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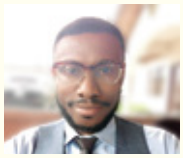

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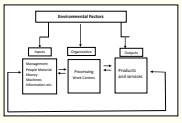

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FROM THE EDITORIAL SUITE

We are pleased to share with our teeming readers the valuable contents of "The Consulting Engineer" magazine Vol. 11 No. 3 edition. The theme of this edition is "Engineering in Industry". Almost every enterprise and structure entails engineering. Industries are the bee-hives of engineering practitioners in several specialized areas. Such areas of specialties include Chemical, Civil, Structural, Mechanical, Electrical, among others.

Engr. Ademola Adeboya, MNSE

The Association for Consulting Engineering in Nigeria (ACEN) houses engineering consultants of numerous disciplines. The relevance of these specialist engineers cannot be over-emphasized. In this edition, a seasoned practising consultant, Engr. Lanre Sagaya Jr, Director, YOLAS CONSULTANTS LTD, provides insight on the topic: "Consulting Engineering in Industry: A Case Study". This is a toast to all stakeholders who should understand the value of consultants. Other experts have presented lucid articles as follows:

- **Green Manufacturing for Healthy Environment** by Engr. Dr. Wilson Dadet, FNSChE, FNSE, FIGEM, Lead Process Engineer Nigeria LNG Ltd
- **Oil & Gas Safety in Project Pre-commissioning & Commissioning** by Mr. Christian Ibra , Lead Consultant, Macjech Integrated Consult
- **Factory Perspectives of Engineering in Industry** by Engr. Enefiok Ubom, FNSChE (Entrepreneurship Consultant)
- **Repositioning Nigeria's Steel Industry for Enhanced Industrialization** by Dr. Oluwafemi Olayebi, FNSChE, Sub-Dean Faculty of Engineering Technology, Federal University of Petroleum Resources.

"The Consulting Engineer" Personality for this edition is Engr. Dr. Wilson Dadet, FNSChE, FNSE, FIGEM serving currently as Lead Process Engineer in Nigeria LNG Limited. He can aptly be described as a purpose-driven engineer steadily rising to an iconic status. His counsel in his presentation, entitled "A Word for Young Engineers", epitomizes his insight in matters on integrity and excellence required in achieving sustainable success in the practice of engineering.

In the period under review, ACEN carried out a number of events. The various activities are recorded in memorable pictures in this edition.

In the Special Supplement section, we are featuring an outstanding company that has contributed immensely to infrastructure development in Nigeria. The company, **VITA CONSTRUCTION LIMITED,** has various flagship projects to its credit cutting across various sectors. We congratulate its Managing Director, Mr. Yiannakis Christodoylo and his team for the diligent contributions to engineering practice in Nigeria.

Engr. Enefiok Ubom, FNSChE, continues to share tit-bits in every edition of the magazine. In this edition, he focusses on some specific engineering practices in industry arising from technological advancements.

Finally, we use this opportunity to thank all the contributors to this edition. These contributions have made this edition to see the light of day.

Relax and enjoy your reading.

Engr. Ademola Adeboya, *MNSE*
(Chairman, Editorial Board)

"Industries are the bee-hives of engineering practitioners in several specialized areas. Such areas of specialties include Chemical, Civil, Structural..."

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THE ASSOCIATION FOR CONSULTING ENGINEERING IN NIGERIA (ACEN)

The Association for Consulting Engineering in Nigeria, ACEN, was founded in 1971 and registered in 1979. ACEN is a body of registered independent private engineering consultancy firms and the voice of the profession in Nigeria.

MISSION STATEMENT

""ACEN shall build a strong membership that fosters equal opportunities, creates competitive advantage through increased visibility with strategic partners, and improves the standards of consulting engineering in line with international best practice."

VISION STATEMENT

"To remain the ultimate reference business association of choice for organisations providing professional engineering consultancy services in Nigeria."

FUNDAMENTAL OBJECTIVES

- Ensure that the highest level of technical competence and business ethics are brought to bear on the practice of the profession in Nigeria.
- Ensure that every State has the highest level of Consulting Engineering practice by having members in every state of the federation and the federal capital.
- Increase the number of engineering firms in the country relative to the size of the nation.
- Ensure that stakeholders in the built environment get maximum value for their investments by monitoring standards of practice within the industry.
- Grow the industry by promoting the growth of large consulting engineering firms.

ACEN MEMBERSHIP

Prior to December 2007, ACEN membership was open to individual and firm members, who possessed the required experience and professional integrity. At the 2007 AGM, a motion was passed limiting ACEN membership to firms. This was to further emphasize the business nature and focus of the association. Membership is therefore now open to Consulting Engineering firms with the adequate experience and commitment to continuous improvement in technical and business integrity. Today, ACEN's member firms numbering about 300 are located in the 6 geo-political zones and the FCT.

ACEN & COREN

The Council for the Regulation of Engineering in Nigeria is the statutory body responsible for the regulation of all Engineering activities in Nigeria. It is empowered to keep a register of all Engineering craftsmen, technicians, technologists, Engineers and Consulting Engineering Firms who wish to practice in the country. No individual or organization is allowed to practice Engineering in Nigeria without the approval of COREN. Thus all member firms of ACEN must be registered with COREN and the members of such firms must also be individually registered by COREN. ACEN has just recently been mandated by COREN to register on its behalf all consulting engineering firms in the country. Furthermore, ACEN President now seats on the Council of COREN. Thus, ACEN is now better positioned within the built industry.

ACEN & NSE

The Nigerian Society of Engineers is the umbrella association of all graduate Engineers in Nigeria and all Engineers employed in ACEN member firms are members of NSE. Conversely, most members of NSE with an interest in Consulting Engineering practice are members of ACEN. ACEN focuses only on the business interest of Consulting Engineering Firms and her interest is, therefore, specific and complementary to the scope of COREN and NSE.

ACEN & FIDIC

The International Federation of Consulting Engineers is a 100-member organisation that provides the strongest platform for our international activities. FIDIC is the voice of Consulting Engineering all over the world, and this it does through seven major focus areas: Representation, Business Practice, Ethics/Integrity, Image, Sustainability, Globalization and Quality.

FIDIC is perhaps best known for its contract documents, which are used all over the world, especially for international projects in the third world. The documents are used extensively by the Nigerian Federal Ministry of Works. In addition, FIDIC has Manuals on a Guide to Practice that teaches best practice in Consulting Engineering, Business Integrity Management, and Quality Management amongst several others.

Two (2) ACEN members, Engr. J.I. Folayan and Engr. Bayo Adeola have served on the FIDIC Executive Committee, the highest level of the organization. Other ACEN members have served on committees and task forces of the organization, and members attend the yearly annual conferences in large numbers regularly.

ACEN & FIDIC Africa

FIDIC Africa is the FIDIC Group of African Member Associations which addresses specifically, African concerns. FIDIC Africa currently has 14 members, holds regular annual conferences and AGMs, and promotes networking among its members. Nigeria played a very active role in the formation of FIDIC Africa and has continued to be very active in the Association.

ACEN Past President, Engr. (Mrs.) Mayen Adetiba, was once Chairman of FIDIC Africa while several ACEN members have served on the Executive Committee including ACEN's past Presidents, Engr. Charles 'Yele Akindayomi and Engr. George C. Okoroma (JP), who are members, presently, of the FIDIC Africa Executive Committee.

ACEN ACTIVITIES

ACEN provides a series of activities tailored to deliver service and benefits to our members in these key areas:

- Training through the ACEN School of Consulting Engineering.
- AGM & EGM for effective dissemination of information to members.
- Attending International Conferences.
- Membership / Certifying Standards.
- Advocacy.
- Quarterly Business Evening meetings to discuss topical issues affecting members.
- The Young Professionals Forum.
- Triannual publication of "The Consulting Engineer" magazine.
- Monitoring and follow-up on policies and bills relating to matters of engineering practice.
- Legal retainership program to advise members on legal issues.
- Advancing the practice of consulting engineering for favourable business environment for members.
- Setting up of Special Task Forces on:
  The collapse of buildings, conditions of engagement/ scale of consultancy remunerations, quackery, Industry study, formation of built industry transparency initiative, local content for the construction industry, etc.

CHALLENGES OF ACEN

Despite the fact that ACEN has been in existence for fifty-three (53) years, some of the challenges leading to its formation have remained while new ones have emerged. The most notable current challenges are as follows:

- Unfavourable Government procurement policies especially in the states.
- Private sector perception.
- Loss of Engineers to other sectors due to low remunerations.
- Number, size and scope of ACEN Member firms.
- Delayed payments to members.
- Limited awareness and knowledge of the savings consultants contribute to the overall cost of projects if employed by governments and entrepreneurs.
- Inadequate corporate sponsorship to enhance smooth operations of the organisation.

We guarantee quality engineering services

Our firm is richly endowed with a superb combination of world class professional expertise and integrity which reliably guarantee quality delivery of projects to the delight of our growing number of clients.

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CONSULTING ENGINEERING IN INDUSTRY: SUSTAINABLE DEVELOPMENT, BUILDING RESILIENT CITIES (CASE STUDY: LAGOS HARBOUR BREAKWATERS)

Engr. Lanre Sagaya Jr., *MNSE*
(Director, Yolas Consultants Ltd)

1.0 INTRODUCTION

Aligning with the theme of the Association for Consulting Engineering in Nigeria (ACEN) 46th Annual Conference "Sustainable Development; Building Resilient Cities", this paper seeks to examine this topic with a Consulting Engineering project, namely 'A Case Study of the Lagos Harbour Breakwaters Project'. Climate change is here; climate change is real and despite the minority of deniers out there, science has established that this is an existential crisis of our time. Globally, the increasing frequency and intensity of extreme weather events is impacting the lives and livelihoods of millions of people. Rising global average temperatures and rapid global warming are causing alarming consequences on all forms of life on planet earth. In addition to reducing greenhouse gas emissions and slowing down the pace of global warming, we must also adapt to the consequences of climate change by protecting our cities and communities from climate impacts.

Given the huge potential consequences, adaptation also needs to take place on a large scale for our communities to become more resilient to the climate impacts. Bridges may have to be adapted to withstand higher temperatures, coastal cities may have to establish flood protection systems, mountainous regions may have to find more ways to prevent landslides etc.

For almost three decades the United Nations has been bringing together almost every country on the planet for a climate change conference, called COPs – which stands for 'Conference of the Parties'. The only exception was 2020 at the height of the COVID 19 pandemic. The 2022 summit, COP27, was held in Egypt. It is significant that it was held on the African continent as we bear a disproportionate load of the effects of climate change. Evidence shows that Africa is the most vulnerable continent to the adverse impacts of climate change. According to the climate vulnerability index of 2021, nine out of the top 10 world's most vulnerable countries, (the ten countries being Chad, Central African Republic, Eritrea, Guinea Bissau, Democratic Republic of Congo, Sudan, Niger, Afghanistan, Liberia and Somalia) are in Sub-Saharan Africa. Meanwhile historically, Africa's carbon footprint has been modest (we never fully experienced the industrial revolution and industrialization of our Western world counterparts) and remains relatively small compared to other parts of the world. Though the biggest contributors of greenhouse gases vary depending on how the emissions are measured (whether in terms of per capital emissions or total fossil fuel emissions) the largest polluters remain in the developed world.

The US and China are generally regarded as the two current largest emitters, while the US has historically been the top carbon emitter over time. In addition, research has shown that the distribution of warming impacts from emitters is highly unequal with climate change disproportionately benefiting well-off countries and harming less-well-off countries.

"…..warm counties have warmed and lost income because of it, while colder countries have warmed but enjoyed economic gains. The responsibility for the warming rests primarily with a handful of major emitters, and this warming has resulted in the enrichment of a few wealthy countries at the expense of the poorest people in the world." - Callahan, C.W., Mankin, J.S. National attribution of historical climate damages. Climatic Change 172, 40 (2022). https://doi.org/10.1007/s10584-022-03387-y

Hence climate change is not just an existential threat, it is currently exacerbating global inequities. Recent studies from Dartmouth University in the USA have in fact been able to calculate in actual terms how much loss the US has caused to other countries in terms of carbon emissions.
"Data shows that the top carbon emitter over time, the United States, has caused more than $1.9 trillion

Fig. 1: The completed West Mole

in climate damage to other countries from 1990 to 2014, including $310 billion in damage to Brazil, $257 billion in damage to India….. and $74 billion to Nigeria. For the first time, we have been able to show clear and statistically significant linkages between the emissions of specific countries and historical economic losses experienced by other countries," says Callahan. "This is about the culpability of one country to another country….."

In order to adapt to this global inequality, the developing countries have to be more resilient to the effects of climate change in terms of their infrastructure. To expand on the importance of building resilient infrastructure I will present a case study of the Lagos Harbour Breakwaters Project.

