

2

EDUCATING AND PROMOTING ENGINEERING PRACTICE AMONG WOMEN IN AFRICA

BY

ENGR. (MRS) UKAZU IRENE UCHENNA, MNSE

DEPARTMENT OF TECHNICAL EDUCATION, SCHOOL OF VOCATIONAL
& TECHNICAL EDUCATION,

&

SAGBARA STELLA DORNHUBARI

DEPARTMENT OF HOME ECONOMICS EDUCATION, SCHOOL OF
VOCATIONAL & TECHNICAL EDUCATION

FEDERAL COLLEGE OF EDUCATION,

PANKSHIN, PLATEAU STATE, NIGERIA

Abstract

This paper examines the promotion of women in Engineering through the education, training and practice of engineering among women and to provide multidisciplinary and multicultural experience in learning and authentic engineering practice.

Keyword: Meaning of engineering, history of engineering, branches of engineering, ways of promoting engineering among women and relationship of engineering with other discipline.

Introduction

Traditionally, engineering has been a male dominated profession; yet despite both a growing interest among women for studying engineering and a level of acceptance for women in

some engineering disciplines remain under-represented. As a result, women experience some particular challenges related to their studies as well as to their professional practice, including female engineering place in leadership, management and on site, and balancing professional and family life. Elise Fahey & Dorothy Missingham (2011).

What is Engineering?

From Wikipedia , the free encyclopaedia, engineering is the science, skill, and profession of acquiring and applying scientific, economic, social, and practical knowledge, in order to design and also build structures, machines, devices systems, materials and processes.

The American Engineer's Council for Professional Development (ECPD), he predecessor of ABET has defined "engineering" as the creative application of scientific principles to design or develop structures, machines, combination, or to construct processes, or works utilizing them singly or in life and property. same with full cognizance of their design, or to forecast their behaviour under specific operating condition, all as respects an intended function, economics of operation or safety to life and property.

History of Engineering

According to Jenkins (1936); engineering has existed since cancient times as shumans devised fundamental inventions such as the pulley, lever, and wheel. Each of these inventions is consistent with the modern definition of engineering, exploiting basic mechanical principles to develop useful tools and objects.

The word 'engine" itself is of even older origin, ultimately deriving from the latin word Ingenium, meaning "innate quality, especially metal power, hence a clever invention" Later, as the design of civilian structures such as a technical discipline, the term civi engineering entered the lexicon as a way to distinguish between those specializing in the construction of such non-military projects and those involved in the older discipline of military engineering.

Ancient Era

In the ancient era, the origins of engineering can be traced back to **Ancient Egypt**, where one of the earliest civil engineers, **Imhotep**, played a significant role. He is believed to have designed and

supervised the construction of the **Pyramid of Djoser** around **2630-2611 BC**. Imhotep is also credited with innovations such as the introduction of columns in architecture. The term "engineer" derives from the Latin word *Ingenium*, which refers to innate talent, skill, or mental power. In the context of early civilization, engineers worked on both military and civilian projects. Over time, **civil engineering** emerged as a distinct discipline, primarily focusing on non-military constructions.

Renaissance Era

The **Renaissance** saw the rise of new engineering disciplines and advancements in technology. For instance, **William Gilbert** is considered the first electrical engineer, having coined the term "electricity" in his 1600 publication *De Magnete*. Similarly, the first **steam engine** was built in **1698** by mechanical engineer **Thomas Savery**, which sparked the Industrial Revolution, revolutionizing manufacturing processes and mass production.

Modern Era

In the **modern era**, advancements in **electrical engineering** began with the experiments of pioneers like **Alessandro Volta**, **Michael Faraday**, and **Georg Ohm**. The invention of the **electric motor** in 1872 and developments in electronics, such as the vacuum tube and the transistor, led to the rapid growth of electrical and electronic engineering.

Mechanical engineering emerged during the Industrial Revolution, with **James Watt** improving steam engines, which contributed to the rise of modern manufacturing. Similarly, **John Smeaton**, regarded as the "father" of civil engineering, made important contributions, including the design of the third **Eddystone Lighthouse** and advancements in hydraulic lime and cement.

