**“ENGINEERING LAW AND MANAGERIAL ECONOMICS FOR INFRASTRUCTURAL DEVELOPMENT IN NIGERIA: CHALLENGES AND WAY FORWARD**”

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# ABSTRACT

The place of any country in this technological age would be predicated on the role of Engineers.

In performing their role, Engineers are faced with a lot of challenges and the Nigerian engineers are no exception. This paper discusses the engineering profession, world federation of engineering organization (WFEO) proposal on Engineering ethics, the history of engineering science in the world and the history of Engineering in Nigeria. It also highlights Engineering challenges in Nigeria and the task ahead for a sustainable development.

**INTRODUCTION**

**What is engineering?**

 Engineering covers many different types of activity. Engineers make things, make things work and make things work better. They also use their creativity to design solutions to the world’s problems and help build the future. Engineering has previously been defined by the Royal Academy of Engineering as the ‘creative application of scientific principles’, principles that are put in practice to invent, design, build, maintain and improve structures, machines, devices, systems, materials and processes. This definition of engineering is broad, intended to account for the fact that the scope of engineering is continually evolving because of the dynamic nature of engineering-related industries.

There is a diverse range of specialized engineering disciplines or fields of application, including (but not limited to):

* aerospace
* chemical and process
* civil and environmental
* computing and communication
* electrical and electronics
* energy and power
* materials and mining
* manufacturing and design
* medical and bioengineering
* Transport and mechanical.

 Engineers are responsible for some of the most important advances in biomedicine, and they have played a key role in building the infrastructure around us – from roads to utility networks. Engineers also play a role in the development of the food we eat and the development of new materials, such as cutting-edge foams and coatings to be used in manufacturing. With half the world living in poverty and millions of people without sufficient food or sanitation6, engineering continues to have a key role to play in helping countries to progress across the world.

. **The History of Engineering Science in the World**

Engineering is the application of science. Without science, no engineering results can be achieved for practical usage [4]. The exact origin of the engineering profession can be considered to have been at the time the first man used his ingenuity to adapt the materials and forces of nature to meet his needs. Civilization brought miracles into science in the third, fourth and fifth centuries B.C. These were the times when Plato (427-347 BC), Aristotle (384-322BC) and Archimedes (287-212 B.C) lived. The modern Science actually came into existence in the

17th century. This century exhibited the works of some of the following scientists
and engineers.

• Kepler (1571-1630) laid down the three laws of planetary motion in 1609-1617.

• Newton (1642-1727) formulated the laws of motions

• Galileo in 1593 invented the thermometer and 1609 use his telescope to discover Jupiter’s moons.

• John Napier developed Logarithms to aid calculation work. This Lead to the invention of a calculating device called slide Rule.

• Leibnitz developed a mechanical computer in 1673.

• Charles Babbage an English man stated in 1823 the idea of the modern computer and there after invented the first automatic machine capable of doing arithmetic at a fast rate.

• Alessando Antonio Volta (1745-1827) an Italian physicist invented the electric battery in 1796, which was named after him.

• Andre-Marie Ampere (1775-1836), a French Mathematician and physicist laid the foundation of electrodynamics.

• Michael faraday (1791-1867), an English chemist and physicist was the greatest Experimentalist who ever lived. He discovered the electromagnetic induction in1831, which opened the door for the generation of electricity.

• Joseph Henry (1797-1878), an American Physicists, discovered the inductance and constructed an electric motor.

• Gauss and Weber in 1833 discovered a telegraph apparatus and the Morse code.

• Draisine, a German in 1816, designed the first two-wheeled vehicle called bicycle.

• Charles and frank Duryea made the first American internal combustion motor car in1893.

The list of Scientist and Engineers is endless, man is creating, solving problems on daily basis and has moved into other planets for research. The rapid advance of technology has brought forth many societies and many technological and professional organizations of potential interest to Engineers such as the World Federation of Engineering Organization (WFEO). The establishment of this unity organization has brought about the further development of the engineering profession.

**The Engineering Profession**

Engineering has been defined as that Art of Science that harnesses the resources of nature to produce and maintain an artefact for the benefit and convenience of mankind. It is the practice of designing machines, bridges, railways, electrification of cities, communication equipment, petrochemical industries etc. In short, it is the application of science to solve societal problems

 The Oxford Advanced Learner’s Dictionary defines profession as “a type of job that needs special training or skill, especially one that needs a high level of education”. There are a number of characteristics which distinguished a profession from other less formally constituted trades and occupations.