Lagos, a coastal megacity (estimated population 20 million) is vulnerable to rising sea levels. The coastline of Lagos and Victoria Islands are protected by three breakwaters, known as the Training mole, the East mole and West mole, which break the force and dissipate the energy of incoming waves. These breakwaters were constructed back in the early 1900's and their maintenance has generally not been a priority, even more so nowadays with dwindling Government revenues. It is imperative that onwards these breakwaters are adequately maintained to make Lagos more resilient to the impact of climate change.

2.0 LAGOS HARBOUR BREAKWATERS/MOLES

A breakwater is a long, artificial barrier built offshore to protect harbours from the effects of waves and currents. Essentially, a breakwater is made up of large concrete blocks strategically placed on top of each other; these blocks are designed to absorb the energy of the waves and reduce their impact on the coastline. The Lagos Harbour Breakwaters commonly known as the Lagos Harbour Moles, is a series of massive breakwater structures built to protect a section of the Lagos coastline. It is composed of three Moles: the East Mole (180m length), the West Mole (350m length) and the Training Mole (500m length); all originally constructed back in the early 20th century to prevent erosion of the Lagos Island coastline. See Fig. 1.

The construction of the Lagos Harbour Breakwater began in the early 1900s and was completed in the 1930s. Before the moles were built large vessels arriving in Lagos were required to anchor some distance offshore due to the shallow waters in the Commodore Channel, the low draught channel leading to the shore. Smaller vessels would then be dispatched to the larger vessels anchored offshore and convey the cargo and people onto land. Hence, the colonial marine engineers of the time also

dredged the Commodore Channel, allowing larger vessels to enter Lagos and built the Moles to protect the coastline.

Since then, the Lagos Harbour Breakwaters have been an important component in the protection of Lagos and Victoria Islands yet despite its importance, the Moles have faced a number of challenges, including erosion and structural damage caused by storms and high waves. Measures to repair and maintain the breakwater have been sporadic to say the least. Part of the reason is that being an offshore structure, the general public does not notice their importance until there is a disaster. The fact remains that the Lagos Island coastline has been denigrated by erosion over the years. A prime example being Bar beach, a famous beach of the 70's and 80's that over the years has been almost completely reclaimed by the Atlantic Ocean. In 2005, some 100 years after the construction of the moles, it was estimated that approximately 2 kilometres of beach front, being the entire Bar Beach, had been lost to erosion. Over the period, Victoria Island has been directly exposed to heavy ocean surges with little/no protection from the Atlantic Ocean.

Major rehabilitation work of the Lagos Harbour Moles was conducted in the 2000's, funded by the Nigerian Government via the Nigerian Ports Authority (NPA). Engineering Design for the rehabilitation was conducted in the year 2005 by Messrs. Royal Haskoning Engineering Consultants; based on investigations (bathymetric surveys etc.) conducted in 2001. The construction of Lagos Harbour Moles was awarded to Messrs. China Civil Engineering Construction Corporation (CCECC) in November 2007. Yolas Consultants (our firm) was engaged as construction supervision consultants in 2008 with Messrs. Royal Haskoning (the Design Consultants) still engaged to provide technical assistance to the NPA on the project. The contractor Messrs. China Civil Engineering Construction Corporation (CCECC) mobilized to site in March 2008 but the occurrence of an earthquake in China in April 2008 delayed the start of works as some of the manufacturers of the equipment and plants required for the project were located in the earthquake zone. The contractor fully commenced work on the project in November 2008.

Visual observation and supplementary bathymetric surveys conducted in early 2009 showed that the situation of the East and West Moles roundheads had seriously worsened as those areas had rapidly deteriorated having been more severely damaged by strong currents. The situation at the southwestern side of the West Mole in particular had changed to an extent that it threatened the overall stability of the Mole. It was evident that the design and construction of East and West Moles roundheads could not be based on the initial investigations conducted in 2001. The rapid progressive scouring, due to their compromised structural integrity since then, necessitated the need for a redesign of the East and West Moles roundheads. See Figs. 2, 3 & 4.

The design consultants, Messrs. Royal Haskoning, recommended a modified solution based on physical model test conducted at Danish Hydraulic Institute (DHI), Denmark in April 2010 and witnessed by

Fig. 2: The dilapidated East Mole

Fig. 3: The dilapidated Training Mole

the Client representatives, Yolas Consultants representatives and the contractor representatives. As a result of the physical modeling a redesign was conducted and the scope of works of the project changed. The construction proceeded based on the outcome of the revised design.

Fig. 4: The dilapidated West Mole

2.1 REVISED SCOPE OF WORKS

2.1.1 EAST MOLE

- Dredging/Excavation of the seabed adjacent to the seaward face of the Mole. The material excavated comprised rock armour displaced from the existing Mole and sand.
- Removal of quantities of rock from the existing Mole.
- Filling the scour around the roundhead and along 180m of the trunk.
- Construction of rock toe berm and new armour overlaying the existing roundhead and 150m of the trunk. The primary armour comprised concrete Accoropode units placed on quarried rock underlayer/regulating layer.

2.1.2 TRAINING MOLE

- Excavation of the seabed (the Tarkwa Bay side).
- Filling the scour around the roundhead and along 500m of the trunk.
- Construction of rock toe berm and new armour overlaying the existing roundhead and 500m of the trunk. The primary armour comprised rock placed on a rock underlayer/regulating layer.

2.1.3 WEST MOLE

- Extensive excavation of the seabed adjacent to the seaward face of the Mole. The material to be excavated comprised some rock armour displaced from the existing Mole and sand.
- Removal of quantities of rock from the existing Mole.
- Filling to scour around the roundhead and along 350m of the channel face of the trunk.
- Construction of rock toe berm and new armour overlaying the existing roundhead and along 200m of the seaward face of the trunk and 300m of the channel face of the trunk. The primary armour comprises concrete cube units on the roundhead (the seaward face and southern 150m of channel face) and Accoropode units (the northern 150m of channel face) placed on quarried rock secondary armour

Though it was not part of the physical modelling that took place at DHI and in general had not deteriorated to the extent of the East and West moles, it was decided that the construction contract should accommodate the training mole, particularly the roundhead. To fortify the breakwaters even further, new items of work, namely more primary rock

armour (3t, 5t and 8t) as well as 12t concrete cube units were introduced in some sections. On top of which are a series of interlocking, x-shaped concrete blocks called accoropodes. See Fig. 5. Each accoropode is made of reinforced concrete, built on site and weighs approximately 5 tons. (Suffice to nots that "Accoropodes" are actually the Chinese variant of the European "Accropodes).

Fig. 5: Accoropodes

Fig. 6: Accoropodes and formwork at fabrication yard

Construction started by first excavating the dilapidated sections of the moles as well as the scoured seabed in the vicinity of damaged sections of the breakwaters. Then the underlayer rocks were dropped into the ocean to form the base of the sea-wall, the rocks then had to be shaped and formed by excavators. This process was able to be achieved as the excavators being used throughout the process of construction were all equipped with a pinpoint accurate GPS system which allowed the excavators to work accurately underwater. The rocks, after being delivered and formed, began to take shape both below the surface of the water and above. It was then time to start building the primary armour section of the Breakwater; that is the rock armour units, concrete blocks and Accoropodes.

There were some other construction logistics such as the quarry, where blasting and grading of various sizes of rock used for the project was undertaken. This was located in Agbede, Ijebu-Ode of Ogun State. The fabrication yard (where rock transported from quarry site by truck were sorted to various sizes, stockpiled and transported to construction site by barge over water), was located at Epe, Production of Accoropodes and concrete cube units were also done in the fabrication yard. See Fig. 6. Tests on samples of materials used for the project were conducted in the laboratory at the fabrication yard in Epe also.

The construction works for the East, West and Training Moles were completed in the following order.

i. TRAINING MOLE: The work commenced on Training Mole in February 2009 and reached completion stage in December 2009.
ii. WEST MOLE: The works commenced on the West Mole in January 2010 and the permanent works reached completion stage in the month of September 2011.
iii. EAST MOLE: The permanent works commenced on the East Mole in January 2011 and was completed in the month of September 2012.

The total cost of the rehabilitation of all three moles was approximately 20 billion Nigerian Naira, with a contract variation approval (because of the revised scope of works detailed previously) from the original construction contract award of approximately 16.5 billion Nigerian Naira.

Since the rehabilitation however, there has been no other maintenance works on the mole and of course deterioration has been observed during this period. These breakwaters are a critical piece of infrastructure in increasing the resiliency of Lagos to climate change.

Their maintenance is imperative especially in the face of global warming and the destruction rising sea levels could wreck on an unprotected Lagos Island.

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SITECH ENGINEERING LIMITED

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- Mineral Survey and Exploration
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- Structural Testing (destructive and NDT testing on concrete)
- Land Reclamation and Remedial Works
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Date of Incorporation:
6th June, 1989

Registration Unit CAC:
RC: 132307

GREEN MANUFACTURING FOR HEALTHY ENVIRONMENT

1.0 INTRODUCTION

Engr. Wilson Dadet, *PhD, FNSChE, FNSE, FIGEM (Lead Process Engineer, Nigeria LNG Limited)*

Green manufacturing is a commitment to using fewer environmental pollutants and natural resources. It is also known as sustainable engineering. Green facilities also make every effort to produce less waste, carbon emissions and try to have as little impact on the environment as possible. Wind turbines and solar panels shown in Fig. 2 are examples of green facilities. In industrial practices, sustainable engineering or green manufacturing is aimed at minimising environmental impact while maximising resource efficiency. By so doing, the health of the environment and its inhabitants is prioritised by waste reduction, energy conservation and promotion of eco-friendly processes.

Another perspective is to look at green manufacturing as practices and processes that businesses use to reduce environmental impact. By modifying the way they work, organizations can reduce carbon emissions, lower energy consumption and promote sustainability.

Furthermore, green manufacturing is the renewal of production processes and the establishment of environmentally friendly operations within the manufacturing field. Essentially, it is the "greening" of manufacturing, in which workers use fewer natural resources, reduce pollution and waste, recycle and reuse materials and moderate emissions in their processes.

Green manufacturers research, develop or utilize technologies and practices to lessen their impact on the environment. Green manufacturing does the following:

- Generates more energy than it consumes
- Births more new materials than it utilizes
- Produces zero waste
- Purify more air and water than it pollutes

2.0 ACTIVITIES AIMED AT ACHIEVING GREEN MANUFACTURING

i. Switch to Renewable Electricity: Energy is responsible for a significant portion of greenhouse gas emissions. Switching to a greener electricity provider or plan that uses renewable energy sources can help reduce these emissions.

Fig. 1: Concept for green manufacturing (Source: Tesla Mechanical Design:https://www.teslamechanicaldesigns.com/blog/concept-of-green-design-and-manufacturing/)

Fig. 2: Green facilities: Wind turbines & Solar panels (Source: https://www.brahmin.solutions.com/)

ii. Green Team: A Green Team is a cross-functional team that collaborates on identifying current sustainability issues in the company and finding realistic and practical solutions. This can lead to cost savings and make your business more sustainable.

iii. Recycling: Launching a recycling program in your company can help reduce costs by reducing garbage collection costs and boost employee engagement and satisfaction. Some electronic companies can allow customers to turn in old computers, printers and cartridges for recycling.

iv. Waste composting into the soil: This improves the soil's fertility which is then used to grow new barley and hops to make more beer.

These are just a few examples of how companies are implementing green manufacturing practices. The goal is to create a more sustainable and environmentally friendly manufacturing industry.

Five types of green technology - solar, wind, hydropower, geothermal energy, biomass and biofuels - can significantly reduce environmental impacts.

3.0 PRINCIPLES OF GREEN MANUFACTURING

- Renewable energy integration: Embracing renewable energy sources such as wind, solar and hydroelectric power reduces reliance on fossil fuels and decreases greenhouse gas emissions.
- Resource Efficiency: Optimising Material Usage. minimising waste generation and implementing recycling programs help in conserving natural resources and reduce landfill waste.
- Eco-Friendly materials: Choosing non-toxic biodegradable and sustainably sourced materials ensures minimum harm to the environment throughout the product life cycle.
- Lean Manufacturing Process: Streamlining processes to eliminate inefficiencies and reduce resource consumption not only enhance productivity but also decrease environmental impact.

* Life Cycle Assessment: Conducting thorough assessment of product from raw materials extraction to disposal allows for informed decision making on how to minimise environmental footprint at every stage.

