THE STATUS OF ENGINEERING EDUCATION IN NIGERIAN UNIVERSITIES

N. S. Maina

Abstract

This paper considered the status of engineering education in Nigerian Universities. The historical developments in the field of engineering education were reviewed. The benefits of engineering education were also highlighted e.g. variety of career opportunities, challenging work, . intellectual development, potentials to benefit society, technological and scientific discovery, e.t.c. Some of the problems confronting engineering education like obsolete curricula, inadequate engineering infrastructure for training, research and industrial development, inadequate human resources for engineering education and then engineering and information technology, were also discussed. The paper made the following recommendations to enhance the status of engineering education - (i) using the right tools and early use of computers, which have taken over in the design, simulation and control of almost all modern chemical/engineering plants; (ii) reassessing our curricula with the changing trend of things in order to make it relevant to the economy.

Introduction

Engineering is the science of systems and processes of creating new systems to provide goods and, services to satisfy identified 'needs (Folayan, 2001). The processes include design, the manufacture and the maintenance of the systems. The design is a process of translating original concept of yet inexistent system into a form defining its build, dimension, materials and probably how it can be manufactured. The identified needs may be clothe, food, house, educational facilities, health facilities, communication, transport and all that makes for healthy mind in a healthy body living in a healthy environment.

The goal of every nation is to develop into a prosperous self-reliant nation where ail necessities for high standard of living and good -quality of life are accessible to every citizen. Engineering technology is the only potent tool for national self-reliance in providing all essential socio-economic needs. Poverty eradication would have been achieved as soon as the nation becomes self reliant in technology for providing her basic goods and services. The level of poverty of a nation is directly related to the level of her dependence on foreign technology for provision of goods and services (Folayan, 2001). As we advance into this "superspeed era", in which things change by the minute or second, in which today's technology is regarded as obsolete tomorrow, an era in which only the most current and up to date engineer can be relevant; there is need to review the teaching, scope, and industrial role of engineering education in the polytechnic and universities (Mumah. 2000).

Historical Developments in the Field of Engineering Education in Nigeria

National development and self-reliance in ail socio-economic activities depend very strongly on science and technology (Folayan, 2001). Exogenous technology may be employed by our national or international collaborators to give a semblance of development, but until such technology is acquired by our nationals and enough human and material resources are internally generated to sustain such technology, we cannot be self reliant. The only way to acquire the skills is by sound science and technology education.

Unfortunately, the founding fathers of this nation had created gaps in our science and technology education. For over a century of colonial rule, engineering education had no place. In fact the first civil engineering university graduate was produced in* 1960 (the year of independence) even though Yaba College of Technology was established in the 1940s (Folayan, 2001). Early Nigerian engineering schools were established by corporations like Nigeria Railways, Nigeria Electricity Corporation and United African Company to train craftsmen for routine maintenance of the machines they use (Folayan;* 2001). Although Nigerian graduate engineer's education prepared him for design and developmental work, the nation's colonial developmental strategy made it difficult for him to have fulfillment. This is because most national engineering projects were secondary in nature (textile, beer brewing, road maintenance, installation of power production units- and communication equipment, repair and maintenance of railways and vehicles) but the basic design and production of machines were done and are still done outside the country. Hence from inception till date, we are dependent on exogenous technology. It is even worse now that most engineering jobs are contracted to international collaborators. ; ,

In the real world, engineering is more of a trade born from experience than a profession born from science and'technology. For instance, despite all our progress in understanding fundamental principles, the design of a plant or a process'remains more of an art than science (Horwitz-et al, 1996). Of course, a good understanding of basic engineering principles is essential. But no sane company would allow a recent engineering graduate (regardless of advanced degrees) to take the lead in designing, building, or operating a facility, or in any other significant engineering task for that matter.

Anyone who has been fortunate enough to participate in any phase of a project- whether research and development, detailed design and engineering, construction and startup, or operation- knows that no amount of formal education or number of advanced degrees can.begin to take the place of experience in equipping art engineer to make the right decisions. Sound choices 'depend upon experience (Horwitz, et al, 1996). This reliance on experience is hardly unique to engineering. It's just as important in other professions such as medicine and law. . .

Experience, simply, is technical knowledge acquired over time via actual work on projects under the watchful eye of supervisors, peers, mentors, contractors, suppliers, and last, but far from least, customers or clients. Experience is nothing if there is no "doing" - with real things, costing real money, in real time period, with real people.

Obviously, the back bone of the work engineers do, whether in research laboratory, a pilot plant, an engineering office, or a plant site, begins with learning the basics of the profession: mathematics, physics, chemistry, and of course, everything associated with being able to construct. Ultimately, though, this knowledge must lead to something real, where the scale is 1ft = 1ft, not just something that works on paper or converge on a computer screen.