1. The professional discipline has a command of a specialized body of knowledge necessary for planning, design, construction and operation of physical structures or engines/machines.
2. The body of knowledge is transmitted through recognized training and regularly updated on behalf of the professional body to ensure certified standards of proficiency.
3. A code of Ethics and standards govern the practice of the profession and ensure the satisfaction and safety of the client in particular and the society in general.
4. A monopoly is usually granted to a professional body by society through laws to ensure that only registered members can engage in the professional practice.
5. The members are committed to constant educational renewal through a lifelong learning of latest technology and professional development.
6. The professional body is legally to regulate itself, discipline its members and control the practice of the profession. The engineering profession exists in every aspect of human endeavor cutting across religious, socio-cultural, economic and political barriers, hence engineering is a way of life. Professionalism is about commitment to standards of excellence in the performance of tasks which require specialized skills and expertise. And a professionalism thus someone whose basic satisfaction is in performing well, task for which he has been trained and always strives to achieve the best standard possible in any circumstance. Thus, to be a professional is to flaunt the highest levels of the skills one professes to command.

**The History of Engineering in Nigeria**

Government establishments and private entrepreneurs in Nigeria have been addressing themselves to the problem of developing technology that is definitely a solution to improving the quality of life of the people, maximization of the use of available resources and creation of more job opportunities. The history of engineering in Nigeria traces its root to the establishment of the Public Works Department (P.W.D) of southern Government in Lagos in 1896, the P.W.D comprised mainly of three sections (Civil, Mechanical and Electrical). It was responsible for the management of engineering problems in the southern Government of Nigeria. As the country entered into independence in 1960, the three regions (North, East and West) had their separate P.W.D. In 1966, the Nigerian council for scientific and industrial Research (NCSIR) was established, The NSCIR gave rise to the establishment of: International Institute of Tropical Agriculture, Ibadan (IITA) in 1967, Kaduna polytechnic in 1968, Yabba College of Technology in 1969, and a new council called Nigerian Council for Science and Technology (NCST). The creation of the NCST engendered the promulgation of Nigerian Steel Development authority (NSDA) Decree of 1971.In the same year, the Agricultural Research Council of Nigeria (ARCN) was established. Also, in 1971 on the recommendation of NCST, the industrial Training Fund (ITF) was established. In 1973, the Petroleum Technology Development Fund was created to train Nigerians in the field of Engineering, Geology, Science and Management in the petroleum Industry. This lead to the establishment of the Petroleum Training Institute, Warri. The National Science and Technology Development Agency (NSTDA) was established in 1977 and in 1980, a separate Ministry of science and Technology was born. In compliance with Vienna (1979), directives and recommendations, apart from the existing specialized Federal Polytechnics, more Federal Universities of Technology were also established in 1980 to cater for the training of engineering manpower. In 1987, the National Science and Technology Fund (NSTF) was put in place to provide fund for activities in science and technology. In 1988, the Raw Materials Research and Development Council (RMRDC) was born for the development of industrial raw materials, creating self-sufficiency and maximization of inputs to local industries. Evidence of Engineering and Technology in Nigeria is seen in development and adaptation of appropriate machines and equipment for easing out tedium and drudgery in certain operations in agriculture and Industries developed by these government agencies. These indigenously developed adapted machines and equipment are now becoming regular exhibits at trade fairs, shows and exhibition that are regularly organized by government agencies, associations and private industrialists.

**What is economic development?**

Economic theory suggests that growth in the economy, which is the only means of increasing the prosperity of a country, depends on the quantities of the factors of production employed – labor and capital – and the efficiency with which those quantities are utilized. Growth is sustained by increasing the amounts of labor and/ or capital that are used and by increasing the efficiency with which they are used individually and in combination to produce output.

Countries in the economic development phase must focus on improving the efficiency of utilization of labor and capital. For example, reducing the price of capital utilization to encourage greater utilization to better ‘sweat’ the assets, or through transport infrastructure improvements that shrink geographies, making labor more mobile and flexible. This increases the likelihood of finding a job in which they can maximize their potential, while reducing search costs for companies that can access a wider labor market. Economic development is crucial in creating the conditions necessary to achieve long run growth, particularly in developing nations.