4.0 SOME BENEFITS OF GREEN MANUFACTURING

Green manufacturing offers several benefits, not just to the environment, but also to businesses and society. Here are some key benefits:

* Reduced Energy-Related Costs: Green manufacturing often involves energy-efficient practices, such as using energy-efficient lighting and machinery, which can significantly reduce emissions and wastes that can threaten the environment.
* Improved Efficiency and Profitability: Embracing sustainable and green principles can help organizations become more efficient.
* Innovation and Technological Advancements: Green manufacturing can lead to technological advancements that optimize efficiency, resiliency and sustainability across the full manufacturing life cycle.
* Environmental Preservation: Reduced pollution,

conservation of resources and protection of ecosystems contribute to a healthier planet for current and future generations. While the transition to green manufacturing can be challenging, the long-term benefits for the environment are substantial.

* Reduced Use of Natural Resources and Energy: Green manufacturing practices often involve using fewer natural resources and reducing energy consumption.
* Lower Carbon Footprint: By using sustainable practices and technologies, green manufacturing can significantly reduce a company's carbon footprint.
* Waste Reduction: Green manufacturing focuses on reducing waste and promoting recycling and reuse of materials.
* Technological Advancements: The Fourth Industrial Revolution and the industrial Internet of Things (IIOT) present new opportunities to unlock process innovations to develop sustainable, environmentally friendly materials; decarbonize energy; tap digital innovation for doing more with less; and extend the life cycle of goods within a "zero waste to landfill" framework.

5.0 SOME CHALLENGES OF GREEN MANUFACTURING

Green manufacturing, while beneficial, does face several challenges. Here are some of them:

* High Initial Investment Costs: The adoption of sustainable innovations in the manufacturing industry can face challenges such as high initial investment costs.
* Resistance to Change: There can be resistance to change from traditional practices.
* Need for Specialized Knowledge and Skills: Implementing green manufacturing requires specialized knowledge and skills.

These challenges can be overcome through strategic planning, government incentives and industry collaboration. Despite these challenges, the long-term benefits of green manufacturing make it a worthwhile endeavor.

6.0 GREEN MANUFACTURING SERVES AS FOUNDATION FOR GLOBAL CIRCULAR ECONOMY

Green manufacturing contributes to building a strong foundation for a global circular economy, where resources are reused and recycled, thereby reducing waste and environmental impact. Circular economy is about using valuable resources wisely, thinking about waste as a resource instead of a cost and finding innovative ways to make the environment and the economy better. The circular economy is an alternative to traditional linear economies, where we take resources, make products, consume them and then throw the waste away.

It is instructive to examine 'How to Make the World More Circular':

i. **Product Buy-Back Program:** Businesses can launch product buy-back programs that recover usable materials or create new materials from product waste. As individuals, we can use circular economy principles to reduce our waste and save money by reusing or repairing items or by sharing services like tool libraries or car rides.
ii. **A Healthier Workplace:** By going green, workplaces can become a far healthier environment. This can have a significant impact on man hours and result in a decrease in sick leave taken by staff. There are benefits in other areas as well such as increased productivity levels and less money paid out for medical benefits. To make the workplace healthier, start small. Provide organic food in the cafeteria and keep the green theme by using cleaning products that are not harmful to the environment.
iii. **Waste Reduction:** Green manufacturing plays a significant role in waste reduction through several strategies:
    a. *Resource Efficiency:* Green manufacturing aims at using fewer natural resources and energy, which inherently leads to less waste.
    b. *5R Approach:* Green manufacturing moves beyond the traditional 3R approach of "reduce, reuse, recycle" towards a 5R approach: "repair, reuse, refurbish, re-manufacture and recycle". This approach optimizes the usage of resources and extends the life of products.
    c. *Zero Waste to Landfill Framework:* The Fourth Industrial Revolution and the industrial Internet of Things (IIOT) present new opportunities to develop sustainable, environmentally friendly materials, decarbonize energy, tap digital innovation for doing more with less and extend the life cycle of goods within a "zero waste to landfill" framework.
    d. *Development of New Materials:* There is significant potential to substitute

"While green manufacturing can significantly reduce our carbon footprint, it can be difficult for companies to do it cost-effectively. Possibly their biggest challenge will be competing with known companies that do not live..."

carbon-intensive materials for less carbon-intensive ones.

iv. **Technological Advancements:** Green manufacturing can drive environmentally friendly technological advancement in several ways:
   a. *Innovation in Manufacturing Processes:* The adoption of green manufacturing practices can spur innovation in manufacturing processes, leading to more efficient, resilient and sustainable operations.
   b. *Energy-Efficient Technologies:* Green manufacturing often involves the use of energy-efficient technologies, which can lead to significant reductions in energy use and carbon emissions.
   c. *Waste Reduction Technologies:* Technologies that help reduce waste are a key part of green manufacturing. This includes technologies for recycling and reusing materials, as well as technologies for reducing the amount of waste produced in the first place.By driving these technological advancements, green manufacturing can help create a more sustainable and environmentally friendly manufacturing industry.

7.0 HOW TO START GREEN MANUFACTURING

Here are few ways in which you can start green manufacturing:

i. **Alternative Energy:** An energy audit is a quick and easy way to start creating an eco-conscious facility. This audit takes into account all energy consumption in order to find areas of waste. After auditing energy use, businesses can determine the best way to correct these losses. Whether it be through energy-efficient lighting or by replacing outdated motors, these small changes can have a big payoff. Many businesses start this process by switching to LED lighting. These bulbs use 25 to 80 percent less energy and last 25 percent longer than traditional incandescent bulbs. When an entire facility switches to LED lighting, it can have a significant impact on energy costs. During the energy audit process, manufacturing facilities may also opt to replace their current energy source with a more renewable one. Renewable sources include wind, geothermal, solar, hydropower and landfill gas. Switching over to a sustainable source may have some upfront cost, but over time, they can be big money savers.

ii. **Reduce Waste:** Businesses can also go through a waste audit to ensure they are not disposing valuable materials. Some raw materials may be recycled or re-used for different projects. Over time, reducing a facility's overall waste will save money and increase efficiency.

iii. **Using Non-Toxic Materials:** In addition to reducing waste and conserving energy, many companies are opting to the use of eco-friendly supplies. These brands are replacing synthetic materials with cleaner, safer ones. For example, traditional mattress brands use foam made of 100 percent petroleum-based oils. However, to reduce their carbon footprint, a portion of the petroleum in the mattress is replaced with plant-based oils. This results in less pollution and ensures the product is safe for consumers.

8.0 CHALLENGES OF GREEN MANUFACTURING

While green manufacturing can significantly reduce our carbon footprint, it can be difficult for companies to do it cost-effectively. Possibly their biggest challenge will be competing with known companies that do not live up to the same standards. Many of these companies do not think anything of the environment, which allows them to keep their operating costs low. Environmental degradation and pollution assumed an alarming rate at the advent of the Industrial Revolution. Industrialization, through advanced manufacturing for that matter, was seen as a sine qua non for development. As these countries scale their manufacturing industries, they are going to create a larger carbon footprint. Fortunately, many of these countries are beginning to recognize the concerns global warming is creating.

9.0 HOW TO IMPROVE GREEN MANUFACTURING

i. **Implement Eco-friendly Products:** Have a workforce that deeply cares about sustainability in the workplace and companies will have to adjust how they operate to attract the next generation of manufacturing workers. One of the best ways to encourage going green in a manufacturing plant is to implement eco-friendly products. Not only are these products more sustainable, but they also cut costs for the company at the same time. Lighting systems are a great example of this. Being mindful of lighting systems can really affect monthly electricity bill and even save up on energy. One way to do this is to change incandescent lights into LED lights. Not only are they more effective (last 25 times longer than incandescent), but they are a green solution since they use 75% less energy than regular lights. That makes a massive difference on the scale of manufacturing plants, especially in the long run. Taking small steps towards creating a more sustainably run manufacturing plant can have a big impact in the long run and get your company that much closer to being completely green. Cutting energy cost is a win-win situation in today's environment. There seems to be little argument that we are close to "peak oil," i.e., availability, when half of the world's known oil reserves have been consumed. The only argument left is when the supply crunch will start or if it has already begun. Save now by turning off machinery when it is not being used. Replace a single-speed motor with a variable-speed or servo drive to reduce energy consumption. Also, look at other alternative sustainable sources of energy such as wind, solar or hydroelectric power.

ii. **Eliminate Waste:** Consume only the supplies and resources that are needed to produce the finished product. Sounds very simple to us today, but in the past, the primary objective was to reduce production costs or time to market. Re-evaluate whether the choice of investing in precision manufacturing equipment can be justified by looking at the ways it may introduce opportunities for waste reduction.

iii. **Recycle:** Recycling reduces greenhouse gas emissions by lowering energy consumption. Using recycled materials to make new products reduces the need for virgin materials. This avoids greenhouse gas emissions that would result from extracting or mining virgin materials.

iv. **Recover Energy**: Do not turn energy into heat. Hybrid cars recover energy that otherwise is wasted during braking; machines can do it too based on design and configuration. Power sharing has its roots in machine tools, where the servos used in metal cutting machines and seam machines share power through a single power supply. Power can be taken during deceleration and returned to the main lines. In the past, that energy was wasted, turned into heat, like the brakes on a car. Another great example is the way some operations are able to coordinate the cycles of several metal presses.

v. **Use Circular Manufacturing to Save Energy and Reduce Waste:** Manufacturing equipment and companies are becoming more sustainable by creating a regenerative model that fuels their facilities. Circular manufacturing is also called lean manufacturing and it includes:
   - Recovering resources and repurposing the materials
   - Lending equipment as a part of the sharing economy
   - Using predictive maintenance to increase the lifetime value and durability of machines and equipment
   - Switching to a renewable power source that provides energy to the factories Instead of purchasing raw materials for themselves, green plants simply use the waste produced by another plant (water, energy and other resources) to meet their needs.

vi. **Implement Safety Measures by Utilizing Automation Tools, AI, IoT and Robots:** The cloud-based technology, alongside the Internet of Things (IoT) will provide the ability for humans to work alongside automation tools, AI and robots. It is one of the ways for companies to go green.

vii. **Digitize Internal Communication:** By making all internal communication 100% digital, not only tons of paper each year are being saved, but overall operations are also more efficient.

10.0 HOW TO GET STARTED WITH GREEN MANUFACTURING

i. **Design for disassembly, remanufacture or reuse:** Make products so they can be taken apart and the parts used again in new products.

"Green manufacturing is primarily about changing business and manufacturing practices, as well as the mindset of stakeholders, to mitigate the industrial impact on climate change and other environmental concerns."

ii. **Rethink product and process technology:** Reduce the number of parts per product. This will help the environment and save resources. Minimize the number of process steps to make the operations more efficient.

iv. **Streamline the supply chain:** Reduce inventory by using just-in-time manufacturing. This means making products only when there is an order for them. Switch to paperless inventory control. Source materials and parts locally.

v. **Reduce energy and water consumption:** Adding energy management software to your building equipment can help make processes more efficient. Upgrading processes and office equipment with fewer energy models can also help save money and conserve resources.

vi. **Choose recyclable or biodegradable materials and packaging:** This gives your products a competitive advantage. Integrate environmental costs into your production budget. When you know how much it truly costs to make a product, you can figure out ways to reduce its environmental impact.

vii. **Find a reverse logistics supply vendor:** These firms help companies eliminate products they do not need anymore. The firms take these products back and reuse them or recycle them for parts.

11.0 CONCLUSION

Green manufacturing is primarily about changing business and manufacturing practices, as well as the mindset of stakeholders, to mitigate the industrial impact on climate change and other environmental concerns. It is a new way of doing business that benefits both the environment and the economy. It is not just a trend but a necessity in the face of escalating environmental challenges. By embracing sustainable practices, manufacturers can play a pivotal role in fostering a healthy environment while simultaneously reaping economic benefits and ensuring long-term viability. Together, let us forge a path towards a greener, healthier future through responsible manufacturing practices.

Green manufacturing involves the renewal of production processes and the establishment of environmentally friendly operations within the manufacturing field. The goal behind green manufacturing is reducing waste, pollution and careless energy usage so that the environment could benefit from it.

Green manufacturing can drive technological advancement, leading to the development of new, less carbon-intensive materials and more efficient manufacturing processes. However, the transition to green manufacturing is not without challenges. It requires a shift in mindset, significant initial investment and the development of specialized knowledge and skills. Despite these challenges, the long-term benefits of green manufacturing for the environment, society, and the business itself are substantial.

Indeed, green manufacturing is not just a trend, but a necessity for a healthy environment and sustainable living.

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"THE CONSULTING ENGINEER" PERSONALITY

ENGR. DR. WILSON DADET, FNSE, FNSChE, FIGEM

Engr. Dr. Wilson Dadet hails from Pankshin Local Government Area of Plateau State. He began his educational pursuit from the following Primary Schools: Army Children School Sokoto, Army Children School Gusau, LGED School Jiblik, LGED School Tingkum, Apostolic Primary School Agenebode, Army Children School Agenebode.

