successful in the changing workplace. It should equip students with technical knowledge and capabilities, flexibility and understanding of the societal context of engineering. While recognizing and encouraging diverse institutional missions and changing industry needs, colleges of engineering must re-examine their curricula and programs to ensure they prepare their students for the broadened world of engineering work.

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