Engineering Education and Product Design: Nigeria's Challenge

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Abstract

This size of Nigeria in terms of size, population and/or resources makes it very relevant not just in Nigeria but in the world. This paper reviews the existing framework on Engineering Education in Nigeria with emphasis on what is missing in the existing Engineering Education curriculum and what is required to turn the abundant resources into finished products using the Total Engineering Design Model. The paper proposes what should qualify an engineer to teach engineering, what to teach (the contents of the curriculum) and the environment where to teach (the facilities that make an environment amenable). The authors of this work believes that if inclusion of product design process and inventing principles are sufficiently incorporated in the engineering curriculum, it will make a lot of difference to the economy and technology growth within the next decade. Suggestions are presented here (especially on product design and development process) for technological desires that Nigeria intends to pursue to be attainable.

Keywords: Engineering Education, Current Curriculum, Product Design Process;

1. Introduction

Africa has been the destination of a lot of products produced from other continents. These products range from the very sophisticated like arms, aeroplanes to such simple as milk and other dairy products, tooth pick etc. The health facilities are still quite poor and the presence of constant electricity is still a mirage even to some big countries as Nigeria. It is surprising to note that a greater portion of the raw materials used for the production of these products are not just in Africa but in abundance. These resources are finished and re-sold to them at higher prices. This scenario has remained for decades and Africa has been proudly occupying the position of the continent with the highest number of the world's poorest of the poor because of the link between Engineering Education and Technological Advancement is still missing. The existing gap in terms of technological advancement have remained between the developing nations and the developed even as quite a number of people from the developing world have had the opportunity to mix with the developed nations through education especially in the area of Engineering and Technology. This paper attributes this Trends to lack of proper Engineering Education and therefore seeks to provide a link between proper engineering education (which produces Engineers) and Technology Advancement through product design and development (which the Engineers promotes thereafter). The development of these linkages when developed according some suggestions will lead to optimum utilisation of Nigeria's abundant natural resources and this will not only give them domestic satisfaction but also add value to their products before sending it abroad. The research questions are:

i. What is missing in the current curriculum that inhibits good results?
ii. What does it take to establish and nurture a proper Engineering Education structure that could guarantee quality training of Engineers who can convert natural Resources into finished goods?

This work concentrates on engineering education in the University more and slightly on the polytechnics because this is the area where product design process should be taught properly with a view to influencing manufacturing of standard products. Though there are other primary skills development programmes like technical colleges that prepare potential engineering craftsmen and even would be engineers at a low level. These levels only implement design methodologies that arise from the Universities research.

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Nigeria is emphasised because Nigeria is reputed to be the most populous African country with one of the oldest and most comprehensive educational system (CODESRIA 2005). The first university (University of Ibadan) was established in 1948(Ajadi, 2010)**.**

A new approach is proposed to be added to basic qualifications of tutors/trainers of engineering education. Emphasis is also made on broader understanding of the product design process because that is the vision for expertise in design.

2. The Current curriculum

Engineering Education is being taught at different levels both in the Polytechnics and the University. Currently, there are 123 universities and 70 Polytechnics regulated by the Government through the National University Commission (NUC) and the National Board for Technical Education (NBTE). These include 36 federal, 37 States and 50 Private universities (www.nuc.edu.ng) while the Federal polytechnics are 21, the states have 33 and Private have 16(www.nbte.gov.ng). The NUC regulates activities of the Universities while the NBTE takes care of Technical and vocational education outside university education. The University produces engineers while the Polytechnics produce Technologists at the higher Diploma levels and Technicians at the lower Diploma levels. In the University, engineering is a straight five year course distributed through 10 semesters (The 10^{th} is out of school Industrial training attachment. The Polytechnics run a 2- year (4semester) programme with 3 months Industrial training between the second and the third semester for the National diploma. For the Higher National Diploma (HND), the programme is also a 2-year (4 semester programme) but there is prerequisite that applicants should have done a compulsory one year industrial experience. The teaching of engineering courses is more theoretical and the practical experiences that are inbuilt in the system are not well implemented to achieve the desired results.

The current curriculum of producing Engineers through the universities cannot create wealth nor foster the much needed development in Technology and engineering expertise. This largely due to the gap the engineering graduates find between what the processes of tutelage provided them and the reality after school. The current curriculum for training engineering graduates emphasises the fundamentals e.g. Physics, Mathematics and chemistry and a bit of technology (Onwuka, 2009). These emphases can only lead to partial design. Partial design is that approach to design that emphasises basic engineering disciplines without a holistic look at the product development process (Pugh, 1993).

In the current curriculum arrangement (fig. 1), a student is admitted to study Engineering for five years after passing through the Senior Secondary School with five credits in subjects that include: Mathematics, Physics, Chemistry, Mathematics and English Language. The first year is spent on general/Natural Sciences. At the end of first year there is a three months Student’s Industrial Work Experience Scheme (SIWES), between the end of the second year and the third there is no industrial experience. At the end of the final year there is a technical project which the student, either as an individual or group with others are expected carry out before graduation. Generally, the course contents in the current curriculum usually include laboratory practice between the second and the fourth study years (except for those whose degree projects concerns further experimentation. A good question to ask is what is the situation of these laboratories? The practical contents relevant to the students may not have been done during the study years. There may be physical structures but are they sufficiently equipped? Are they relevant as input to produce the desired outcome.