Benefits of Engineering Education

Engineering offers a rewarding and lucrative career—one in which you can use your mind to find creative solutions to the challenges facing our society. Some of the benefits of engineering education include the following (www.engineeringkl2.org):

1) Job Satisfaction

Studies show that, by far, the number-one cause of unhappiness among most people, worldwide is job dissatisfaction. Thus, it is important to find a career that provides you with enjoyment and satisfaction. After all, you might spend 40 or so years working eight hours or more a day, five days a week, 50 weeks a year. For numerous reasons, some of which are listed below, engineering provides a satisfying field of work.

2) Variety of Career Opportunities

An engineering degree offers a wide range of career possibilities. Within the practice of engineering, there is an enormous variety of job functions (www.engineeringkl2.org).

* If you arc imaginative and creative, design engineering may be for you.
- . If you like laboratories and conducting experiments, you might consider test engineering.
- If you like to organize and expedite projects, look into being a development engineer.
* if you are persuasive and like working with people, consider a career in sales or field service engineering.

The analytical skills and technological expertise you develop as an engineering student can also be put to use in many other fields. For example, as an engineering graduate, you could go on to study medicine or law. You could become a politician and use your knowledge of technology and science to set important national policy. You could also become an entrepreneur in a related Field such as construction, manufacturing, or consulting. Or you could combine engineering and business skills in a career as a technical manager or a salesperson for a high-tech company.

3) Challenging Work

If you like challenges, engineering could be for you. In the engineering work world, there is no shortage of challenging problems. Any engineering manager will tell you that he or she has a huge backlog of problems that need to be solved. Generally, "real world" engineering problems are quite different from most of the problems you will solve in school (www.engineeringkl2.org). In school, "most problems have a single, correct answer. When you get into the engineering work world, virtually all problems will be open-ended. There will be no single answer, no answer in the back of the book, no professor to tell you that you are right or wrong. You will be required to devise a solution and persuade others that your solution is the best one.

4) Intellectual Development

An engineering education will "exercise" your brain, developing your ability to think 'logically and to solve problems. These are skills that will-be valuable throughout your life—and not only when you are solving engineering problems. For example, your problem-solving skills can help you undertake tasks such as planning a vacation, finding a job, organizing a fund-raiser, purchasing a house, or writing a book (www.engineeringkl2.org).

5) Benefit Society

Just about everything that engineers do benefits society. Engineers develop transportation systems that help people and products move about easily. Engineers design the buildings that we live and work in, the systems that deliver our water and electricity, the machinery that produces our food, and the medical equipment that keeps us healthy. Depending upon your value system, you may not view all things that engineers do as benefiting people. For example, engineers design military equipment like missiles, tanks, bombs, artillery, and fighter airplanes. Engineers are also involved in the production of pesticides, cigarettes, liquor, fluorocarbons, and asbestos fwww.cngineeringk12,org>, As an engineer, however, you can choose to work on projects that clearly benefit society, such as cleaning up the environment, developing prosthetic aids for disabled persons, developing clean and efficient transportation systems, finding new sources of energy, alleviating the world's hunger problems, and increasing the standard of living in underdeveloped countries, like ours.

6) Professional Environment

As an engineer, you will work in a professional environment in which you will be treated with respect and have a certain amount of freedom in choosing your work. You will also be in a position to influence what happens at your company. In most cases, you will receive adequate work space and the tools you need to do your work, including the latest computer hardware and software. You will probably also receive the secretarial and technical support staff you need to get your work done. You will have the opportunity to learn and grow through both on-the-job training and formal training. Often, your immediate supervisor will closely mentor you and 'help you tackle progressively more challenging tasks. You will learn from experienced engineers in your organization and will be offered 'seminars and short courses to increase your knowledge.

7) Technological and Scientific Discovery

• Do you know why golf balls have dimples on them? Do you understand how the loads are transmitted to the supports on a suspension bridge? Do you know what a laser is or how a computer works? When you drive on a mountain road, do you look at the guard rails and understand why they were designed the way they were? An engineering education can help you understand how these, and many other things in the world, work (www.engineeringkl2.org). Furthermore, an understanding of technology-will provide you with a better understanding of many issues facing our society. For example: Why don't we have zero-emission electric vehicles rather than highly polluting cars powered by internal combustion engines? What will we use for energy when oil runs out? Can we produce enough food to eliminate world hunger? Do high-voltage power lines cause cancer in people who live or play near them?

