FEDERAL UNIVERSITY OF TECHNOLOGY MINNA

REPOSITIONING ENGINEERING MATERIALS RESEARCH AND INNOVATION FOR SUSTAINABLE DEVELOPMENT

By

Engr. Professor Oladiran Kamardeen Abubakre
M.Sc (Donetsk), Ph.D (Minna) R.Eng, MNSE, FNMS
Professor of Materials Engineering

INAUGURAL LECTURE SERIES 50

12TH JANUARY, 2017

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Preamble

Thanks, Adoration and Glorification be to Allah, the Almighty. We pray for His Blessings on all His messengers from the first of them – Adam through Musa, Isa (ASW) to the last of them all - Muhammad (SAW).

Majority of our audience are firm Believers in Supreme Being variously referred to as Allah, God, Olodumare, Chineke, Ubangidi, Soko. We are thus at home with His messages as found in the revealed scriptures. These scriptures give comprehensive accounts of creations in its diversity, variance and sequence. Suffice it is to quote one of the numerous account of creation in one of these revealed scriptures – Al – Qur'an.

"It is He who has created FOR YOU the entirety of what is on the earth ....." Q 2v29.

Thus God created the material world first in its full diversity and put them in the services of human being to be exploited to the extent and as far as his knowledge permits.

"O Company of jinn and mankind, if you are able to pass beyond the regions of the heavens and earth, then pass. You will not pass except by the Authority of Allah." Q55v33.

1.0 Introduction

My venture into engineering profession is more of God design rather than deliberate personal plan or scheming. I have always had my eyes on professional courses and had attempted studying Veterinary Science and Medicine before providence finally placed me in these noble professions of Engineering and Pedagogy.

Engineering: Engineering is a profession in which knowledge of mathematics and natural sciences is applied with judgment and responsibility to invent, design, construct, operate and maintain machines, structures and systems, utilizing the **materials** and

forces of nature economically for the benefit of mankind (Olorunmaye, 2012).

Engineering which started with two broad divisions of Civil and Military/Mechanical has evolved into numerous branches which presently include Aerospace, Agricultural, Biomedical, Chemical, Civil, Computer, Electrical, Environment, Geological, Geomatics, Industrial and Manufacturing, Mechanical, Materials, Metallurgical, Mining, Mechatronics, Naval Architectural and Ocean, Nuclear, Petroleum, Software, System and Telecommunication Engineering. (Enibe, 2008)

All Engineering structures, devices and systems came into existence after careful and comprehensive design based on accurate analysis of forces. Numerous indeed are engineering fantasies and dreams but only those that could be supported by the existence of the appropriate materials will eventually come into existence and benefit mankind. Thus, Material Engineering occupies a unique place amidst other branches of Engineering.

Materials Engineering: The study of materials comprising metals, ceramics, polymers, semiconductors and composites, built on the scientific principles established in mathematics, physics and chemistry and applying them to various material-related problems or needs in society. It is also defined as the application of structure-property correlations, in designing or engineering the structure of a material to produce a predetermined set of properties

Considering the pioneering and the long standing status of the study of metals compare to other materials, Metallurgical Engineering is usually addressed in its own right while other materials find umbrella under Material Engineering.

The various options available to Materials engineers to specialize in, includes but not limited to, the following:

- Metallurgical engineering- specialization in metals, such

as steel, aluminium and copper usually in alloyed form with additions of other elements to provide specific properties.

- Plastics engineering – the practice of developing and testing new plastics – known as polymers – for new applications.
- Ceramic engineering – the development of ceramic materials and the processes for making them into useful products – from high-temperature rocket nozzles to glass for LCD.
- Composites engineering – working in the development of materials with special, engineered properties for applications in aircraft, automobiles and related products.
- Semiconductor processing engineering – the practice of applying materials science and engineering principles to develop new microelectronic materials for computing, sensing and related applications.

Materials engineers develop, process, and test materials used to create a range of products, from computer chips and aircraft wings to golf clubs and snow skis. They work with metals, ceramics, plastics, composites, and other substances to create new materials that meet certain mechanical, electrical, and chemical requirements.

2.0 Materials - Milestone of Civilisation

The evolution of knowledge in harnessing the material world for the benefit of mankind gave rise to epoch of civilisation. Various classifications exist but for the purpose of this presentation, a five stage evolution of civilisation based on the advancement of human being in harnessing material endowment is adopted. The evolution of civilization base on prevailing materials has gone through the Stone Age, the Bronze Age, the Iron Age, the Steel Age, and the Silicon Age (Table 1). The typical material-based

classification presumes that such materials must be product of human ingenuity, must cause huge impact globally, and the materials must subsist for considerable period (Bangwei and Yinjian, 2011).

