What are they made up of today? A look at Engineering Education in Developing Nations with Nigeria as a Case Study

Samuel T. Adedokun
Civil and Environmental Engineering Department, Florida State University, Tallahassee, FL 32312, USA

Abstract
There are thousands of young people in developing nations today whose dreams are being ‘assassinated’ and their hopes being ‘erased’. These young men and women will be the ones to lead their nation’s engineering industry tomorrow but may we ask what they are made up of today? This paper looks at what developing nations engineers are made up of today, how developed nations and the international professional societies like IEEE can help to save them out of their present predicament and save present generations and those coming. A case study for this article is Nigeria. Nigeria is the largest black nation in the World with about 130 million people and about 90% live below poverty of less than 1$ a day according to recent United Nations report. Also, Nigeria is the third largest exporter of crude oil in the world.

Keywords: engineering, education, IEEE, Nigeria

INTRODUCTION
I had a Dream
They filed out of the dormitory, just to catch a glimpse of “the star”. The news was all over the school… an ex-student had returned! That he was an ex-student wasn’t the issue and that he was even in the University was of no serious weight. But that he was a student of Engineering said it all! Here was someone who could look at a problem, come up with a solution and implement his idea, it was no exaggeration to say a wizard was in town. They were in high school, and had an unusual respect for engineers because they were creators – maybe not on the scale of the deity, but in a class of their own. The dream of becoming an engineer dwelt in the heart of many, if only they could cross the examination hurdles. A few friends therefore decided to embark on the prestigious journey – the journey into the world of engineering. It was a tall dream, but it was worth it. They were not exactly thrilled by the monetary prospects, but the power to create solutions and calm chaos was an adventure they were willing to embark on.

They knew that one of them would solve the problem of erratic power supply in their country (a developing one) if he could implement his “Independent Electric Power Generation” pet project. That was John. He was not endowed with so much flesh on his body but his brain was full of an idea. He had hurdles to cross but he was willing to give up anything just to become his dream “an engineer”GJ, and not only an engineer but the one to solve the “Christmas light” phenomenon he grew up to know. John finished as part of the top 10% of the class and proceeded to one of the foremost universities in his country to study Electrical Engineering and he did not hide his dream from anyone who could spare a few seconds. He must have used the phrase, “I have a dream” more than Martin Luther did.

The first tragedy struck when, at the Physics laboratory in his first year, he challenged a theory while conducting an experiment on gravity. He was willing to explain to the laboratory attendants that there was an error in the lecturer’s calculations during the lecture on gravity but they would not listen. “My friend, will you write what you see and stop feeling like Albert Einstein...”. He wouldn’t allow the case to settle there as he proceeded to the lecturer to clarify issues – and he was right. What was “stop feeling like Albert Einstein” supposed to mean? He discovered the answer to his thoughts over time. He graduated from the university with good grades but he knew that he wasn’t ready to create anything. He could remember the course titles but applying them to real life problems was going to be difficult – if not impossible. Then came another hurdle – he needed a job. He was at an interview and the only proof that he studied Electrical Engineering was his certificate!

The engineering literature today is saturated with diverse research documentations on the various aspects of the field. Extensive research has been conducted on the application of computer to engineering education (Abeles, 2001), how to improve the quality of education (Peel and Quayle, 2001), as well as the nature of certification and licensing of graduates (Jaeger, 2010). Sadly, these novel studies have failed to consider the situation in developing countries like Nigeria. It is hoped that this article, a picture of the state of engineering education
in Nigerian universities, will stimulate more research in this area of need.

**Historical Perspective of Technological Progress**

Engineers need to be interested in their own future, both as individuals as also as a group or profession. They normally look at it in terms of incomes, career progression, social status and relativity with other professions – especially bureaucrats and managers. Less often do they discuss engineers of the future in terms of what would be needed. Skill profiles of engineers change drastically when a technological revolution takes place. Agriculture represents the first revolution in the technological change brought about by mankind. This revolution started about 10,000 years ago and brought in the first major skill transformation in history.

The second revolution, known as the Industrial Revolution, took place in the 18th and 19th centuries. Countries that adopted it, left others behind and emerged as industrial giants. The divide is identified by the prevalent 2-segment model comprising of the north and the south, or the 1st and the 3rd world. The Industrial Revolution bypassed Nigeria, thanks to its colonial status. After independence, technological awakening commenced through a serious effort at development. Remarkable improvements took place in agricultural production, small and large-scale industries, infrastructural facilities e.g. irrigation, power and communications, and strategic areas such as education. Yet, the country is one among the numerous developing countries ridden with chronic problems of unemployment and poverty. With about 90 million people below the poverty line, literacy level and healthcare coverage woefully short, and supply of electricity and drinking water beyond the reach of millions, the gap between the potential and performance obscures the remarkable achievements of half a century of ‘planned development’. Nigeria became an independent Country in 1960!! The situation poses a tremendous challenge to the engineers of the future.