8) Creative Thinking

Engineering is by its very nature a creative profession. When practicing engineers develop solutions to open-ended, real-world problems, they must employ conscious and subconscious mental processing as well as divergent and convergent thinking (www.engineeringkl2.org). Because we are in a time of rapid social and technological changes, the need for engineers to think creatively is greater now than ever before. Only through creativity can we cope with and adapt to these changes, if you like to question, explore, invent, discover, and create, then creative thinking will be your greatest asset.

Problems Confronting Engineering Education

Our inability to sustain our apparent development has its root in the inadequacies of the engineering education. These inadequacies include:

(i) Obsolete Engineering Education Curricula

Engineering education curricula are not updated due to inadequacy in number and quality of engineering teachers and engineering educational facilities at all levels of engineering education (crafts, technician and engineer). Yesteryears engineering was man-machine relationship. Today it is man-computer-machine relationship (Folayan, 2001). The obsolete technology is not efficient or precise. The nation is weak in new technologies. Hence graduates of such obsolete curricula cannot handle new technologies and find it difficult to compete with their overseas counterparts.

(ii) Inadequate Engineering Infrastructure for Training, Research and Industrial Development

At the- secondary/technical school levels, basic science leaching apparatus and technology practice equipment arc inadequate, Early introduction to technical drawing and computer use cannot be done for most pupils. The breakdown of obsolete laboratory and workshop equipment at the universities and poor facilities for research increase the technological gap between developing and developed nations thereby decreasing the chances of creating a self sustaining development (Folayan, 2001). The basic infrastructural facilities of water, electricity, communication and transport must be available for any effective educational system. The inadequate educational infrastructural facilities produce half-baked engineers and consequently unsustainable development,

(in) Inadequate Human Resources for Engineering Education

Adequate manpower must be available at all levels of engineering education. Science educators and technical instructors at secondary schools'. Engineers and Technicians at the polytechnics and university levels must be adequate in number and quality. For this to be achieved, a national plan must be put in place and be executed faithfully to produce required-number of students. in 1975-1980 National Development Plan anticipated annual requirements of 5,000 engineers, 30,000 technicians and 75,000 craftsmen engineering personnel for the National Development programmes (Folayan, 2001). Twenty five years, or more, after this plan with more than 40% increase in national population, it is not certain whether there is achievement in the goals set for a quarter of a century ago! Even then the phenomenon of brain drain has greatly affected the number of seasoned hands available. To update knowledge of engineering educators, they must train and retrain in order to bring them to the front of knowledge. There .must be opportunities to attend international conferences. They must have facilities to research into current problems. These problems must be market/industry driven. There is need for university - industry staff exchange lo update both personnel.

(iv) Engineering and Information Technology

The fast development in the technology arena now, means that-educators have to reassess their methods of training and imparting knowledge. For our graduates to become relevant in the world's work places, changes must be made in our training methods. Computers have taken over in the design, simulation and control of almost all modern chemical/engineering plants (Carlson. 1996; Horwitz, 1994; & Mumah, 2000). There is no doubt that we have to reassess our curricula with this changing trend. The Information Technology (IT) revolution worldwide has caused professionals to be "knowledge based'[1]. (Mumah, 2000). This means that accessing the- internet, e-mail communications and other forms of IT based communications are vital if one must keep abreast with recent trends in his/her profession. Gone are the days when a professional would have to wait for a monthly subscription of his professional journal. One or two months are too much as compared to just a few minutes of browsing the Internet. With the computer based IT tools now available and used by many tertiary institutions worldwide, a student can receive all his lectures, and even write his exams without .leaving his home. The engineering student must take advantage of this information revolution. To do this, our teaching methods must ..encompass these aspects of IT. Computer based softwares must be introduced to our students at an early stage,

A look at Chemical Engineering

Engineering in general differs from other professions like medicine, law, nursing, and the like in a critical respect: A medical student taking a course in thoracic surgery will be taught by a professor (M.D.) who certainly has been in an operating room and has performed that type of surgery.

.Similarly, a law student taking a course in criminal law will be taught by a professor (lawyer) who undoubtedly has been in u courtroom trying a case. A student nurse will be taught by a nurse who surely has been in a hospital giving shots, and so on. But, almost as certainly, a chemical engineering student (for example) will be taught by a professor who probably has never worked as a chemical engineer in any capacity - who never designed ,a real process or spent time, in a plant and, furthermore, who never made a process or plant work. At most, maybe the professor spent a few years working in research for a chemical company, and then went right into teaching.

The vast majority of engineering professors went directly from four/five years of undergraduate work to graduate work, got a doctorate, and then went right to a university to teach even advanced courses. The basics, of reactor design, distillation, fluid flow, and the like can be taught by a professor who never has been in a chemical plant. But wouldn't it be helpful to have one or even two professors who have indeed practiced chemical engineering in the real world and who can relate industrial practice to their students? Wouldn't that benefit those students and their future employers? Shouldn't that be possible in the confines of the department?