He attended Government Secondary School Jak and Government Science School Lafia where he obtained a division I GCE result.

He attended the following Higher Institutions: Kaduna Polytechnic, Aberdeen College UK, University of Port-Harcourt, Rivers State University, Walden University Minnesota USA

Dr. Dadet is an accomplished Chemical Engineer with a PhD in Chemical Engineering, an MBA and has over twenty-five years of progressive Operations and Process Engineering experience. He has a proven track record of delivering technical excellence in process design, optimization and safety management.

He is adept at leading multidisciplinary teams, facilitating HAZOPS, HAZIDS and OMAR sessions, including driving continuous improvement initiatives. He is a notable personality in exceptional problem-solving skills and a commitment to operational excellence and safety.

Engr. Dr. Wilson Dadet

He has been to various plants in Europe and Asia namely:

1. St. Fergus Gas Plant in Scotland.
2. Mossmoran Fife NGL Plant in Scotland
3. Brunei LNG Lumut, Brunei.
4. Foster Wheeler Office in Reading UK.

Some courses he has attended are:

- Persons In Charge of Worksite (PICWS)
- Safety Induction and Emergency Training

"He is adept at leading multidisciplinary teams, facilitating HAZOPS, HAZIDS and OMAR sessions, including driving continuous improvement initiatives. He is a notable personality in exceptional problem-solving skills and a commitment to operational excellence and safety."

- Basic Health and Safety of the Chartered Institute of Health
- Scottish Vocational Qualification in Process Operations
- Basic Certificate in Instruments, Electrical, Mechanical and General Health and Safety
- Quality Matters
- Diagnostic Skills
- Safety with Bottled Gas
- Centrifugal Compressor Operations Training seminar by Dresser Rand USA
- RISC Basic Safety Training
- GE Power Systems in University of Clydebank
- Dresser Rand Centrifugal Operations in Florence Learning Center
- Sultzer Axial Compressor Operations in Florence Learning Center
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- Compressor Control Corporation for Panel men (CCC)
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- Leadership Advanced Firefighting Course
- Gas Treating and Sulphur Recovery in Houston Texas
- Leading HAZOPS Shell Global Solutions in Rijswijk the Netherlands
- Reliability Engineering
- Team Leadership Training in Lagos Business School

PROFESSIONAL MEMBERSHIPS INCLUDE:

- Fellow, Nigerian Society of Chemical Engineers (FNSChE)
- Fellow, Nigerian Institute of Management Consultants (FIMC)
- Fellow, Nigerian Society of Engineers (FNSE)
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- Senior Member, American Institute of Chemical Engineers AICHE
- Member, American Chemical Society
- Fellow, Institution of Gas Engineers and Managers (FIGEM) UK
- Chartered Engineer (CEng) with the UK Engineering Council
- Council member, Nigerian Society of Engineers (2016 -2018)
- Fellow, Commonwealth Academy (FCA)

He served as Chief Examiner (2012-2017) Nigerian Society of Engineers.

He was in the team that commissioned and started the first NLNG Train.

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- Member, Am
- Chief Examiner of the Nigerian Society of Engineers Bonny Branch. Responsible for Panel of Examiners
- Conducting seminar for intending candidates
- Conducting workshop for intending candidates
- Assessing candidates' technical reports

A WORD FOR YOUNG ENGINEERS

BY ENGR. WILSON DADET, PhD, FNSE, FNSChE, FIGEM

The country is home to a significant and growing young engineers with high expectations for the future. These high expectations sometimes get dashed due to prevailing circumstances as employment opportunities are not commensurate with the number of graduates being churned out of higher institutions. Those employed too, may not find the conditions attached to their employment terms satisfactory. Menaces of dashing expectations by young engineers can be surmounted by securing meaningful choices and lives for young engineers including reframing their expectations beyond labour markets alone. To help young engineers properly direct their thoughts, it is my pleasure to present the following words of advice:

i. Build and maintain your reputation.
ii. Do not just be a good engineer but strive to be a good person.
iii. Do not be the engineer that is always defensive, always pessimistic. Be positive, be supportive, give credit, be respectful, be inclusive, be nice. You will be a better team player and less defensive if you do.

In addition to the above, it is worth taking note of the following:

a. **Integrity**: The man of integrity walks securely, but he who takes crooked paths will be found out. Choose integrity over indifference, faithfulness over duplicity, honesty over deception and be committed to be an engineer of great character over compromise. Strive to become a great role model worthy of emulation and consciously committing to be a professional of great character. A good name is better than gold. Remember that people in your area of practice may pay attention to what you do at work and outside of work. Aim to be professional and positive in your daily interactions and practice boundary-setting between your career and your private life to ensure your workplace behaviour is appropriate. Taking on additional responsibilities, volunteering to help teammates and behaving ethically at work are all ways you could establish a good reputation early in your career.
b. Learn from people you admire: Consider finding someone who has a career you would enjoy and learn how he reached their current status. Learning what opportunities successful people pursued early in their careers can help you set short-term goals. You could identify someone in your network and ask to meet with him informally to ask questions. Alternately, you might carry out a research on a public figure spotted in career interviews, podcasts or social media to learn what advice they can offer.
c. Prioritize self-sufficiency: Having an effective relationship with your forerunners at your place of engagement can help you reach your goals, but it can be beneficial to take ownership over your career path. Communicate about the opportunities you are interested in and the ways you want to grow. Being proactive about your advancement could enable you achieve your objectives sooner than you might if you were to wait for others to suggest changes.
d. Prioritizing professional development: Seek out opportunities to grow in your career. Engaging in professional development seminars, training and courses can help you learn new skills that you can utilize in your job. Additionally, professional development allows you to build upon and strengthen the skill set you have already established. Furthermore, professional development provides opportunities to network with other professionals in the field. Constantly look for ways to improve yourself, personally and professionally.

In conclusion, perspire to aspire to acquisition of your required desire. Do not wait for your employer to keep sponsoring, sponsor yourself because some of the skills can be helpful both at work and outside work. Stand up to be counted, do not be afraid of failure when you confront roadblocks, learn from them. Celebrate with others when they succeed and avoid the zone of envy.

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OIL AND GAS SAFETY IN PROJECT PRE-COMMISSIONING & COMMISSIONING

ABSTRACT:

The oil and gas industry represents a monumental infrastructure investment, with billions of dollars at stake. Despite its undeniable profitability, this sector is susceptible to high-risk environments, where the slightest human or mechanical error can trigger catastrophic consequences, including loss of life, assets and investments. Safeguarding human life, protecting assets and preserving the environment are top priorities for industry operators, stakeholders and business owners. This paramount objective is precisely what oil and gas safety endeavours to achieve.

Historical tragedies such as the infamous Piper Alpha incident and similar events serve as haunting reminders of the dire need for comprehensive safety measures within the industry. As aresult, there is a resounding call for the rigorous implementation and application of safety management systems in every oil and gas project. This article delves into the critical domain of oil and gas safety during the pre-commissioning and commissioning phases, scrutinizing its approaches, stages and implementation methodologies. Moreover, it seeks to identify and evaluate the role of safety management systems in mitigating risks during these pivotal phases of facility development.

Mr. Christian Benedict Ibra
(Lead Consultant, Macjech Integrated Consult)

1.0 INTRODUCTION

As one of the major energy industries, the oil and gas will continue to remain relevant in providing energy source and raw materials for the petrochemical and refinery downstream sector. Various facilities are built to process oil and gas and its derivatives; process units, a subset of the facility are integrated to achievethis product. For a facility to be operational it must pass various tests and a certificate issued for each test phase. It is the certificate that shows integrity-proof for the safe operation of a new plant having carried out commission activities. Records have it that pre-commissioning, commissioning, start-up and Shut-down activities have resulted in many forms of accidents and system failures. It is, therefore, very crucial in ensuring that both pre-commissioning and commissioning processes are done adequately so as to mitigate critical safety and operational issues.

Significant risks that may occur usually emanate from the following:

- The energy that is transferred to newly installed equipment may create mechanical and electrical failures and relevant hazards.
- The introduction of chemicals in vessels and pipes may create hazards to people and environment.
- Unauthorized activation or modification of equipment may create serious hazards.

As we look into pre-commission and commission phases, their approaches and implementation methodologies, it is noteworthy to point out that a collaborative effort of various engineering specialists and HSE team will serve to effectively support the development of Job Hazard Analysis and HSE manual so as to implement a comprehensive HSE management system for the commissioning activities. This involves:

- Developing Occupational and Environmental Risk Assessments

"As one of the major energy industries, the oil and gas will continue to remain relevant in providing energy source and raw materials for the petrochemical and refinery downstream sector."

"The objectives of safe pre-commissioning and commissioning in industrial or construction..."

- Developing Safe Work System (Lock Out – Tag out procedures, hot works and confined spaces permits, etc)
- Developing Site Safety Regulations and Commissioning HSE Plan.
- HSE training of the involved personnel
- HSE site monitoring and supervising by competent and experienced safety engineers

2.0 DEFINITIONS

i. **Mechanical Completion:** Mechanical completion denotes also construction completion. During this process, all machines, equipment and piping systems are installed and connected. All site constructions are verified through inspection and test, after which they are validated according to approved drawings and specifications and certified ready for pre-commissioning and subsequent commissioning.

ii. **Pre-Commission:** Upon mechanical completion of the process systems or plant, pre-commissioning activities of the plant are carried out. The pre-commissioning activities are done before the introduction of hydrocarbons in the piping system. The test performed during this stage is to ensure no impairment to equipment and the design specifications and onsite results align with factory expectations. The most likely activities of pre-commissioning may include but not limited to: checking for design conformity, checking the status of electrical, mechanical and instrument installations, running of equipment, in safe running state are carried out. Functional checks, operational adjustments, systems and subsystems components are tested and validated according to project design requirements.

iv. **Start-up:** In this context, start-up refers to the period when the construction or installation of the plant's equipment is mechanically completed and the facility is ready for operation, up to the moment when control and operation are handed over to the plant's operating crew. It marks the transition from the construction and commissioning phase to full operational capability.

v. **Safety:** Safety refers to the state or condition of being protected from harm, danger, risk or injury. It encompasses a broad range of concepts and practices aimed at minimizing or eliminating potential hazards and ensuring the well-being of individuals, organizations and society as a whole.

v. **HSE Management System:** An HSE (Health, Safety and Environment) management system is a structured framework and set of processes that an organization employs to manage health, safety and environmental matters within its operations.

3.0 OBJECTIVES

The objectives of safe pre-commissioning and commissioning in industrial or construction projects are to ensure that all systems, equipment and processes are safely and effectively tested, verified and prepared for operation. This presentation is primarily focused on:

- Scanning the approaches of pre-commissioning and commissioning phases and activities
- Evaluating the role and significant of HSE management systems

4.0 DISCUSSION

The commissioning phase is the most important stage of an oil and gas facility project. Acceptance tests, cleaning, pre-commissioning, commissioning punch listing, core commissioning and final handover to operations are all included in this phase. Close-out, the last phase of the commissioning process, entails closing down and marking up all commissioned and completed documentation, as well as providing support for continuous operation and troubleshooting.

Usually, commissioning is broken down into three phases:

1. **Pre-commissioning:** This stage sets up the facility station for the major commissioning phase and takes place at the conclusion of the construction and installation phase.
2. **Core (main) commissioning:** During this phase, the station's various systems are turned on and put into first operation.
3. **Start-up:** This stage signifies the beginning of the facility real operation.

This article offers guidelines to facilitate the commissioning, start-up, and operationalization of machinery. In simpler terms, commissioning

"Pre-Start-up Safety Reviews (PSSR) and Hazard and Operability (HAZOP) activities are..."

involves a series of checks, tests and final activities that verify the readiness of a facility for operation. The key to successful commissioning lies in following a standardized and systematic approach. The activities involved in project pre-commissioning and commissioning are very enormous. It, therefore, calls for a diligently planned system which must be followed in a sequential manner. The process must be critically analysed and a working document developed. To achieve this goal, it is best implemented in phases and sub-phases of activities. Main phases are:

- Offsite Phase
- Site Phase

i. Off-Site Phase

Off-site or office phase is the basis for all planning and preparatory works. The preparation of the Instruments for measurements, reporting of progress of Pre-Commissioning & Commissioning activities, detailing of project and operative deployment plan, preparation of detailed "procedures" take place in this phase. Two key activities performed in this phase are Pre-commissioning engineering accompanied with the generation of various documents and startup manual.

a. Pre-commissioning engineering documents:

- Detailed Pre-Commissioning / Commissioning Execution Plan
- Generic Method Statement
- Commissioning Plan and Critical Path Network
- Organisation Roles and Responsibilities
- Punch-listing method Statement
- Sample and Testing Schedule

b. Pre-commissioning start-up manual

- Development of (Pre-) Commissioning and Start-Up Manuals
- Quality Manual

During this phase, it is expected that process safety and project HSE plan are factored in the preparatory works and their implementations in every of the sub-phase plan.

ii. Site Phase: The site phase is an organisation of integrated parties saddled with the responsibility of performing the activities developed in the off-site phase. They share common resource information and monitor the progress of their interdependent parties. This generally covers three key areas namely: Mechanical Completion Check, Pre-Commissioning, Commissioning and Start-Up Performance Tests.