The third revolution was brought about by information technology. The advent of microelectronics, computers, satellite communications, internet and mobile telephony have radically changed the way people learn, think, work and live. Applications of IT have spread to all the production and service sectors including agriculture, health, education, entertainment and domestic appliances and even governance. This revolution also has affected countries to varying extent, grouping them broadly into two sets through the digital divide. Nigeria has a very poor penetration of IT activities amongst the masses. Yet, the country has made significant progress in the acquisition of knowledge and skills. International presence of Nigerian expertise in IT is a phenomenon by itself – even in most developed economies, including the United States. In Nigeria, engineering is taught in the universities, which award degrees at both undergraduate and graduate levels, and in polytechnics, which award diplomas. Historically, the first Nigerian engineers to receive formal training attended the old higher college, Yaba, Lagos, Nigeria in the 1940s. With the establishment of the University College Ibadan (now University of Ibadan, Nigeria) in 1948, Nigerians were sponsored to British Universities to train as engineers, on completion of a two-year pre-degree program at Ibadan. (Oladapo, 1994). Later, more universities such as Ahmadu Bello University, University of Lagos, Obafemi Awolowo University (formerly University of Ife) and University of Benin were established in the 1960s making it possible to train engineers locally. The number of Nigerian youths seeking education has increased in recent years and the number of universities and polytechnics has also increased. There are more than forty-five Federal, Private and State Universities and a large number of polytechnics, most of which offer courses in engineering or engineering science. At the same time, it is the author’s view that the standard of engineering education in Nigeria has fallen drastically.

**A Sincere Assessment of Today: The Problems**

There are thousands of young people like John in developing nations today. Their dreams are being assassinated and their hopes being erased. These young men and women will be the ones to lead their nation’s engineering industry tomorrow but may we ask what they are made up of today? How many of them still carry their dreams of revolutionising the engineering industry? Or has that been replaced with the drive to settle down to a plum job? How many of them are equipped with practical/working knowledge? How many of them can handle tomorrow’s tool – Information Technology? Or what can an engineer do without Information Technology?

From Geographic Information Systems to automated manufacturing processes, the sustainability of any engineering experience is built on the application of Information Technology.

I’m sure that this distinguished profession is conscious of its future. If the future is built around people and a profession around what its people-players know, we must then ask a sincere question: **How much of engineering do today’s Nigeria engineering graduates know?** We may be quick to blame students – they don’t read like we used to. Or we may be tempted to accuse lecturers of teaching theory and the nation of not producing a conducive environment but I think a holistic view will do a lot in helping us maintain standards of excellence in this non-compromising industry and also create an enviable future for the same.
Laboratories Or Museums
The state of laboratories/equipment rooms in much of engineering training institutions in developing nations needs some attention. It is embarrassing to know that there are graduates who never touched or handled tool of their profession. If there were to be an honest Engineering Equipment Audit for all institutions that award Engineering degrees in Nigeria, many of emerging engineers could have their certificates recalled!

The Problem of Obsolete Curricula
Another problem hindering effective engineering education in Nigeria is the issue of curriculum design. The engineering education curriculum in Nigerian Universities can be said to be obsolete. This curriculum, uniform to most universities, has not been thoroughly reviewed since the British who established universities and assisted in their development (Akintunde, 1994). To the author’s knowledge, computer based design packages (such as AutoCAD) are not taught in any Design programs at any of our universities; probably some have introduced them in the last couple of years. Instead, where computers would be used in developed nations, our students continue to use drawing boards and instruments. Even the instructors are not proficient in the use of computers! The course curriculum of our Universities must be revisited if we must break this cycle of half-baked graduates. Lecture notes are not updated regularly and this should also be discouraged - I would not be surprised if some lecturers’ notes are as old as their BSc certificates. Today, there are many engineering professors in American universities that had their first and second degrees from Nigerian universities in the good old days!!

The Problem of Student Exposure to Industrial Practice
In Nigeria, engineering students gain exposure to professional engineering practice through the Student Work Experience Program (SWEP) and the Student Industrial Work Experience Scheme (SIWES). These programs constitute part of the requirements for the award of an engineering degree. The SWEP program is usually conducted within the students’ local university at the end of the second year and lasts for between one to three months. The SIWES is an exposure to industrial practice. It runs for three months at the end of the third year plus a minimum of three and maximum of six months after the first semester of the fourth year.