The technological evolution of Nations also revolved around various prevailing engineering materials of the era: The Industrial Revolution (1740-1840) in the 18th Century England relied on Iron works. The boom in rail transportation (1850-1900) had Steel making as its backbone. The invention and subsequent spread in the use of Electricity and Internal Combustion Engine (1900-1950) was made possible courtesy of steel, aluminum and copper. Petrochemicals, Electronics, Computing, Aerospace industries flourished in 1950-1980 due to advanced knowledge in silicon, steel, light and heat resisting alloys. Mass production of affordable automobiles (Fordism) and mass production of goods in general (1930-1980) relied heavily on cheap steel (Obikwelu, 2014).

Table 1: Chronological Order of Evolution of Civilisation based on Materials (Bangwei and Yinjian, 2011)

Era	Stone Age	Bronze Age	Iron Age	Steel/Cement Age	Silicon Age
Duration	3 Million years	1800 years	3400 years	60 years	40 years
Span	3 Million BC – 3300BC	3300 – 1500BC	1500BC – 1900AC	1900 – 1960AC	1960 – 2000AC

It is worthwhile to preview the role of materials in the technological development of the previous civilisations to have a clear understanding of the challenges facing the Nation in terms of Material development. Attempt will be made to read the future trend of material development such that while we pay good attention to 'catching up' with the rest of the world, we also lay a good platform to become active participants in dictating the

trend of technological evolution through our innovative contribution to the trending global material requirements.

2.1 The Early Civilisations – Stone Age to Iron Age

2.1.1: The Stone Age

The Stone Age derived its name from the major material used for tools and weapons at this early stage of human history. The Stone Age dates as far back as 3300 BC. The tools and weapons made of stone include axes, spear points, scrapers, and knives. The resort to stone was dictated by the challenges facing the early man who was left at the mercy of his environment. Thus to meet the basic needs of food and security, he has to rely on the material provision that would enable him to successfully hunt for his food and defend himself against the predators. A look at the early man, his tools and weapons is quite instructive. Wood, leather, stone and other materials were freely used by him, yet the era was referred to as Stone Age. In my opinion, two reasons may be responsible for this:

(i) Stone was the most crucial and most indispensable material in the bid of man to transform himself from Hunter-gatherer life to a sedentary existence.

(ii) The intellectual input in the conversion of stone to the appropriate tool was higher than in other materials.

The contribution of various parts of the globe to the Stone Age was wide spread. The earliest evidence of stone implements by Anthropologists was found in the rift valley of East Africa. One other early evidence of permanent settlement was found in Natufian culture in the present-day Israel. Archaeology findings at sites at Mount Carmel and Hula valley in Northern Israel revealed enormous quantity of gazelle bones, large number of flint sickle blades, arrow head, stone mortars, harpoons, hooks and net sinkers. This discovery attested to the dexterity of early man in hunting gazelle and processing it for food and his creative skill of fashioning out hunting, fishing, farming and food processing tools and equipment from stones.

Obsidian and Flint were the two types of naturally occurring stones formed as an extrusive igneous rock and were ready natural materials that were readily transformed into these various tools. The most advanced settlements were those, innovative enough to evolve a form of heat treatment that facilitates transformation of these stones into tools of choice.

Another interesting epoch of Stone Age was the discovery of the technology of firing clay. The Artisans at sites located in the present day Czech Republic fired a mixture of clay and loess in oven to obtain the first substance to be totally transformed by human through thermal processing. Ceramic – a remarkably transformed clay with water and hydroxyl molecules driven off upon heating was discovered at about 2600BC and yet remain one of the most influential material today and will still play a significant role in the foreseeable future. Ceramics was very strategic in the emergence of the first cities of the world in Mesopotamia – present day Iraq as it provided silos for storage of farm produce, vessels for water storage and clay plates for record keeping and documentation (Postgate, 1994).

One significant issue in the emergence of Mesopotamia as an independent city state is that the region is less endowed with obsidian and flint – the crucial natural resources of the era, yet it took over from other cities with more resource endowment through superior knowledge and more outstanding creativity of its leaders and artisans. Mesopotamian technology was a comprehensive, a non-documented process of training, organization, and recruitment of artisans and this gave it an edge over other previous city states and empires.

2.1.2 Bronze Age (3300 – 1500BC)

Early civilisations exploited readily available materials hence stone, bones, wood leather and clay were prominent in Stone Age. Metals can hardly be said to be readily available considering the insignificant fraction of major metals in the earth crust as shown in Table 2.