Chemical engineering grew during the Industrial Revolution, with the demand for large-scale chemical production in industries. By the late 19th century, **aeronautical engineering** began to take shape with the work of **Sir George Cayley** and later, the **Wright brothers**.

Branches of Engineering

Engineering is a broad discipline that is divided into several branches, each focusing on specific aspects of technology, design, and production. Some of the main branches of engineering include:

1. **Chemical Engineering:** Involves the application of principles from physics, chemistry, biology, and engineering to carry out chemical processes on a commercial scale.
2. **Civil Engineering:** Focuses on the design and construction of infrastructure such as airports, roads, bridges, dams, and buildings.
3. **Electrical Engineering:** Deals with the design and study of electrical and electronic systems, including circuits, motors, generators, telecommunications, and computer systems.
4. **Mechanical Engineering:** Concerned with the design of physical systems such as engines, compressors, power trains, transportation products, and energy systems.

Other Branches of Engineering

Additional specialized branches of engineering include:

- **Aerospace Engineering:** Focuses on the design of aircraft and spacecraft.
- **Environmental Engineering:** Addresses environmental protection through sustainable technologies.
- **Software Engineering:** Involves the design, development, and maintenance of software systems.
- **Biomedical Engineering:** Combines principles of engineering and biology to design medical devices and equipment.

From ancient civilizations to the present day, engineering has evolved into a highly specialized and diverse field. From the construction of the pyramids in Egypt to the development of modern technologies such as electrical and aerospace engineering, the history of engineering highlights its crucial role in shaping the world as we know it. The various branches of engineering today continue to drive innovation and development across industries and sectors, playing an essential role in shaping future technological advancements.

Ancient Era According to Bary, Ancient Egypt, the earliest civil engineer known by name is Imhotep. As one of the officials of the Pharaoh, Djoser, he probably designed and supervised the construction of the pyramid of Djoser (the step pyramid) at Saggara in Egypt around 2630- 2611 BC. He may also have been responsible for the first known use of columns architecture.

Renaissance Era

According to Bilington, David P. (1996), the first electrical engineer is considered to be William Gilbert, with his 1600 publication of *De magnete*. who coined the "electricity". The first steam

engine was built in 1698 by mechanical engineer Thomas Savery. The development of this device gave rise to the industrial revolution in the coming decades, which mathematics and science were applied to these ends, allowing for the beginnings of mass production. With the rise of engineering as a profession in the eighteenth century, the term became more narrowly applied to fields in which mathematics and science were applied to these ends.

Modern Era

Electrical engineering can trace its origin in the experiments of Alessandro Volta in the 1800s, the experiments of Michael Faraday, Georg Ohm and others and the invention of the field of electronics Billington (1996). The later inventions of the vacuum tube and the transistor further accelerated the development of electronics to such an extent that electrical and electronics engineers currently outnumber their colleagues of any other engineering speciality.

The inventions of Thomas Savery and the Scottish engineer James Watt gave rise to modern mechanical engineering. The development of specialised machines and their maintenance tools during the industrial revolution led to the rapid growth of mechanical engineering both its birth place Britain and abroad.

John Smeaton was the first self-proclaim civil engineer and often regarded as the "father" of civil engineering. He was an English civil engineer responsible for the design of bridges, canals, harbours and lighthouses. He was also a capable mechanical engineer and an eminent physicist. Smeaton design the third Eddystone lighthouse (1755-59) where he pioneered the use of hydraulic lime (a form of mortar which will set under water) and developed a technique involving dovetailed blocks of granite in the building of the lighthouse. His lighthouse remained on use until 1877 and was dismantled and partially rebuilt at Plymouth Hoe where it is known as Smeaton's Tower. He is important in the history, rediscovery of, and development of modern cement, because he identified the compositional requirement needed to obtain "hydraulicity" in lime; work which led ultimately to the invention of Portland cement. Wikipedia, the free encyclopedia.<http://en.wikipedia.org/wiki/engineering>.