Sadly, the universities have not gained the cooperation of industries in the SIWES program. Students still find it difficult to get positions for industrial attachment and when they do, they are not properly supervised to ensure that they actually acquire knowledge as well as technical skills. This is partly because the industrial/manufacturing base in Nigeria is very low and also because of the reluctance of industries to allow their facilities to serve as training grounds.

The Problem of Staff Qualifications and Experience
One major problem affecting the quality of engineering education in Nigeria is the low number of Senior Lecturers with ‘honorary’ PhD qualifications. There exist presently in Nigerian universities, especially in the engineering faculties, an unhealthy situation where most of the academics belong to the junior cadre (Lecturer I, Lecturers II, Assistant Lecturers who are still learning the ropes) by virtue of their qualifications (having only Masters degree). A small minority is of professorial rank; most of who are fast approaching the age of retirement. Thus, a vacuum exists in the middle stratum, occupied by very few senior lecturers. How this vacuum came to be, isn’t quite clear. However, it is clear that if this situation persists, the standard and quality of engineering education in Nigeria will drop when the more experienced staff retires. Nigerians abroad with PhDs in Engineering have refused to return home because of the low standard of living. This trend started in the late 80’s and has since continued to this day.

Should Engineers Be Innovators?
Many young Nigerians grow up as innovators but pass through school to become job seekers! It is a cycle that must be broken by all stakeholders concerned. I grew up hearing of a certain Okati Motors that was building automobiles from 70% local materials, but such have since disappeared. Course advisers do not identify and assist young people to become tomorrow’s innovators. Final year projects are not solution-specific endeavours and are usually reproduction of some forgotten thesis from the school library. This would never move us forward! The proportion of students enrolled in engineering and technology increased from 9 to 12 percent between 1998 and 2003, the level of unemployment among the engineering graduates still remain at 18% at the end of 2003; that was about the time the statistics was available!!

The Problem of Low Funding
Inadequate funding of the academic sector besets engineering schools in Nigeria. Funding for Nigerian Universities has traditionally been from grants by governments and international agencies, research donations and contracts usually tied to specific projects, consultancy and other services rendered by the university, and endowments (Akintunde, 1994). Our first generation institutions, the ones that have existing facilities for teaching, are the most deeply affected by low funding. For example, the University of Ibadan needed about N250 million per month for
salaries alone (in 2003!), but the government provided just 42% of this amount. The University of Lagos required at least N200 million monthly the same year (2003) [6]. A dollar was about one hundred and thirty Naira (1$ = N130). Whilst engineering education in Nigeria cannot be described as substandard, it is nevertheless inadequate to completely equip students to cope with the challenges of modern day society. The Government funding amounts are grossly inadequate to support existing staff, maintain infrastructure and facilities, much less embarking on new project which are capital intensive. Except, of course, such projects are funded by grants from international agencies. Nigeria’s education sector has been allocated a declining share of GNP over the past two decades (see Table 2).

Table 1: Advertized Job Openings in the Nigeria Economy, 1995 – 2003

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<tbody>
<tr>
<td>Engineering</td>
<td>191</td>
<td>267</td>
<td>136</td>
<td>118</td>
<td>65</td>
<td>53</td>
<td>72</td>
<td>902</td>
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<tr>
<td>Computer Services</td>
<td>97</td>
<td>79</td>
<td>52</td>
<td>19</td>
<td>61</td>
<td>35</td>
<td>72</td>
<td>415</td>
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<tr>
<td>Administration</td>
<td>176</td>
<td>159</td>
<td>249</td>
<td>109</td>
<td>68</td>
<td>61</td>
<td>73</td>
<td>895</td>
</tr>
<tr>
<td>Accounting</td>
<td>147</td>
<td>173</td>
<td>139</td>
<td>44</td>
<td>87</td>
<td>49</td>
<td>80</td>
<td>719</td>
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<tr>
<td>Marketing</td>
<td>132</td>
<td>90</td>
<td>84</td>
<td>61</td>
<td>67</td>
<td>51</td>
<td>9</td>
<td>439</td>
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<td>Education</td>
<td>96</td>
<td>71</td>
<td>74</td>
<td>10</td>
<td>5</td>
<td>20</td>
<td>1</td>
<td>277</td>
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<tr>
<td>Insurance</td>
<td>30</td>
<td>40</td>
<td>17</td>
<td>6</td>
<td>5</td>
<td>2</td>
<td>2</td>
<td>100</td>
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<tr>
<td>Agriculture</td>
<td>34</td>
<td>23</td>
<td>1</td>
<td>4</td>
<td>4</td>
<td>-</td>
<td>6</td>
<td>72</td>
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<tr>
<td>Health</td>
<td>165</td>
<td>245</td>
<td>93</td>
<td>18</td>
<td>13</td>
<td>31</td>
<td>390</td>
<td>955</td>
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<tr>
<td>Total</td>
<td>1068</td>
<td>1147</td>
<td>845</td>
<td>389</td>
<td>375</td>
<td>302</td>
<td>703</td>
<td>4774</td>
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Table 2: Total Public Expenditure on Education as Percent of GNP (Recent data are not available!)