The site phase key main activities:

a. Mechanical Completion Verification & Interim Handover

b. The Pre-Commissioning activity

- System turnover
- Plant cleaning
- Punch-Listing
- Leak testing
- Inerting

c. The Commissioning & Start-Up Period

- Ready for Commissioning
- Commissioning critical path
- Start-up procedure
- Licensor/Vendor support
- Conduct and supervise all activities during the Introduction of feedstock to the units
- Stabilize the Unit
- Conduct Performance test run

5.0 COMMISSION SAFETY

Pre-Start-up Safety Reviews (PSSR) and Hazard and Operability (HAZOP) activities are two examples of the safety events that commissioning representatives ought to be concerned about. Before start-up, PSSR is the last opportunity to identify and address any safety concerns.

Equipment must first undergo registration, documentation, and safety checks before it can be put into use, which is another crucial safety requirement. Effective Management of Change (MOC) necessitates a methodical, reliable process. If changes are not properly managed using a strong MOC procedure, they may pose numerous safety and reliability risks to facility station.

Activities related to pre-commissioning and commissioning activities must be independent and begin as soon as the mechanical completion (construction phase) is achieved. It is worth noting that any involvement of a commissioning team in construction could present challenges. Therefore, before beginning pre-commissioning activities, all engineering and installation changes should be documented and well managed to prevent rework. However, tests, final inspections, and

"Safety in recent times has become an integral part of every engineering and operational system."

activities related to completion should involve the commissioning team.

6.0 THE SAFETY ASPECT

Safety in recent times has become an integral part of every engineering and operational system. Over the years, the incorporation of safety both in design and construction engineering has paved ways for improved project execution and completion.

Creating a Health, Safety and Environment (HSE) management system is a comprehensive and systematic approach to managing health, safety and environmental risks for a complex operation like pre-commissioning and commissioning activities. No project will be considered readily safe if there is no HSE Management System (MS) plan as part of the overall project plan. Here is the framework of an effective HSE management system:

i. **Commitment from Leadership:** A deliberate commitment and support from top management need to be established. Leadership should demonstrate a strong commitment to HSE and establish the framework for the management system.

ii. **HSE Policy and Objectives:** Develop a clear and concise HSE policy statement that outlines the organization's commitment to HSE. Define measurable objectives and targets for HSE performance improvement.

iii. **HSE Risk Assessment:** Identify and assess health, safety, and environmental risks associated with the organization's activities, products and services. Evaluate compliance with relevant laws, regulations and standards.

iv. **Legal and Regulatory Compliance:** Ensure that the organization is aware of and complies with all applicable laws, regulations, and industry standards related to HSE.

v. **HSE Management Plan:** Develop a comprehensive HSE management plan that includes specific actions, responsibilities, and timelines for addressing identified risks and achieving objectives.

vi. **Organizational Structure and Responsibilities:** Clearly define roles and responsibilities for HSE within the organization. Appoint an HSE manager or coordinator to oversee the management system.

vii. **Training and Competency:** Establish a training program to ensure that employees have the necessary knowledge and skills to work safely and in compliance with environmental regulations. Monitor and assess employee competence regularly.

viii. **HSE Procedures and Work Instructions:** Develop and document procedures and work instructions for safe and environmentally responsible work practices. Ensure that procedures are accessible and understood by all employees.

ix. **Incident Reporting and Investigation:** Implement a clear and systematic process for reporting and investigating incidents, accidents, and near-misses. Learn from incidents and take corrective and preventive actions to prevent recurrence.

x. **Emergency Response and Preparedness:** Develop and maintain detailed emergency response plans for various scenarios, such as fires, chemical spills, and natural disasters. Conduct regular drills and exercises to ensure preparedness.

xi. **Communication and Consultation:** Establish effective communication channels for sharing HSE information with employees, contractors, and other stakeholders. The system should be one that encourages feedback and consultation on HSE matters.

Xii. **HSE Performance Monitoring & Measurement:** Define key performance indicators (KPIs) to track HSE performance. Regularly measure and monitor progress towards HSE objectives and targets.

xiii. **Audit and Review:** Conduct regular internal audits to assess the effectiveness of the HSE management system. Review the management system to identify areas for improvement.

xiv. **Documentation and Record Keeping:** Maintain comprehensive records of HSE activities, including incident reports, training records, and audit results. Ensure easy access to documentation and records.

xv. **Continuous Improvement:** Implement a process for continuous improvement, including corrective and preventive actions based on findings from audits, incidents, and reviews.

"...an effective HSE management system is an ongoing process. It requires dedication, continuous improvement, and the involvement of all employees to create a safe, healthy..."

Adapt to the HSE management system as the organization evolves and as new risks emerge.

xvi. **Legal and Regulatory Updates:** Stay updated on changes in HSE laws and regulations, and adapt the management system to remain in compliance.

xvii. **Employee Engagement and Culture:** Foster a strong HSE culture by involving employees in HSE activities, encouraging reporting, and recognizing good practices.

xviii. **External Certification (Optional):** Consider seeking external certification to recognized HSE management system standards like ISO 14001 (Environmental Management) and ISO 45001 (Occupational Health and Safety).

The above is further cascaded into continuous

- Development of Project Risk Register
- Review and Updating of HSE Project Plan
- Review of Project Risk Register

Remember that the development and maintenance of an effective HSE management system is an ongoing process. It requires dedication, continuous improvement, and the involvement of all employees to create a safe, healthy and environmentally responsible work environment.

7.0 THE SAFETY ASPECT APPLICATION

PRE-COMMISSIONING AND COMMISSIONING

EMERGENCY PROCEDURES

- Emergency Response Plan
- Emergency Equipment
- Emergency communication systems
- Hazard Identifications and Risk analysis
- Emergency Drills and Training
- Activation of Safety Systems
- Emergency Equipment Inspection
- Testing of Emergency Procedures
- Documentation
- Regulatory Compliance

8.0 GENERAL SITE HAZARDS

- Pressure Testing and Air Freeing of Process Plant
- Piping hazard
- Mechanical hazards
- Chemical hazards
- Electrical hazards
- Safety in Plant Commissioning
- General Fire Protection and Prevention

9.0 PROTECTIVE CLOTHING AND EQUIPMENT

- Respiratory Protective Equipment
- Compressed Air Breathing Apparatus
- Escape Filter

10.0 PRE-COMMISSIONING AND COMMISSIONING

SAFETY TRAINING

- Safety Training Concept
- Training Modules Common to Pre-Commissioning and Commissioning Activities
- Safety Training Modules Content

11.0 PERMIT-TO-WORK PROCEDURE

- Lockout and Tagging
- Working Inside Energized Buildings
- Confined Space Entry

12.0 PROJECT SAFETY FORMS

- Permits to Work
- Lockout/Tagging
- Other Checklists

13.0 SAFETY CONCEPTS

- Codes and Standards
- Climatic Condition
- Hazardous Area Classification
- Fire Protection
- Personal Protection
- Fire and Safety Point Shelters
- Fire & Gas Detection
- Fire Proofing

14.0 GENERAL INFORMATION

- Fire Water Network -
- Deluge System
- Inert Gas System
- Fire Equipment

The above aspect on safety must be incorporated into the entire planning of pre-commissioning

"Safety during plant commissioning requires a proactive and multifaceted approach to ensure that all aspects of the process are conducted safely."

and commissioning phases. They should be fully implemented for a safe plant and process facilities.

15.0 CONCLUSION

Safety during plant commissioning requires a proactive and multifaceted approach to ensure that all aspects of the process are conducted safely. Collaboration between engineering, operations and safety professionals is essential to minimize risks and prevent accidents.

The well-being of personnel, the protection of assets and the successful transition of a newly constructed or modified industrial facility from the construction phase to full operation entail shared responsibilities among all parties, namely contractors, engineers, operators and safety professionals. Collaboration, communication and a proactive approach to safety are essential for a successful and incident-free commissioning process.

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6. *Occupational Safety, Health and Environmental Administration and Management.*
7. *Use of Safety Administration on Minimizing and Mitigating occupational/Industrial Hazards and Disasters.*
8. *Process and Operational Safety in Production/ Manufacturing and Construction Industries.*
9. *Creating Safety Awareness and Consciousness: Working and Living Safety*
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14. *Safety Administration in/for Disaster Management (for Policy Makers and Executives).*
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16. *Safety Administrations in Waste Management (for Policy Makers and Executors).*
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21. *Analysis of Safety Administration & Management Systems in Oil and Gas Project Development/Execution.*
22. *Analysis of Safety Management Systems in Oil & Gas Project, Pre-Commissioning and Commissioning*
23. *Construction and Fabrication Safety Management*
24. *Process Audit*
25. *Risk Assessment*
26. *Risk Management*

ACEN ACTIVITIES IN PICTURES

3RD BUSINESS EVENING 2024 IN MAIDUGURI

30TH AUGUST 2024

At the middle, ACEN President, Engr. Kam-Selem A. Bukar, FNSE and other participants.

Engr. M. B. Shettimah, FNSE – Zonal Coordinator, ACEN Zone 4 and Chairman, NSE Maiduguri Branch, and other participants present at the event

A cross-section of the participants present at the event

FEDERAL MINISTRY OF WORKS TRAINING IN ABUJA THURSDAY 5TH – FRIDAY 6TH SEPTEMBER 2024

A 2-day Technical Workshop Programme on Professional Ethics in Engineering, Contract Administration & Construction Works Supervision for Directors and Federal Controllers of Works, Federal Ministry of Works, Abuja

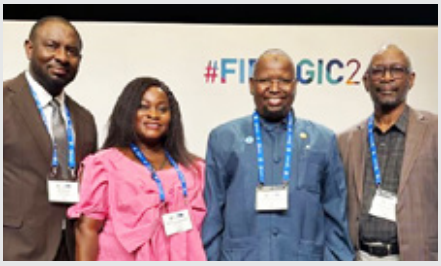
Cross-section of participant

Group picture at the end of the training

GLOBAL INFRASTRUCTURE CONFERENCE IN GENEVA, SWITZERLAND 8TH – 10TH SEPTEMBER 2024

Engr. Bayo Adeola (R), FNSE Past President of ACEN, and (L) Engr. Kam-Selem A. Bukar, FNSE the incumbent President of ACEN

Engr. Kam-Selem A. Bukar, FNSE President of ACEN, alongside Catherine Karakatsanis, President of FIDIC



***R-L:** Engr. Kam-Selem A. Bukar, FNSE President of ACEN and other participants*

COMMISERATION VISIT TO BORNO STATE GOVERNOR

1ST & 2ND OCTOBER 2024

ACEN Present & Past Presidents and Nigerian Academy of Engineering on a Commiseration Visit to Borno State Governor Over Alau Dam Flood Disaster, visit Shehu of Borno in Maiduguri.

ACEN President, Engr. Kam-Selem A. Bukar(R), FNSE presenting cheque to Engr. Prof. Babagana Umara Zulum, Executive Governor of Borno State.

L-R: On the first row (5th) WFEO President, Engr. M. B. Shehu, (6th) ACEN President, Engr. Kam-Selem A. Bukar, FNS (7th) Nigerian Academy of Engineering, Engr. Prof. Rahman Adisa Bello, FNSE FAEng (8th) Shehu of Borno, Alhaji. (Dr.) Abubakar Ibn Umar Garbai Al-Ameen El-Kanemi, CFR (FNSE), (9th) ACEN Past President, Engr. Y. O. Sagaya, FNSE, Zarna of Ilorin, (10th) ACEN Past President, Engr. Nurudeen A. Rafindadi, FNSE, FAEng, OFR, (11th) Past President of COREN and now Deputy President of NSE, Engr. Ali Alimasuya Rabiu, FNSE, FAEng, MFR, (12th) Past President of NSE, Engr. Kashim A. Ali, FNSE, FAEng and Engr. M. B. Shettimah, FNSE – Zonal Coordinator, ACEN Zone 4 and Chairman, NSE Maiduguri Branch.

L-R: Past President of NSE, Engr. Kashim A. Ali, FNSE, FAEng, Past President of COREN and now Deputy President of NSE, Engr. Ali Alimasuya Rabiu, FNSE, FAEng, MFR, ACEN President, Engr. Kam-Selem Alhaji Bukar, FNSE, ACEN Past President, Engr. Charles 'Yele Akindayomi, FNSE, ACEN and COREN Past President, Engr. I. S. Ogunbayo, FNSE, FAEng and other distinguished members of the visiting team.

