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TOWARDS ACQUIRING THE REQUISITE 21ST CENTURY ENGINEERING SKILLS

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Abstract

The preparation of graduate engineers for jobs both those demanded now, as well as those projected with the required skills, abilities and competencies for the 21st century knowledge based-economy requires a pragmatic approach which demands engineering educators and trainers to understand the changing trends and needs of the society. For instance, it is evident that today's students are no longer the people our educational system was designed to teach. This paper therefore seeks to identify some non technical skills that an engineer of the 21st century should have, and also suggested the pedagogy for realizing the impartation of such skills.

Keywords: Pedagogy, sophisticates skills, engineering educators/trainers lifelong learning innovation.



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Introduction

The complexity of 21st century technology coupled with the rapid product innovation, rapid dissemination of scientific and technological discoveries and quick global deployment and movement of capital have placed a very high demand for commensurate response by the engineering educational and training system. This is because the requisite sophisticated skills for a prosperous attractive lifestyle of the century is based on effective professional contributions in work by the engineer. It is pertinent to state that if we must train engineers who will confidently tackle the challenges of tomorrow, then we must appreciate how rapidly and immensely the world has changed from a decade ago. Kolawole (2012) noted that the contents of engineering training curricula around the world are shifting towards what are seen as the 21st century priorities for the profession. Engineering educators and trainers must therefore prepare the current and future engineers with sufficient basic knowledge to see new opportunities, create new ideas and solutions, as well as to give them the skills needed to marshal the available resources to realized their ideas.

This paper seeks to define the “non-technical skills” needed by a 21st century engineers to be functional, competitive and successful and the strategies by which new pedagogies based on emerging trend can aid students acquire them.

In Nigeria, engineering education fundamentally nexuses tertiary education. Therefore higher education is the hub of engineering knowledge and skills acquisitions in Nigeria.

Regrettably however, our tertiary education products appear apparently to be of very poor quality occasioned by very weak secondary education foundation. Hence it is expedient



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that educators in Nigeria structure the secondary school system so that it will product high-quality students well prepared for lifelong learning (ie continuing development of knowledge and skills that people experience after formal education and throughout their lives; and thereby provide the society the required sophisticated skills to fit into the rapidly changing economic and technological environment. This is because survival in such a dynamic economic and technological environment does not depend on strength neither does it depend on intelligence, but on one's prompt responsiveness to change.

Authorities from various quarters have eloquently emphasized that the competitiveness of any country and consequently, the general standard of living hinges on its ability to educate a large number of sufficiently innovation engineers. (the engineers of 2020, 2004); (Engineering Workforce, 2005); Rising above the Gathering storm, 2005).

Apelian, (2007) documented that during the industrial revolution, higher technical education had no meaningful governmental funding. He further noted that much of the industrial revolution was by individual ingenuity and entrepreneurial initiative. In that era knowledge was gained pragmatically in workshops and on construction sites. Apprenticeships became the way young men went it no engineering. This culture of practical hands-on attitude, a typical British culture and the culture which recognizes engineering as a noble profession that prepared the future statemen and leaders of the society occupying posts in the highest economic strata which is believed to be the perspective of the French, according to Apelian (1994) permeated across the Atlantic and impacted the development of engineering educators in American and other parts of the world including African. This marriage of theory and practice played on small role in engineering practice all over the world in the 20th century; however, finding, the right mix occupied engineering educators throughout the century.

There is no doubt that engineering education has undergone series of changes to adapt to the need of the society. This evolutionary trend will continue hence, change is needed to address the needs of the 21st century with respect to engineering.



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Grayson (1993) documented the major trends and classification of engineering education from where the following summary was deduced.

19th Century and First Half of the 20th Century: professional Engineer: As engineering became a distinct profession, early engineering programmes focused on providing their graduates with considerable hands on training. However the role of science and mathematical modeling slowly increased and gained acceptance.

Second Half of the 20th Century: Scientific Engineer: By mid century, technology progress, including the successful harnessing of nuclear energy, as well as geopolitical realities as materialized by sputnik, drove home the need for engineers to be well versed in science and mathematics and the engineering curriculum adjusted to the changed needs. This structure has, to a large degree, continue until the present time, although “design” content increase slowly. In the early nineties it was clear that more than science was needed and many schools started to emphasize non-technical professionals skills such as teamwork and communications.

The 21st Century

The rapid changes that the world is currently going through, coupled with changes in engineering education starting to take place in the nineties, are likely to result in an extensive re-engineering of engineering education. While the new structure will, almost certainly, continue to be based on a solid preparation in mathematics and science, it is likely to emphasize the professional role of the engineer, and then demand new qualifications suited for the new world order. Certainly, therefore, the engineering education has to add value beyond teaching skills. Again, the engineers of the 21st century must constantly be able to gather information and decide on a course of actions, including what tools are needed for a given task. In summary, technical skills the people skills and the innovation skills are required by the 21st century engineer.