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<tr>
<td>Nigeria</td>
<td>6.4</td>
<td>1.2</td>
<td>1.0</td>
<td>0.7</td>
<td>0.7</td>
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<tr>
<td>Ghana</td>
<td>3.1</td>
<td>2.6</td>
<td>3.3</td>
<td>4.8</td>
<td>4.2</td>
</tr>
<tr>
<td>Kenya</td>
<td>6.8</td>
<td>6.4</td>
<td>7.1</td>
<td>6.7</td>
<td>6.5</td>
</tr>
<tr>
<td>South Africa</td>
<td>-</td>
<td>6.0</td>
<td>6.5</td>
<td>6.8</td>
<td>7.9</td>
</tr>
<tr>
<td>Sub-Saharan Africa</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>4.2</td>
</tr>
<tr>
<td>Low-income Countries</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3.7</td>
</tr>
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Source: EdStats, World Bank, 2002; *the 2002 figures are unweighted group average

Certificates Versus Proficiency
Our present educational system is certificate-driven which should not be. Our lives and careers are not built around being proficient so that we can stand up and be counted. Below are comments on the Nigeria engineering graduates by some major employers/organizations as reported by Dabalen and Oni, 2000.

Preparing for Tomorrow: Solutions
It is not too late to awaken the spirit of excellence in Nigeria’s emerging engineers - recent graduates and students. But beyond that, young people should be involved in mainstream decision-making, as they will be the ones to maintain the outcomes of such decisions. I grew up being told that “today’s young people are tomorrow’s leaders” but is that saying still valid today? Probably not in Nigeria! If we do not equip young people today, we must not complain if they derail the society tomorrow.

Changes to Funding Paradigm
Inadequate funding is a most serious problem. The Science and Engineering programs at Nigerian universities feel the pinch more than others because they depend on laboratory, workshop and industrial activity (Akintunde, 1994). All federal universities in Nigeria receive a basic level of funding from the government, which is quite inadequate. Assistance from the international community is needed in the provision of teaching aids, equipment in the laboratories and books in the libraries. About 99% of the articles in our libraries were published before 1990.
Table 3: Comments of Employers in Key Sub-Sector