ACEN President, Engr. Kam-Selem Alhaji Bukar, FNSE making an address at the Council Chambers of University of Maiduguri on a courtesy visit to the Vice Chancellor, Prof. Mohammed Laminu Mele.

***L–R:** ACEN President, Engr. Kam-Selem Alhaji Bukar, His Royal Highness, The Shehu of Borno, Alhaji. (Dr.) Abubakar Ibn Umar Garbai Al-Ameen El-Kanemi, CFR (FNSE), Engr. Muhammad Abba Sanda, MNSE, Director of Ankabut Engineering Limited presenting an Award to the Shehu of Borno who served as Royal Father of Occasion during the investiture ceremony of the 20th ACEN President and Engr. M. B. Shettimah, FNSE – Zonal Coordinator, ACEN Zone 4 and Chairman, NSE Maiduguri Branch.*

The team of visitors to the His Royal highness, The Shehu of Borno, Alhaji (Dr.) Abubakar Ibn Umar Garbai Al-Ameen El-Kanemi, CFR (FNSE)

VITA CONSTRUCTION LIMITED

Lagos Head Office: Plot 18, Aminu Jinadu Close, Iganmu Surulere, Lagos, Nigeria

M: 09030417598 | E: vitalos@vita-construction.com | W: vita-construction.com

The Company in Brief

Vita Construction Ltd was incorporated in Nigeria as a private company in 1981. Since its establishment, the company has delivered more than 850 projects of every size in numerous fields including industrial, commercial, residential as well as port terminal construction.

The company's offices are situated in Lagos and Abuja. The Head Office in Lagos incorporates a yard and workshops occupying approximately 13,000 m2, including a steel and aluminum workshop as well as a timber joinery.

OUR PEOPLE

Vita Construction Ltd, boasts of a workforce numbering 2,500 - 3,000 people made up of well-trained Nigerian and expatriate professionals comprising, engineers, quantity surveyors, artisans and laborers, supported by a well-managed finance and administrative team.

We believe that maintaining in-house artisans and other well trained and experienced construction personnel ensures that we maintain our high-quality standards and thus ensuring our ability to deliver projects to our clients' full satisfaction.

OUR SERVICES

Our expertise spans over a variety of buildings and civil engineering projects such as:

i. Large scale industrial and commercial projects
ii. High-rise and low-rise residential buildings and estates

Large scale industrial and commercial projects

iii. Commercial buildings and office fit-outs
iv. Institutional buildings
v. Religious buildings & estates
vi. Hotels
vii. Complex steel structures
viii. Container Terminals
ix. High volume concrete hardstands for port terminals
x. Specialised data center facilities

INDUSTRIAL & COMMERCIAL PROJECTS

High-rise and low-rise residential buildings and estates

Commercial buildings and office fit-outs

Institutional buildings

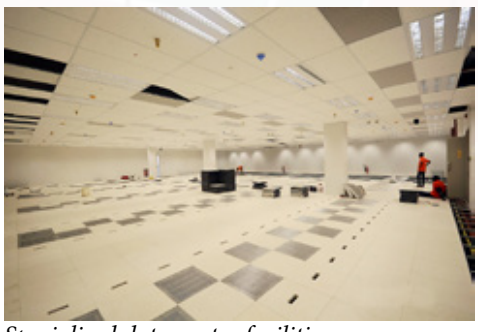
Religious buildings & estates

Hotels

Complex steel structures

High volume concrete hardstands for port terminals

Container Terminals



Specialised data center facilities

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WE ARE PROUDLY CERTIFIED

While striving for excellence and continuous improvement, we adhere to high standards of quality, health and safety and the promotion of teamwork on each and every site.

INDUSTRIAL & COMMERCIAL PROJECTS

West Africa Container Terminal Onne Port Project

Southern African Institute of Steel Construction – Steel Awards 2020.

OneHealth Medical Center by AXA

Guinness Head Office Remodeling

Friendship Centre for MTN Nigeria, Asaba

INDUSTRIAL & COMMERCIAL PROJECTS CONT'D

Office Block for Petroleum Product Pricing Regulatory Agency, Abuja

Renovation of Health Clinic for Central Bank of Nigeria

CCTV Command Centre

Head Office Development For Trust Fund Nigeria

Federal Palace Hotel Pool & Casino

Saudi Arabian Consulate Building & Ambassador's Residence

INDUSTRIAL & COMMERCIAL PROJECTS CONT'D

Centre of Excellence at the University of Jos

International Training Institute For The Central Bank Of Nigeria

Swimming Pool For Tourist Company Of Nigeria

Complex steel structures

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ESTABLISHED 1981

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FACTORY PERSPECTIVES OF ENGINEERING IN INDUSTRY

Engr. Enefiok Ubom, *FNSChE (Entrepreneurship Consultant)*

1.0 INTRODUCTION

One of the definitions of Industry is stated thus: 'Industry is a classification for a group of companies that have similar business activities'. *(Source: https://www.investopedia.com/terms/i/industry.asp).* Another definition of Industry is: 'The production of goods from raw materials especially in factories'. (Source; Oxford Advance Learner's Dictionary, International Student's Edition).

Leaning on these definitions, we can deduce that factories exist within various industries or industrial sectors. In other words, factories are subsets of industries. For instance, petroleum refinery (petroleum refining factory), compressed natural gas (CNG) factory and liquefied natural gas (LNG) factory are in the Oil and Gas industry, soap factory is in the Detergent industry; Paracetamol factory is in the Pharmaceutical Industry; Car engine factory is in the Automobile manufacturing Industry and urea is in the Fertilizer industry. Indeed, the list is endless. This paper will examine the typical roles of engineers in a factory setting.

2.0 PRODUCTION MANAGEMENT IN A FACTORY

Production Management is concerned with decision making related to production processes, so that the resulting product is produced according to specifications, in the quantities and by the schedule demanded in the market at minimum cost (Ubom, 2006).

In factories, production management is carried out by designated personnel. In a factory producing bolts and nuts, a mechanical engineer would be considered most suitable in the position of production manager by virtue of his training. In petroleum refinery or a chemical processing factory, a chemical engineer would be more suitable as production manager by virtue of his training as a process engineer. Irrespective of the type of factory, the engineer serving as production manager is expected to perform the functions of planning, organizing, directing and controlling materials and human resources.

A brief description of the management functions provides a better appreciation of these management fundamentals.

i. **Planning:** Planning results in the selection of courses of action (plans) that will direct an organization's human and material resources for future time spans. Plans establish the boundaries within which people make decisions and carry out assigned activities. Such plans must anticipate future events, problems and causal relationships. In this sense, planning refers to deciding what to do, how to do it before action is taken. An acceptable plan is one that is selected as the best course of action from alternative courses of action.

ii. **Organizing:** Organizing combines various human and material resources into a meaningful whole. This is accomplished by dividing the work to be done into specialties, grouping similar activities (departmentalization), identifying desired authority relationships between individuals and groups; delegation of authority; and considering the social and economic consequences associated with various organizational forms. By combining people, work to be done and physical factors into a meaningful structure, goals can be achieved more effectively.

iii. **Directing:** Directing includes motivation, leadership, communication, training and other forms of personal influence.

iv. **Controlling:** Controlling involves checking and comparing performance to established standards. If performance deviates from standards, corrective action is required to get things back on path. Such action might take the

'Industry is a classification for a group of companies that have similar business activities'

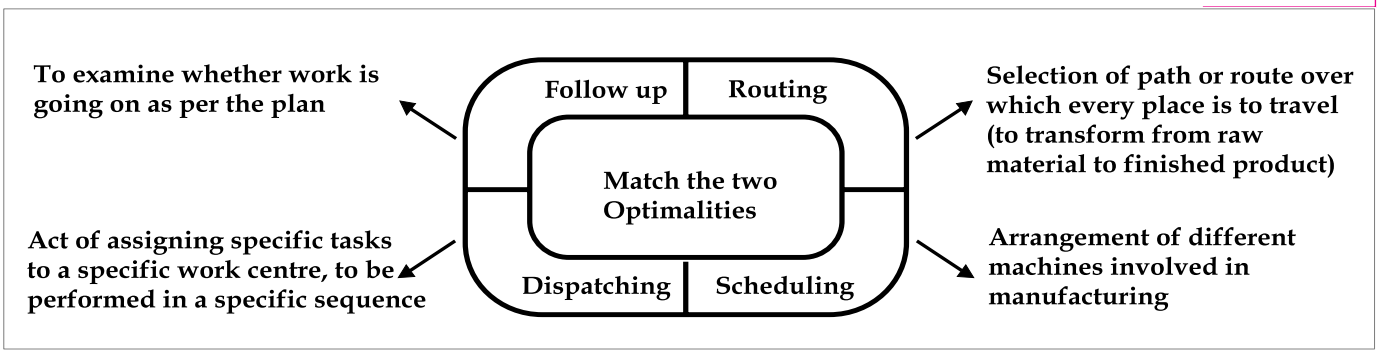

Fig. 1: Production planning and control

form of repairing faulty equipment, changing the behavior of employees, re-organizing a department or revising an original plan and its corresponding standards.

v. **Production Planning and Control:** Production planning and control can also be viewed together. Production planning and control can be viewed as the nervous system of a production/factory operation. The primary objective of production planning and control is the delivery of products to customers or to inventory stocks according to some predetermined schedule. All the activities in the manufacturing or production cycle must be planned, coordinated, organised and controlled to achieve this objective. From a long-term point of view (usually from seven to ten years or more), production planning is a major factor in plant construction and location, number of product lines design and development. See Fig. 1.

By performing these functions, co-ordination of individual effort is achieved throughout the organization. Trewartha and Newport give an illustrative figure to show how the management processes (functions) provide co-ordination among the inputs to produce goods and services, which the marketing department must manage and market (See Fig. 2).

The actual impact of the management process within an organization depends upon:

i. The authority possessed by managers who plan, organize, direct and control
ii. The stage of development of the organization and
iii. Various environmental factors including government regulations, the actions of competitors and the desires of customers.

One of the key areas that brings satisfaction to the Production Manager and indeed the entire Management is meeting production target without compromising quality and safety. One aspect that causes dissatisfaction to the Production Manager is unwarranted factory shutdown or breakdown of plant and equipment. This underscores the importance of effective maintenance of factory facilities. In what follows, we will provide a brief discussion on maintenance management.

3.0 MAINTENANCE MANAGEMENT

Factories are different from one another though there may be some similarities in terms of capacity, equipment setup and layout. The difference always lies in management, manpower composition, working environment and the type of challenges associated with the day to day running of the

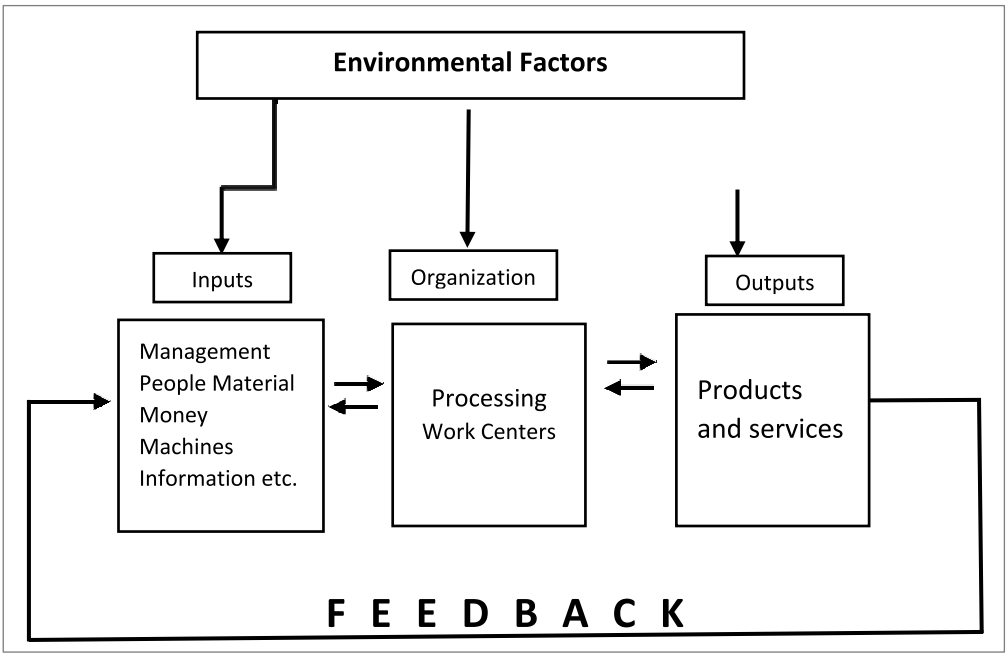

Fig. 2: Management as systematic part of the organization Feedback (Source: Trewartha and Newport: Management Function and Behavior, Business Publication, Inc., Revised Edition, Dallas 1979)

Fig. 3: Electrical equipment repairs

factories. The challenges associated with keeping factory equipment in continuous operation coupled with its management response and input determine the type of factory maintenance practice and culture. Factory assets such as vessels, machines, tools, equipment, appliances and building(s) wear out and deteriorate due to use and exposure to the environment. If this process of deterioration is not arrested, the assets may become functionally unviable and unserviceable. It is, therefore, essential to repair and recondition them from time to time to enhance their economic life.