Chemical engineering, like its counterpart mechanical engineering, developed in the nineteenth century during the industrial revolution. Industrial scale manufacturing demand new materials and new processes and by 1880 the need for large scale production of chemicals was such that a

new industry was created, dedicated to the development and large scale manufacturing of chemicals on new industrial plants. The role of the chemicals engineer was the design of these chemicals plants and processes.

Van Grery, Kenmit (1986), aeronautical engineering deals with aircraft design while aerospace engineering is a modern term that expands the reach of the discipline by including spacecraft design. Its origins can be traced back to the aviation pioneers around the century from the 19th century to the 20th although the work of Sir George Cayley has recently been dated as being from the last decade of the 18th century. Early knowledge of aeronautical engineering was largely empirical with some concepts and skills imported from other branches of engineering only a decade after the successful flights by the Wright brothers, there was extensive development of aeronautical engineering through development of military aircraft that were used in World War I. Meanwhile, research to provide fundamental background science continued by combining theoretical physics with experiments. In 1990, with the rise of computer technology, the first search engine was built by computer engineer Alan Emtage.

Main Branches of Engineering

Engineering, much like other science, is a broad discipline which is often broken down into several sub-disciplines. These disciplines concern themselves with differing areas of engineering Work. The engineering profession (<http://web.archive.org/web/2007/08/0194330> quote the main branches of engineering, they are:

Chemical Engineering: The Application of physics, chemistry, biology and engineering principles in order to carry out chemical processes on a commercial scale. **Civil Engineering:** The design and construction of public and private works, such as infrastructure (airports, roads, railways, water supply and treatment etc.), bridges, dams and buildings.

Electrical Engineering: The design and study of various electrical and electronics systems, such as electric circuit, generators, motors, electromagnetic/electromechanical devices, electronic devices, electronic circuits, optical fibres, optoelectronics devices, computer systems, telecommunications, instrumentation, controls, and electronics

Mechanical Engineering: The design of physical or mechanical systems, such as and energy systems, aerospace/aircraft products, weapon systems, transportation products. engines, compressors, power trains, kinematic chains, vacuum technology, and vibration. isolation equipment.

Other Branches of Engineering

ENGINEERING COURSES

Chemical engineering

Civil engineering

Electrical engineering

Mechanical engineering

Building construction engineering

Agricultural and biological engineering

Audio engineering

Soil and water engineering

Wood product engineering

Structural engineering

Geodetic and photogrammetric engineering

Marine and ocean engineering

Mining engineering

Computer/software engineering

Communication engineering

Petrochemical engineering

Polymer and textile engineering

Materials and metallurgical engineering

Ceramic engineering

Manufacturing engineering

Nuclear engineering

Instrumentation engineering

Power system engineering

Automobile/automotive engineering

Environmental engineering and so on.

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Ways of Promoting Engineering Practice among Women

According to Laraba (2014) engineering is rewarding, fun, exciting and within reach. Everything that makes up your world was made possible by engineers This makes the number of female in engineering to be growing in this male dominated profession. It is hard to mention engineering without technology and seldom clear to mention engineering and technology are frequently referred to as applied science and mathematics. Therefore, in tackling issues to do with engineering practice and the dearth of female, we have chosen to tackle it from science, technology, engineering and mathematics view point.

Preparation of Girls/women for Engineering and Technology

Mathematics, physics and chemistry skills are considered essential to success in science, technology, engineering and mathematics (STEM) fields especially engineering and technology. They tend to get blended along the way with such preparatory subjects. The entry qualification into university is at least minimum of five(s) credits in ordinary level subjects in West Africa Certificate Examination (WACE) or National Examination Councils (NECO) or (NABTEB) in combination subjects English language, mathematics and basic science which includes physics, chemistry, biology, geography, technical drawing etc with this qualification, candidates apply through JAMB, final admission is given by Joint Admission and Matriculation Board (OAMB)