Table 1. Existing schedule for current University Engineering Students

Year	Description of Courses	Practical Experience
1	Natural Sciences(2 semesters)	SIWES(1 month)
2	General Engineering courses (2 semesters)	No Practical Experience
3	Specific Engineering Discipline courses e.g Civil (2 semesters)	Industrial Attachment. (3 months)
4	Specific Engineering discipline courses (1 semester)	Industrial Attachment. (6 months)
5	Specific Engineering discipline courses (2 semester)	Degree project

3. What is missing?

The current engineering educational system lacks: adequate funding, facilities (library, laboratories), human resources and most importantly, sound contents (Kofoworola, 2003; Alabe, 2008) especially in the design Process. The current system does not give special remunerations to engineers as is done to other professions like medical Doctors (Alabe, 2008).

The culture of dynamic Machine design process is greatly ignored. Old and traditional methods that lead to what is termed partial designs are still taught and practiced. These lead to failed designs. The Total design concept (design process that is systematic and takes into consideration all factors necessary to produce a successful product) with such tools as TRIZ inventive principles are not known let alone being taught in the current curriculum. A model for the Total design process is as shown in fig. 2. This is the Design core. The event of advanced manufacturing technology with Information and Communication Technology (ICT) is good but it is wrongly misunderstood to take the place of design instead of tools that facilitate design.

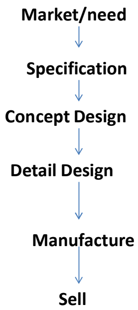

figure. 1 Total Design(Design Core)

4. What is required

For an efficient Engineering education system that can sustain the following must be present:

4.1 Physical infrastructure

This includes buildings-administration, laboratories, libraries (with adequate contact and subscription to relevant data base around the world) and workshops. These are very important because they create the required enabling environment for teaching and learning.

4.2 Human Resources

A critical mass of very sound, qualified, up-to-date and professionally certified human resource base is required. A good engineer should possess Sound judgement, Technical ability and ability to visualise (Kofoworola, 2003). This is one of the issues that hamper the progress of engineering education in the existing format. University Education system can employ graduates who do not have working experience and recruit them for teaching because they had good grades. Even when the implementation of Industrial attachment trainings has been closely followed, it does not equate actual working experience for the same period. These days most of the Industrial experiences are done in places that are not cognate with the specific engineering discipline. The exercise is seen more as requirement to go to the next stage than as part of the learning process. Imagine if the system is faulty at any point. The implication is that if a student was not properly tutored, and he is involved in the knowledge transfer chain his faults and inefficiencies will be transferred through teaching to other students in multiples. The natural situation is that you can only give what you have. Even when he goes to the industry upon completion of his studies, his employers will be required to train in the discipline that he got the degree. This should not be confused with orientation at the work place as a fresh employer. It should also be noted that the authors appreciate good grades as achievement but as an engineer and a trainer for example they need a bit more. There should be a proviso that those who wish to teach Engineering should upon graduation seek employment and work for a minimum of 3yearsin the industry related to their expertise before lecturing. That way they will have combined insight into what should be imparted on the students both theoretically and practically. This should be in addition to other basics he should know as a teacher. Re-training of trainers must be a continuous affair. Engineering educators must also be very good researchers (boaduo et al, 2011).

4.3 A Dynamic Engineering Curriculum

A standard, globally competitive design and dynamic engineering curriculum, with inventive principles is required (See fig. 1 Total design model). The curriculum should take into cognisance from the very onset that the engineer is meant to convert the indigenous resources to solve local problems that are immediate first and then to outsiders. The problems indentified for a particular period should guide the practical part of the curriculum from the second year through graduation. In fact expansion of physical infrastructures should be done as part of the relevant course by the relevant faculty/department. The implementation of the engineering education curriculum should be excused from the monetisation policy and contract to external bodies avoided.

4.4 Collaborations/Partnerships

Fig. 3 shows a proposed active relationship between the Governments, Industry, the community (People) with the academia. The academia should involve the people in their needs analysis such that they will embrace the outcome. Funding should be collectively done: Industry, Government, Community and the university including outputs from Researches ceded to the Industry. These could take the form of Research grants, facility support etc. Efficient monitoring and balancing should also be done by government especially where the output are to benefit the generality of the populace through tax cuts and subsidies.

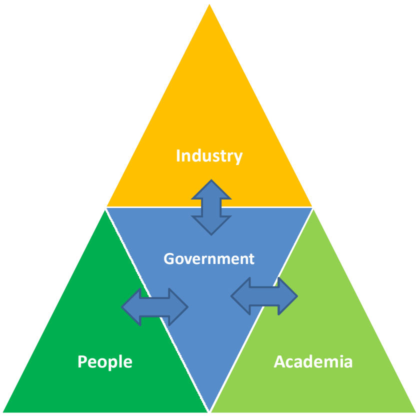

Figure. 2. Engineering-Stake Holders Education model

5. Conclusion

Nigeria desires to be among the 20 most developed economies by the year 2020. This vision will require an accelerated improvement of engineering education curriculum, product design and development culture. Some suggestions have been made by the authors which if well implemented, will facilitate technological development and by extension the achievement of this dream.

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