There are many forms of maintenance practices known in factory setup. In terms of execution, maintenance can either be done as preventive maintenance or breakdown/ reactive maintenance. The management always wants to ensure continuous and uninterrupted production runs which can be achieved through effective maintenance policy based on minimum cost and downtime.
In factory setting, we consider that the facilities have all passed through the design phase (as designed by the engineers), then the installation and commissioning stage by engineers. Factories in operation regularly need maintenance. At this juncture, the emphasis will be on factory maintenance which is the major responsibility of engineering managers. The specialist areas of interest are HVAC Engineers, Mechanical Engineers, Electrical/Electronic Engineers and Civil Engineers in a factory setting.

i. HVAC ENGINEERS: HVAC is an acronym used for 'heating, ventilation and air conditioning'. The development of HVAC systems has become an integral part of daily living because of the useful impact and pleasurable comfort derived from it by man. An air conditioner is an electro-mechanical system that controls the temperature, humidity and ventilation of an enclosure using refrigerants or other recommended cooling agents.

The primary function of an HVAC system is either the generation and/or maintenance of comfort for occupants in an air-conditioned space or the supply of a set of environmental conditions (high temperature and high humidity, low temperature and high humidity, etc.) for a process or product within a space.

The key items in a factory which require effective maintenance in HVAC systems by HVAC Engineers include: compressors, condenser, pressure switch, filter dryer, evaporator, ventilation blower, expansion valve as well as piping. As a point of responsibility, most equipment manufacturers provide the necessary information and guidelines in their manuals on maintenance procedures that should be adopted.

ii. ELECTRICAL/ELECTRONIC ENGINEERS

In all cases, maintenance of the electrical facilities is required to keep factory facilities in good working condition. Good maintenance culture promotes safety and improves the reliability of the electrical facilities. In factories, there is no gainsaying that the breakdown of electrical facilities would result in costly interruption of normal operation. See Fig. 3.

Some modern factories in Nigeria depend only on in-house power generation facilities so as to efficiently manage factory operations and plan maintenance in a satisfactory manner instead of depending on

Fig. 4: Production Control Room with electrical/electronic facilities equipment are carried out using tools and gadgets.

epileptic power supply from the public source. The situation seems to be improving gradually in Nigeria with the recent policy of providing electricity supply for up to 20 hours per day to customers placed in Band 'A'. Most factories are placed in Band 'A'. If this practice is sustained, it means there should be further improvement in the future to the extent of supplying electricity for 24 hours per day not only to industries but the entire populace.

There are specific legislative and regulatory responsibilities placed on factory personnel and occupiers of factory buildings to ensure the safety of electrical installations. There are also statutory obligations to ensure the successful operation of life safety systems such as emergency lighting and fire detection and alarm systems when they are actually needed. Transportation systems such as lifts, escalators and moving walkways also need periodic assessment. Insurance policies may be an additional driver of this practice. If periodic certification cannot be produced, then insurance policies may not be honored when the need arises. It is the responsibility of professionally competent electrical/electronic engineers to see to the effective maintenance of electrical/electronic facilities in the factories such as production control room facilities,

Fig. 5: Repair of mechanical equipment

Fig. 6: Mechanical piping repairs

electric motors, switch gears, transformers, among others. See Fig. 4. Most standard factories have Electrical Engineering Workshop where repairs of electrical equipment

iii. MECHANICAL ENGINEERS

In factories, it is the responsibility of Mechanical Engineers to handle the maintenance of equipment such as pumps, pipes, heat exchangers, boilers, process vessels among others. See Fig. 5 & 6.

Major mechanical refurbishment and replacements take place during scheduled factory shutdown or turnaround maintenance. Most standard factories have specially designed Mechanical Engineering Workshop where mechanical equipment are repaired including the fabrication of spare parts for use when necessary. Spare parts store, housing various spares, is also maintained in most factories where new parts can be taken out to replace worn-out or defective parts of equipment.

"The situation seems to be improving gradually in Nigeria with the recent policy of providing electricity supply for..."

Fig. 7: Factory road repairs

iv. CIVIL ENGINEERS

Civil Engineers carry out civil works maintenance in factories. These are primarily factory buildings, road network and drainage systems. See Fig. 7.

4.0 ENERGY EFFICIENCY IN FACTORIES

Globally, climate change concerns are staring everyone in the face in each country. The key motivation in seeking energy efficiency in factory operations is to achieve environmental sustainability apart from increased profitability. By reducing energy consumption, Factory Management can significantly lower greenhouse gas emissions, minimize waste and decrease the environmental impact of their operations. Energy efficiency supports global efforts to combat climate change and promotes the responsible use of natural resources.

Some key environmental benefits in adopting energy efficient factory operation are as follows:

i. Reduction in greenhouse gas emissions and volatile organic compounds
ii. Conservation of natural resources including water
iii. Waste Minimization
iv. Promotion of Renewable Energy integration

As a case in point, it is reported that Dow Chemical Company embarked on strategic energy efficiency measures and achieved great success in its factory operations. Since 1990, Dow's energy efficiency strategy has saved 5800 trillion Btu of energy. These energy savings also led to $27 billion in cost savings. About half of every dollar the company spends goes toward energy, mostly in the form of natural gas and natural gas liquids, which are the energy feedstock for the company. Dow's energy efficiency and chemicals management efforts have significantly reduced the company's GHG emissions footprint. As a result, Dow has prevented over 308 million metric tons of GHG emissions from entering into the atmosphere since 1990. A key element of Dow's Energy Efficiency and Conservation (EE&C) program is the energy data collecting, reporting and accountability system built around the company's global asset utilization reporting (GAUR) system. Source: https://onlinelibrary.wiley.com/doi/10.1002/9781119033226.ch02

5.0 CONCLUSION

This paper has concentrated specifically on the roles of specialists in various engineering disciplines such as chemical engineers, HVAC engineers, mechanical engineers, electrical/electronic engineers and civil engineers in factory operations and maintenance. Other groups of engineers such as geotechnical engineers are required to bring in their expertise prior to the installation of factory plant and equipment in relation to sub-surface conditions.

Apart from the goal of achieving effective factory operation leading to safe output of products within specification, it is essential to carry out planned maintenance of plant and equipment to promote long life. All engineers are now very conscious of energy efficient practices in factory operation to minimize adverse environmental impact and achieve higher profit. Dow Chemical Company is cited as a good example and should serve as lesson for engineers in all industries.

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REPOSITIONING NIGERIA'S STEEL SECTOR FOR ENHANCED INDUSTRIALIZATION

1.0 INTRODUCTION

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No nation has ever transformed into industrial and modern society without the acquisition of heavy industries, primarily iron and steel technology. The difference between developed and developing nations, rich and poor nations, is their steel technology base. All G20 nations are steel producing nations. Countries like India and Turkey experienced industrial boost through steel development. Japan and Germany, after the 2nd world war, rebuilt their economies through massive development of their steel technologies. Other countries like China, Russia and South Korea produced more than their domestic needs and started exporting steel products (Madagua, 2015). One of the key indices for measuring economic growth is the per capita consumption of steel and allied products. The apparent per capital steel consumption in Nigeria is about 10 kg. Some countries in Africa have these figures: Ghana – 25 kg, Kenya – 27.5 kg, South Africa – 83 kg, Gabon – 30 kg etcetera (NIETI, 2015).

Nigeria has the 12th largest iron ore resource worldwide and the 2nd largest in Africa yet Nigeria imports more than 90% of its steel needs from China and other countries, consuming more than 6 million tonnes of steel per year (NIETI, 2015). According to the Economic Development in Africa Report 2022 (UNCTD, 2022), all countries have some potential for export diversification into all the sectors shown in Fig. 1 through relatively small jumps. The values reported in Fig. 1 represent the global increase in imports of the products, hence, countries that produce these goods which also include the iron and steel products and by-products, can compete for the same expanding market opening up more export opportunities for African countries and companies.

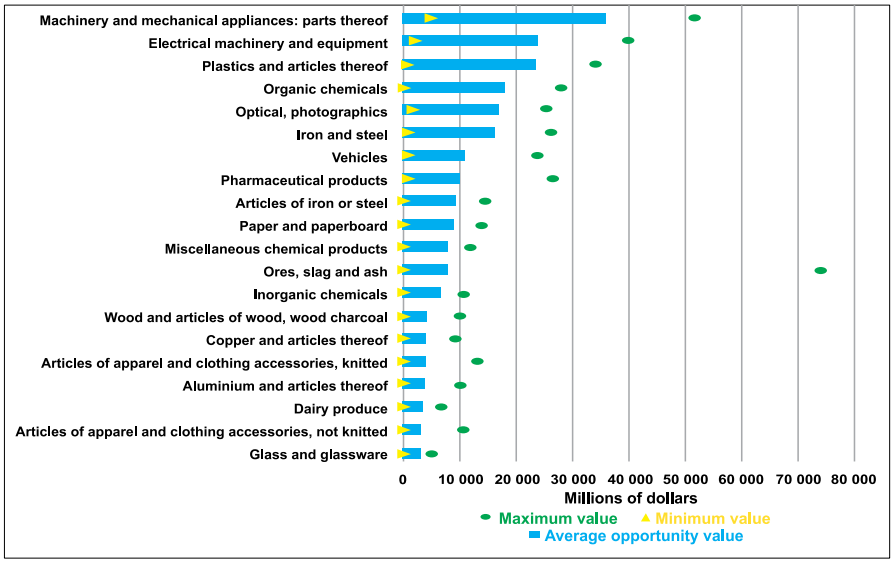

Fig. 1: Product diversification export opportunities to the world by top 20 sectors, country average, maximum and minimum values in millions of dollars (UNCTD, 2022)

In the ores, slag and ash sector, Benin is thought to have had a market opportunity of $74 billion. It was further reported that this potential can be increased by exporting iron ore concentrate, which is in high demand in countries such as China and these opportunities can be exploited by Nigeria. Interestingly, Benin Republic has a better Thiel index than Nigeria based on a 2018-2019 report as shown in Fig. 2. South Africa, Egypt and Morocco all in Africa, are reported to have an index higher than the world average and are all steel producing nations. The report also indicates that the ability of a nation to increase productive capacities and

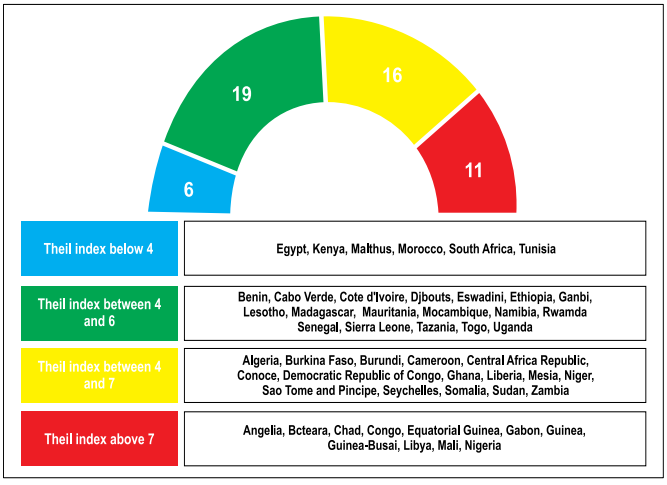

Fig. 2: African countries by Theil index, 2018–2019 (UNCTD, 2022)

structural change heavily depends on the availability of inputs, technology and services which can be greatly enhanced through the revival of the steel industry with the attendant downstream and spin-off effects.

Only recently, Zimbabwe commissioned a brand new iron and steel manufacturing plant which is expected to be Africa's largest integrated steelworks and will become one of Africa's leading iron and steel producers projecting a Steel Manufacturing Capacity of 5 Million Tons per annum. It is also expected to start producing billets and other products like pipes, bolts, nuts and even smaller slags, rolled tubes, fences, shafts, wires and bars in the next phase. Zimbabwe plans to make use of its abundant deposits of iron ore, coking coal, to produce iron and steel products that will strengthen its value chain. The country plans to export several Billions of Dollars' worth of products annually. This is a position Nigeria was supposed to have occupied several years ago. It is also planning to revive the Zisco steel plant which shut down in 2008.