**S**ince Nigeria’s Independence in 1960, successive governments of the federation have devoted a lot of effort to the creation of physical facilities, such as roads, power supply, water supply,

Educational buildings, housing, hospital, communication etc., which are basic requirements for the social and economic well-being of the nation. And itis obvious that the nation has been faced with a lot of engineering challenges since independence .The issue now is the extent to which Nigerian Engineers responded to these engineering challenges for sustainable development. Much has been written about sustainable development. The varying definitions are based on the economic, social, environmental and political realities, sustainable development suggests a condition wherein the decisions undertaken today do not prevent possible alternative decisions in the future. In addition, it is generally accepted that sustainable development is driven by a need to demonstrate increased environmental awareness in our day-to-day lives and decision making. And the Nigerian Engineers just as their counterpart in other part of the world who have acquired the Art and Science which would enable them to harness and direct the resources of nature for the benefit and convenience of mankind, should be able to harness and direct the resources of nature for the economic, social, environmental and political well-being of mankind.

**Engineering Challenges in Nigeria**

* Engineers being all in all: In most government and private establishments in Nigeria, engineering personnel are assuming to know all. A civil engineer can be employed to do the work of an electrical engineer, chemical engineer, Mechanical Engineer etc. at the same time instead of seeking the services of engineering professionals in these other areas of engineering.
* Corruption: most engineering projects in the country is carried out using the fifty percent (50%) rule, thereby eating the capital and not the profit. That is, contractors giving even more than fifty percent of the total cost of a project to some corrupt government officials and politicians before actually embarking on a project and in most cases, since the remaining part of the money will not be enough to do the job, the project may not be carried out and if it is carried out at all, it is usually sub-standard or abandoned.
* Non-Engineers carrying out engineering contracts using engineering credentials: Most engineering contractors carry out engineering projects using engineering credentials of engineering professionals in order to win or get engineering contracts.

* Politics: the nature of the training of the engineers does not actually expose him/her to be actively involved in politics, though they may be passively involved. For instance, a power engineer in a power station cannot be actively involved in politics. Since power stations are usually sited in secluded areas.
* Existing engineering facilities and infrastructures not being upgraded: most engineering establishment ever since they were commissioned have not been upgraded, thereby not able to meet up with the present-day demand.
* Non-adherence to workshop sections in conferences: most engineering conferences do not adhere to workshop sections, usually after technical paper presentation, then, it is all over.
* Attitude towards maintenance: our industries and infrastructures are built “once and for all” without any routine maintenance work, the result is the general decay of industries and infrastructures in the country.

* Reverse engineering not in our engineering curriculum; hence, making technology transfer somehow difficult.

* Engineers not fellowshipping with their colleagues; most engineering personnel occupying managerial positions are not registered with the Nigerian society of Engineers (NSE) and the council for the regulation of engineering in Nigeria. (COREN). Hence, such person’s may seem not concern with the advancement of engineering and technology in the country.
* Research and Development: Government lackadaisical attitude towards research and development hinders research opportunities in research institutions and universities. Government considers research and development to cost a lot of money and there is no link between research institutes, universities and industries in the country.

Technological advancement serves as a major key to a nation's development. On the other hand, proper engineering knowledge (acquired through appropriate structures) plays a major role in the attainment of a high level of technological advancement. Most developing countries (Nigeria) find it difficult to impact adequate knowledge and training to engineers at different levels of training.. In addition to finding solutions to the above problems, recommends better remuneration for practicing engineers, appropriate government policy and disposition and intervention of professional and international bodies (through provision of financial and material assistance) for assisting in the training and practice of engineers in Nigeria and in order that the country may achieve meaningful development comparable with foreign countries.

**The Task Ahead for A Sustainable Development**

* Different engineering personnel in various fields should be employed in all engineering Departments in both government and private establishments, so that specific jobs can be given to an engineer in his/her chosen area of specialization. That is, there should be division of labor.
* The pay package of engineers in Nigeria should be commensurate with their counterparts in Europe and America, so that they will not be tempted to eat the capital of any project.

* Engineers should be discipline and avoid non-engineers using them to achieve their selfish aim. They should only tender their certificate when they are involved in a project. And establishments should be mandated by the Nigerian society of engineers, to employ at least one registered engineer.