Using the Right Tools-

In the history of Chemical Process Industries (CP1), no single development has affected in a more positive way the practice of chemical engineering than computers. The operation of plants has been transformed by distributed control systems. Perhaps even more profoundly, though, the personal computer and software like simulation and mathematical programs have changed the very way that chemical engineering is performed (Carlson, 1996; Horwitz, 1994; & Lee, i995).

For a student to go through four/five years of a chemical engineering undergraduate program and not know the workings of a process simulator is a tragedy in our opinion. Now performing a multicomponent flash calculation or drawing a McCabe-Thiele diagram by hand definitely is a good exercise. We certainly would recommend these exercises continuing as an integral part of the curriculum. Not only do they give the student a "feel" for just what is going on but the sheer frustration and mathematical manipulations build character. But each exercise needs only to be accomplished once There's certainly no need to continuously repeat these boring calculations. Instead, process simulation software (ChemCAD HI, ASPEN PLUS, PRO II, HYSYS, PD Plus, and the like) should be introduced (Carlson, 1996; & Horwitz, 1994). The student surely will appreciate how it improves engineering efficiency.

Chemical Engineers use process simulation to perform a variety of important works. This work ranges from calculations of mass and energy balances of large flowsheets to prediction of the performance of process alternatives that can save millions of dollars. An engineer very quickly can define a complex flowsheet and all the process conditions. Desktop computers now allow rating, sizing, optimization, and dynamic calculations that previously required large mainframe computers. In the past, simulations were often built by a group of experts, including physical property experts. Now, the simulation softwares are easier to use and more powerful than the standalone programs of the past (Carlson, 1996 & Horwitz, 1994). Today, a single engineer can set up the basic simulation specifications, including the physical properties, in very little time.

But how many professors know how to use such simulation software and actually incorporate the use of it into their courses? Such programs are the new tools of the profession. Just like doctors, who constantly are required to keep abreast of new developments in their discipline, professors of chemical engineering and other branch of engineering, should keep astride of the latest developments.

Recommendations

Government must invest in the educational sector, It is important to note that lecturers in the polytechnics/universities must be trained and retrained to catch up with the global trend of computer based IT, and facilities must be made available, facilities that would enable the smooth teaching of these ideas. Furthermore, the engineering curricula must be assessed continuously In order to make it relevant to the economy.

Conclusion

The need for infrastructural facilities for education, research and industrialization cannot be-over emphasized. The infrastructure for good engineering education and research is fundamental, as this would build the human resources, stimulate them and culture them for engineering solution to socio-economic demands. From the above discourse, it is obvious that sustainable development in ail socio-economic-cultural sectors is very dependent on the nation's ability to sustain engineering development.

However, engineering development can only be sustainable if the engineering and science education is given the necessary attention. Bottle necks, such as obsolete curricula, the inadequacy in infrastructure! facilities for training and research, the inadequacies in number and quality of human resources for engineering education and the poor exposure of trainee engineer to industrial training are to be removed.

Unfortunately, during national service (NYSC), while graduates of medicine, nursing, law and pharmacy are posted to hospitals, clinics and chambers to further boost their professions, the engineering graduate suffers the opposite. It is sad to hear and see engineering graduates teaching even in primary and secondary schools, when they should be in the industries or appropriate places like other professional courses as highlighted above. Government, through the Council-for the Regulation-of Engineering in Nigeria (COREN) and even the Nigerian Society of Engineers (NSE) should do something concerning this, if at all engineering could be developed and sustained.

References

Carlson, E.G. (1996). Don't gamble with physical properties for simulation. *Chemical Engineering Progress.* 22(10)35-46. Folayan, C.O. (2001). Elements of a Sustainable Engineering Development for National Self Reliance, Dinner Lecture, Nigeria Society of Engineers, Zaria Branch.

Horwitz, B.A. and-Nault, L.G. (1996). Relate to the Real World. *Chemical Engineering Progress.* 92(10)84-86.

Horwitz, B.A. (1994). Using Simulation for Troubleshooting. *Chemical Engineering Progress.* 90(10,62-65.

Lee, W.E. and Dorland, D. (1995).' Careers in Induslries Vs. Academia. *Chemical Engineering Progress.* 97(5)55-58.

Mumah, S,N. (2000). Chemical Engineering Education in the Polytechnics in the 21^{51} century. *Study and Practice of Chemical Engineering.* A publication of the Zazzau 2000 Organizing Committee. Dept. of Chemical Engineering, Ahmadu Belio University, Zaua.

www.engineeringkl2.org/precollege/bencrits.cfm - 29k - 24 Aug. 2004.