Non-technical Skills Required by the 21st Century Engineer



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The Engineer of the 21st century must be able to do more than just perform technical tasks. The following non-technical skills are required for him/her to be able to compete and function globally.

- a. ***Century and Innovation:*** land (1998) and Friedman (2005) identified innovation as one of the most important factors in the future prosperity of both nations and individuals. In Engineering however, the challenges are much greater because, not only must the Engineer innovate, he or she must be able to help the innovation become a reality. Thus, the education of the engineers of the future must prepare them to see new opportunity as well as to give them the skills needed to assiduously harness the resources towards the realization of their ideas. Creativity involves expert thinking which entails effective pattern matching based on detailed knowledge; and meta cognition, the set of skills used by the stumped expert to decide when to give up on one strategy and what to try next. (Levy and Murnance, 2004). What a skilled auto mechanic does when all diagnostic system shows normal functioning, but the car is still malfunctioning is “expert decision making” inventing new problem solving heuristics when all standard strategies have failed.
- b. ***Entrepreneurship:*** Top remain functional and relevant engineers for an increasingly technological society, entrepreneurship as well as social context of engineering must be central in our curriculum for the 21st century. Linkage between the societal needs ought to be explicitly articulated. The engineer should be able to see the needs and gaps in the society, proffer solutions to them by tenaciously organizing resources (Human and Capital) together and then, make his profits.
- c. ***Communication Skills:*** Engineering programmes should require their graduates to exhibit proficiency in oral and written communications; this will enable the engineer work on diverse teams. The Engineer of 21st century therefore requires accurate and efficient communication perhaps more than most profession-I have to understand what you are saying and vice versa. Communication therefore, has to be an integral part of the engineering curriculum (Sachs 2005). It is surprising



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therefore that many institutions in Nigeria still admit students into their engineering programme without a credit pass in english languages; and yet no adequate provisions are made by such institutions for remedial programme for such inadequate prepared students.

Therefore, the 21st century Engineer should be able to communication effective, using both written and oral methods, use information technology effective, work in a multidisciplinary team and undertake lifelong learning for continuing professional development.

- d. ***Collaboration/Team Work:*** Working with others respectfully and effectively to create, use and share knowledge, solutions and innovation.
- e. ***Information Managements:*** Accessing, analyzing, synthesizing, creating and sharing information from multiple sources.
- f. **Effective use of Technology:** Creating the capacity to identify and use technology efficiently, effectively and ethically as a tool to access, organize, evaluate and share information.
- g. ***Career and life Skills:*** Developing skills for becoming self-directed, independent learners and workers, who can adapt to change, manage projects, take responsibility for their work, lead others and produce results.

Delivery and Padagogy

Today's students are no longer the people our educational system was designed to team. Engineering curriculum globally is shifting towards what are seen as 21st century priorities fro the profession. That Engineers solve problem, make things happen and enhance the quality of life on this planet is not new; however, what changed over time have been the need of the society and how engineers have responded to those needs. In going forward therefore, there are specific actions that we as a community (Engineering Community) should consider; the underlying theme is that we need to change the image of engineering and we need to fuel the "Innovation engine" we have always wanted students to be creative



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thinkers and problem solvers who have the skills necessary to function effectively in society and in the work place. However, the way in which these skills are incorporated in the classroom and how technology is integrated will greatly change instructions.

Instructions that meet the needs of today's students will incorporate: A verity of learning opportunities and activities for instance, need to move from sage on the stage to guide on the side. Team projects, open-ended problem solving, experimental learning, engagement in research and the Philosophy of CDIO (Conceive/design/implement. Operate) should be integral element of engineering education.

The role of teachers in a 21st century classroom shifts from that of the "expert" to that of the "Facilitator". Effective teaching would therefore require more emphasis on learning and less on grading. Sometimes, grading is very degrading.

To prepare students for their future lives and careers, they need to wrestle with real life problems that are engaging and relevant. The demand of the new era requires students to the active learners who learn important concepts through creative and innovative projects. Their involvement in the problem-solving process builds a culture of inquiry, in which asking and answering their own questions becomes the center piece of the learning process. As problem solvers, students use high levels of thinking a they apply content knowledge in innovation ways.

CONCLUSION

It is unthinkable that an engineer can remain competitive and relevant in our society in the 21st century without the know-how to innovate. To educate ready to face the challenges of tomorrow we must appreciate how profoundly the world has changed from a few decades ago. We therefore need to embrace these changes and move ahead to ensure that engineering profession and Engineers understand the societal context of the human dimension around the globe, coupled with innovation and creativity. The challenged daunting to academia but not impossible to tackle.



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