Relationships with other Disciplines

Science

Walter Vincenti (1993), quoting Theodore Von Kaman, says that scientists study the world as it is, engineers create the world that has never been. There exists an overlap between the sciences and engineering practices, in engineering, one applies sciences. Both areas of endeavour rely on accurate observation of materials and phenomena. Both use mathematics and classification criteria to analyse and communicate observations. Scientists may also have complete engineering tasks such as designing experimental apparatus or building prototypes. Conversely, in the process of developing technology engineers sometimes find themselves exploring new phenomena, thus becoming scientists. Walter Vincenti asserts that engineering research has a character different from that of scientific research. First it deals with areas in which the basic physics and/or chemistry are well understood, but the problems themselves are too complex to solve in an exact manner. Examples are the use of numerical approximation to the Navier-Stokes equations to describe aerodynamic flow over an aircraft, or the use of Miner's rule to calculate fatigue damage. Second, engineering research employs many semi-empirical methods that are foreign to pure scientific, one example being the methods of parameter variation. As stated by Fung et al in the revision to the classic engineering text *Foundation of Solid Mechanics*.

Although engineering solutions make use of scientific principles, engineers must also take into account safety, efficiency, economy, reliability and constructability or ease of fabrication, as well

as legal considerations such as patent infringement or liability in the case of failure of the solution Thus engineering sciences are born.

Medicine and Biology

According to Bronzino (2006), in the Biomedical engineering handbook opines that the study of the human body, albeit from different directions and for different purpose is any different directions and for different purpose, is any important common link between medicine and some engineering disciplines. Medicine aims to sustain, enhance and even replace functions of the human body, if necessary, through the use of technology.

Modern medicine can replace several of the body's functions through the use of artificial organs and can significantly alter the function of the human body through artificial devices such as, for example, brain implants and pacemakers. The fields of bionics and medical bionics are dedicated to the study of synthetic implants pertaining to natural systems.

Conversely, some engineering disciplines view the human body as a biological machine worth studying, and are dedicated to emulating many of its functions by replacing biology with technology. This has led to fields such as artificial intelligence, neural networks, fuzzy

Logic, and Robotics.

Medicine, in part, studies the function of the human body. The human body, as a biological machine has many functions that can be modelled using engineering methods.

Arts

There are connections between engineering and art; they are direct in some fields, for example, architecture, landscape architecture and industrial design (even to the extent that these disciplines may sometimes be included in a university's faculty of engineering), and indirect in others. Princeton U: Robert Maillart's Bridges. The Art of Engineering: The Art Institute of Chicago, for instance, held an exhibition about the art of NASA's aerospace design. Robert Maillart's bridge design is perceived by some to have been deliberately artistic. At the University of South Florida, an engineering professor, through a grant with the National Science Foundation, has developed a course that connects art and engineering. Among famous historical figures Leonardo Da Vinci is

a well-known Renaissance artist and engineer, and a prime example of the nexus between art and engineering. The institute for interactive Arts and Engineering.

Other Fields

In political science, the term engineering has been borrowed for the study of the subjects of social engineering and political engineering which deal with forming political and social structures using engineering methodology coupled with political science principles. Financial engineering has similarly borrowed the term.

Conclusion

Promoting engineering practices amongst women may entail asking and answering the question why are so few women in engineering and technology. The answer lies in part in our perceptions and unconscious belief about gender in mathematics and science, which are the foundations of the practice. Luckily, stereotypes, bias and other cultural beliefs can change: often the very act of identifying a stereotypes or bias begins the process of dismantling it. Base on the content of this paper, the following recommendations are proffered in four areas.

Recommendations

1. Cultivating girl's achievement and interest in science, technology ana engineering, by creating college environments that can support womnen in science technology and engineering and counteracting bias.
2. Parents and educators can do a great deal to encourage girl's achievement and interest in science, technology, engineering and mathenatics (STEM).
3. The women have to be carried along in both private and public sector of the economy because they have shown interest and effort in the profession therefore; the male counterpart should see the women engineers as partners in progress.
4. Engineering as a profession is not an easy task therefore, any female engineer that qualify should be given a level ground to operate.

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