<table>
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<tr>
<th>Employer</th>
<th>Comments</th>
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<tr>
<td>Nigerian Institute of Personnel Management (NIPM) and Nigerian Institute of Management (NIM)</td>
<td>NIPM and NIM are not employers. They assist employers to recruit qualified manpower and cater for the interest of members of their institutes. Comments: Quality of graduates is on rapid decline. Graduates lack in all skills: communication, technical, conceptual/analytical and human interactive/social skills. Firm engage in long, tortuous and costly processes of recruitment. National Manpower Board is already moribund. Neglect of the education sector is the major cause of the problem of low quality graduates.</td>
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<tr>
<td>Council of Registered Engineers of Nigeria (COREN)</td>
<td>COREN maintains a register of engineers and monitors engineering practice. They feel that Nigerian engineering education does not teach problem-solving skills. Although quality of engineering education is poor, engineering graduates are particularly wanting in technical and communications skills.</td>
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<tr>
<td>Shell Nigeria PLC</td>
<td>The petroleum industry is a major employer of engineering and other science graduates. In 2002, Shell alone employed 132 out of 189 graduates that were accepted into its training programs. Most of the remaining 57 were accepted by other oil companies. To minimize the effect of poor graduate preparation on its operations, Shell runs an intensive training program in Warri, Nigeria. The training program runs for a year and is implemented by consultants from Europe and lecturers from Nigerian universities. Other oil companies such as Mobil have similar programs although not in the same scale as Shell. Shell spends about $12000 per year per trainee as of 2005.</td>
</tr>
<tr>
<td>Halliburton, Port Harcourt, Nigeria</td>
<td>Between 1997 and 2000, Halliburton employed 500 engineers. However, in just one year, the corporation receives thousands of applications. In the year 2000, it received 8000 applicants, from which 14 will be selected for training in the USA.</td>
</tr>
<tr>
<td>Anambra Motor Company (ANAMCO), Enugu, Nigeria</td>
<td>Both companies find that polytechnic students on industrial attachment have relatively higher technical competence than university graduates. However, the quality is generally so bad that most recruits add no value to the company. The screening process is necessitated by what the employers see as unacceptably poor preparation of graduates for the world of work. In particular, PAN plans to initiate a more intensive training program even for those who pass the aptitude test, to teach cutting-edge automotive engineering techniques that are unavailable from the university course loads.</td>
</tr>
<tr>
<td>Dantata and Sawoe, Kano, Nigeria</td>
<td>Dantata and Sawoe is a construction company. They recruit mainly graduates in surveying, civil and mechanical engineering. As to the quality of graduates, the supervisors were not impressed by the average graduate, but they also acknowledged that their firm did not have a significant problem finding good engineers because the company always selected the very best out those who came for industrial training and national service. Once recruited, they are assigned to mentors – supervisors for good on-the-job training.</td>
</tr>
<tr>
<td>Nigerian Telecommunications Limited (NITEL), Abuja, Nigeria</td>
<td>NITEL is one of the largest of the engineering employers. It employs graduates from various engineering fields (but especially electronics and electrical engineering), physics, computer science and other professions such as accounting and economics. They rarely employ fresh graduates because the quality of their training is not good.</td>
</tr>
</tbody>
</table>

Source: Dabalen et al, 2000

Facilitation of University-Industry Partnerships
Government policy must be directed towards removing obstacles such as the small industrial base and the unwilling industrialists to co-operate with the SIWES and SWEP programs. Nigeria is in urgent need of industries that are willing to support research efforts in the universities. These industries are not available now!

Modernisation of Curriculum Through Contact with the International Community
It is important that engineering curriculum, course content and teaching methods evolve in partnership with changes in environment and technology. Extensive educator-practitioner interaction is a vital element in maintaining the currency of the engineering program and ensuring that it achieves the needs of industry, government and society. Advisory groups and professional activities should be a vehicle for the development of programs which enable engineering faculty and engineering practitioners to work at the student level, so that engineering education will truly be educating engineers for doing engineering.
Programs in which students work on real engineering projects provided by local engineering industries must be developed. This will expose students to all aspects of design from initial concept to the finished product.

**Changes to Licensing Requirements for Professional Engineers**

In Nigeria, licensing of engineers is done by the Council for the Regulation of Engineering in Nigeria (COREN) and the Nigerian Society of Engineers (NSE), the regulatory bodies for the Engineering profession in the country. The process entails the presentation of a written report on relevant post-graduation work experience and an assessment by examination. There is a need for a new licensing model. COREN and NSE should consider the possession of a Masters degree in any engineering program as an alternative requirement for licensed practice, apart from further examination as the sole route to licensure.

This, of course, would only be possible if our universities are able to satisfy accreditation requirements and our engineering students graduate from COREN and NSE accredited programs, which would provide necessary and sufficient evidence of education preparation.

**Information Technology And Engineering – Together In Technology**

Engineering and Information Technology cannot be isolated from each other. It should be a taboo for a graduate of engineering to say he/she does not have a working knowledge of the computer – at the very least! This is a challenge to every emerging engineer as the days when we had all the excuses are gone. We can now access information on practically every sphere of engineering on various websites, including those built by Nigerians and Nigerian corporations. Developing nations have a lot of catching up to do as far as the Information Society is concerned. With the physical boundaries that separated nations melting off due to the emergence of a boundless Information Society, any people-group, nation or region that does not line up with the expectations of the New Economy – which is primarily driven by Information and Communication Technologies - will experience lonely moments on the island of insignificance.

**CONCLUSION**

The task of building a new Nigeria is the Nigerian general responsibility and with support from the international community. I know it is a question of **when** Nigeria would be great, but **who**? I can decide to answer the **when** question now but can Nigeria’s engineers be the ones to answer the **who** question?

I hereby solicit for assistance from the international community who have items that are not being used and can be useful to us in our universities. Any assistance can be directed to Nigeria Universities Commission, the body that regulates Nigerian Universities. Also, our universities would be appreciative to receive copies of articles in our libraries.

Thank you for the opportunity given to me to put up this article.

**REFERENCES**