* Just as the office of the Attorney General is occupied by a lawyer, the offices of the ministers and commissioners of Energy, Works and Housing, Environment and Transport should be especially for engineers.

* Existing engineering facilities and infrastructures should be upgraded with the present-day state of the art facilities in order to meet up with the present-day demand.

* Engineering conferences organized in Nigeria should always adhere to workshop sections after technical paper presentation, this will go a long way to develop our local technology.

* Routine maintenance work should be carried out, on a regular basis after a project have been commissioned, this will increase the life span of such infrastructures and facilities.

* Reverse engineering should be introduced into our educational curriculum, in order to make technology transfer very easy, we should all embrace the popular “Igbo-made “and stop using foreign labels on our locally manufactured goods.

* Engineers should be mandated to belong to their professional bodies and without this, they should not be allowed to practice. That is, they should be mandated to fellowship with their professional colleagues.

* Government should make money available for engineering research and development, in order for the country to advance technologically.

**Sustainable Development Goal**

1. End poverty in all its forms everywhere
2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture
3. Ensure healthy lives and promote well-being for all at all ages
4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
5. Achieve gender equality and empower all women and girls
6. Ensure availability and sustainable management of water and sanitation for all
7. Ensure access to affordable, reliable, sustainable and modern energy for all
8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
10. Reduce inequality within and among countries
11. Make cities and human settlements inclusive, safe, resilient and sustainable
12. Ensure sustainable consumption and production patterns
13. Take urgent action to combat climate change and its impacts
14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development
15. Protect, restore and promote sustainable use of terrestrial eco-systems, sustainably manage forests, combat desertification and halt reverse land degradation and biodiversity loss
16. Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels
17. Strengthen the means of implementation and revitalize the global partnership for sustainable development

 Engineers help countries by developing infrastructure that provides basic services such as energy; water and food security; transport and infrastructure; communication; and access to education and healthcare. Linked to these goals, engineering should also have a positive impact on factors such as life expectancy that over time can be expected to aid economic development through improvements to productivity, which in turn results in increased GDP. However, the extent to which engineers can aid development is also dependent upon governments committing finance and resources to infrastructure projects, as well as developing a favorable business environment with good regulation and without corruption.

**The current and future role of engineering**

 According to UNESCO, engineering has been, and will continue to be, challenged with designing systems that facilitate education and healthcare, enhance quality of life, and help to eliminate global poverty. It considers that the development of technological approaches that can help prevent or mitigate hostile acts76, reduce the impact of natural disasters, and motivate humans to reduce their use of the earth’s valuable resources, will be key challenges for engineering in the coming years. Alongside these, we can expect that engineering will continue to play a key role in helping to avert environmental crises, as well as helping to reduce poverty – for example through engineers providing community infrastructure.77

Engineering already plays an important role in managing and conserving resources, from water to food, energy and materials. For example, engineering skills have been essential in ensuring the development of systems relating to water and wastewater treatment. Given that some parts of the world still lack access to water, engineering skills will remain essential to ensure universal access to clean water and sanitation. Engineering has also been extensively involved in finding solutions to reducing carbon emissions alongside ensuring increased portions of the world’s population have access to sustainable power. Engineering’s role in this area is likely to continue to be important in the coming years, especially as in 2015 it was estimated that 2.8 billion people still did not have access to modern energy services, and that over 1.1 billion people were without electricity.78

In addition, with the global population expected to grow to 9.7 billion by 205079, engineering will become increasingly important in ensuring future food security. For example, by ensuring that there are sustainable food production systems in place that maintain ecosystems, and by helping to improve land and soil quality. Over and above.

**Conclusion**

Engineering is a double-edged sword. It is both the cause of many environmental, social, economic and political problems faced by man and also a key to solving them. It is now recognized that engineers need considerable support in their attempts in various walk of life to promote sustainable development. There is no doubt that a lot has been achieved by the Nigerian engineers in this respect, but our unsatisfactory performance so far is a principal challenge for us to preserve the conditions for life and welfare of mankind, today and in the future. Even though our submissions here may not be all inclusive, it is our candid opinion that if the opinion given above are adhered to, and the engineer upholds the values of truth, honesty and trust-worthiness human life will be safeguarded.