It is on record that, in 2020, according to the United Nations COMTRADE database on international trade, Nigeria imported $1.18 billion worth of steel materials and from the statistics available from the National Bureau of Statistics, in the 3rd and 4th quarters of 2021, Nigeria imported iron, steel and metals, valued at N837.76 billion. This can be reduced if the iron and steel industry, in Nigeria, is revived.

2.0 OVERVIEW OF STEEL INDUSTRY IN NIGERIA

Nigeria is blessed with most of the major raw materials required for the production of iron and steel. Exploration of iron and steel in Nigeria started, in 1963, at the Itakpe iron ore deposits. However, in 1967, experts from Russia came to conduct feasibility studies in Nigeria with the aim of establishing an iron and steel plant. The second National Development Plan (1970–1974), led to the establishment of the National Steel Development Authority (NSDA) by the government, with a mandate of iron and steel development in Nigeria. NSDA conducted various geological survey, under the coordination of the Russian experts, which steered the discovery of commercial quantities of iron ore in Nigeria.

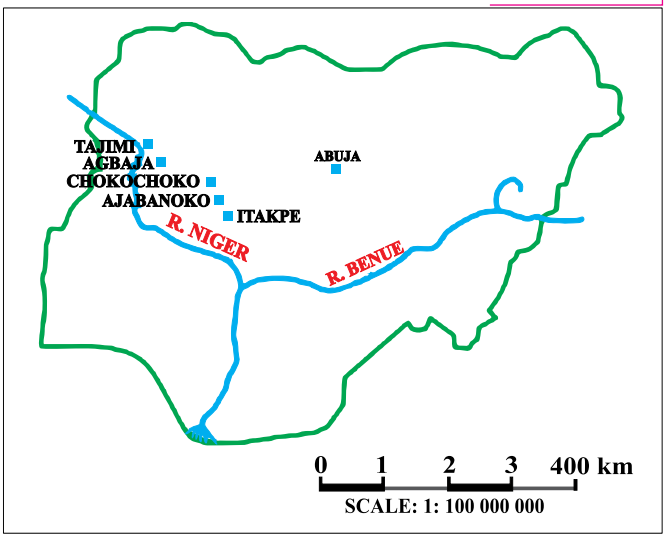

Fig. 3: Location of Iron Ore Deposits in Nigeria (Adebimpe and Akande, 2011)

Furthermore, the third National Development Plan (1975 – 1980) led to the ratification of various agreements by government for the construction of two integrated steel plants and three rolling mills. In 1979, the government promulgated Decree No. 60 of 18th September 1979 that unbundled NSDA and established the Ajaokuta Steel Company, Delta Steel Company, Jos Steel Rolling Company, Katsina Steel Rolling Company, Oshogbo Steel Rolling Company, National Iron Ore Mining Company, National Steel Raw Materials Exploration Agency, National Metallurgical Development Centre and the Metallurgical Training Institute. Fig. 3 shows the location of some iron ore deposits in Nigeria while Table 1 shows the estimated deposits of iron ore which is believed can sustain the production of iron and steel in Nigeria.

In order to reposition the steel sector for increased economic development, the two major iron and steel plants at Ajaokuta in Kogi State and Aladja in Delta State must be revitalized.

3.0 AJAOKUTA STEEL PLANT

In 1974, TYAZHPROMEXPORT (TPE) of the then USSR submitted a Preliminary Project

Iron Ore Deposit	Fe	SiO:	A1:O$_3$	Ca O	Mg O	Ti O:	MnO	P	S	Indicated/Inferred Reserve in MT	
Itakpe	36.88	44.80	1.0	0.30	0.20	0.10	0.05	0.18	0.05	200	300
Oshokoshoko	34.45	51.07	9.67	0.15	0.18	0.61	0.08	0.02	0.007	10	85
Ajabanoko	37.22	46.50	3.39	0.21	0.15		0.01	0.01	0.03	25	65
Agbaja	47.80	10.89	9.60	0.72	0.38	0.37	0.14	2.08	0.12	962	1250
Kotan Karfi	48.15	5.13	6.70	0.45	0.07	0.24	0.56	2.14	0.04	428	850
Bassan Nge	46.90	8.28	10.87	0.46	0.46	0.26	0.13	1.45	0.05	82.5	450
Muro	31.60	40.00	0.40	5.50	2.10	0.20	0.10	0.10	0.10	3.8	

Table 1: Estimated Iron Ore deposits (Osemenam & Afeni, 2019)

Fig. 4: View of Ajaokuta Steel Plant Blast Furnace

Report (PPR) and in 1975 it was agreed upon to site the company at Ajaokuta because of proximity to the Itakpe iron ore. The report also recommended an alternative production scheme based on both local and imported raw materials. Furthermore, the report projected an initial capacity of the plant at 1.3 million tons of liquid steel per annum with a projected first phase future expansion to 2.5 million tons per annum and a second phase expansion up to 5.2 million tons per annum (Madagua, 2015). The accepted TPE report gave room for a Detailed Project Report (DPR), which was completed in 1977 and accepted in 1978 after various deliberations. The Ajaokuta Steel Plant Limited was established in 1979 and between 1980 and 1983, 84 % of the Plant structures were erected. It is imperative to mention that the priority mills such as the Light Section Mill and the Wire Rod Mill were commissioned in 1983 and 1984 respectively. However, despite several attempts to complete the project by successive governments, an integrated commissioning of the plant remains an elusive dream to date. Fig. 4 presents a current view of the blast furnace of the Ajaokuta Steel Plant. This condition is the outcome of prolonged neglect and the project's failure to reach completion and commissioning. What remains are deteriorated, aged and outdated equipment and infrastructure.

The plant units of the Ajaokuta Steel Plant facilities, which are Primary, Secondary and Ancilliary units if in operation, can be utilized for proper industrial growth. In order to reactivate the Ajaokuta Steel Plant and bring it back on stream, two options are proposed (Olayebi and Alabi, 2023). This would be in addition to completing the rail link to the Jakura Limestone deposit and the Osara dolomite deposit and other supporting facilities that would make the plant to function effectively.

I. PROPOSAL I:

This proposal which is in line with the TPE's PPR and DPR and without any modification to the conceptual plant design, will require the completion of the primary units and establishment of a clear route for effective transportation of imported coking coal to the Ajaoluta Steel Plant. In this case, the Blast Furnace and other primary units will be completed and commissioned and will require the implementation of the original Detailed Project Report concept in which imported coking coal will be brought into the country though the Onne Port and transported by rail through Oturkpo to Ajaokuta. This will entail the provision of bulk handling facilites at the Onne Port in Rivers State and the installation of rail line from Onne to Ajaokuta. An alternative solution for transporting coking coal to Ajaokuta involves deepening the Escravos River to a depth of 10 meters. This would enable larger vessels, with capacities of up to 35,000 dwt, carrying imported coke to access the Delta Steel Company harbor. From there, the coking coal could be transported to Ajaokuta via rail. The need for dredging the river arises from the current limitation, as only ships of 10,000 dwt can currently dock at the Delta Steel Company harbor. This restriction is due to the presence of a natural gas pipeline in the river, which hinders the passage of larger vessels inland. Consequently, this would potentially lead to an increase in the cost of coke per tonne.

The arguments in favour of this option include the following:

a. This may require extra cost implication and energy requirements.
b. The Blast Furnace produces its own heat and does not need any electrical energy at all, except for its auxiliary inputs and charging system.
c. It is a continuous process, producing round the clock for over five or six years before it is stopped for relining of its refractory bricks.
d. Addition of an electro-metallurgical unit has no value added to the BF-BOF process.
e. Mixing imported coke with Nigerian coal in ratios that would result in the goal of steel production.
f. There is a possibility of achieving the cokability of Nigerian coals based on researches conducted by some Nigerian Universities, Nigerian Geological Survey Agency, the National Metallurgical Development Centre and the National Steel Raw Materials Exploration Agency that may eliminate the need for importation of coke. This is in line with the views propounded by the Nigerian Society of Engineers.

II. PROPOSAL II:

The second proposal will require a modification of the conceptual design that would involve the

replacement of the Blast Furnace and its prior (sinter and coking) units with the Corex process (reduction shaft and melter gasifier units). This would entail the use of the Corex process which is presently the only industrially acceptable alternative to the Blast Furnace route for hot metal production and satisfies the need for low environmental impact, economics and a reduction in the annual production rate. The Corex technology is marketed by Voest – Alpine Industrienlagenbau (VAI), Austria and there are, at present, five commercial Corex units operating in China, Korea, India and South Africa (Siemens-VAI, 2007; APP, 2010). Environmental degradation and the depletion of coking coal led to the development of a smelting reduction process, which has the capacity of utilizing non-coking coal. The Corex process is made up of two reactor units namely the reduction shaft and melter gasifier. The reduction shaft is always above the melter gasifier, for easy transfer of materials. The melter gasifier has a volume that is more than three times that of the reduction shaft (Prachethan, et al., 2006). Fig. 5 shows a schematic representation of the Corex process.

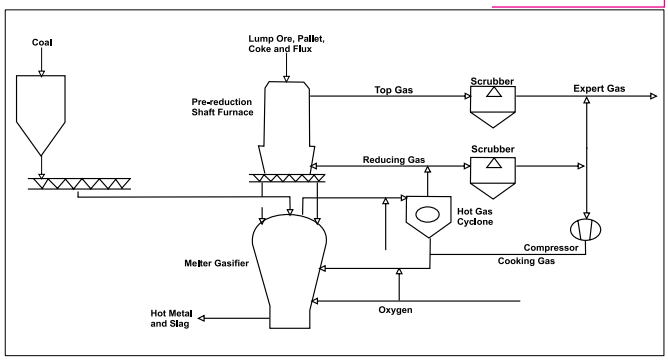

Fig. 5: Schematic representation of the Corex Process

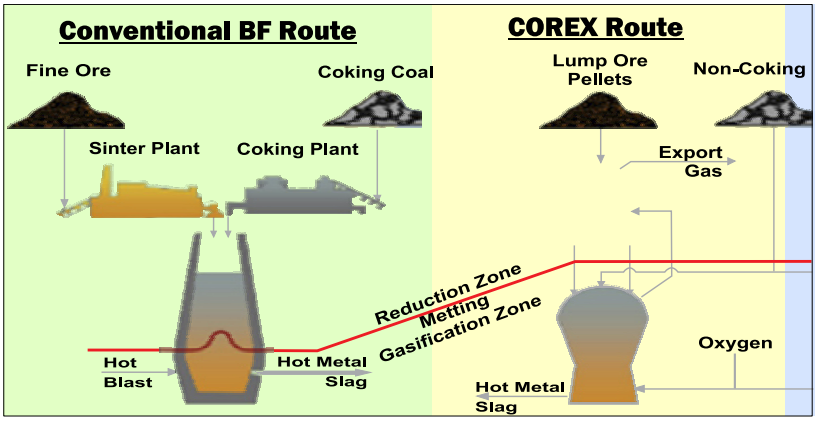

Fig. 6: Comparison between Corex process and Blast Furnace process (Almpanis-Lekkas, et al., 2016)

The arguments in favor of this option are as follows:

a. Fuel savings of 18 percent and oxygen consumption reduction of 13 percent
b. Approximately 20-percent lower CO2 emissions per tonne of product
c. Approximately 30-percent lower NOx emissions per tonne of product
d. No VOC (Volatile Organic Compounds) emissions; significantly lower SOx emissions
e. Fuel rate significantly reduced by circulation of the shaft furnace top gas back to the furnace
f. Reduced investment and operation costs
g. Lower slag production

Since coal is charred completely inside the melter gasifier at a temperature of over 1000 0C, leading to complete cracking and leaving no room for tar formation, non-coking coal can be charged into the melter gasifier. Thus, the proposed Corex option will require the gross utilization of the Nigerian coal which are primarily non-coking in nature. Nigeria's present coal deposit is estimated at about 2.8 billion tonnes reserves in 17 identified coalfields (Ewepu, 2017). The confirmed reserves are projected at 639 million tonnes containing 12% lignite, 49% subbituminous and 39% bituminous coal (Chukwu, et al., 2016). Beneficiation of the non-coking Ogboyaga coal, which was reported as the highest coal deposits in Nigeria (Ocheri, et al., 2017) and located in close proximity to the Ajaokuta Steel Plant, will aid the course of the Corex modification to the current design.

For the two proposed options however, there will be the need to rehabilitate the Itakpe iron ore plant which has been left moribund for several years, for the supply of iron ore.

A detailed economic analysis was carried out by Olayebi and Alabi (2023), based on which Proposal II is suggested as a route to bringing the Ajaokuta Steel Plant on stream.

"Fuel savings of 18 percent and oxygen consumption reduction of 13 percent"

4.0 DELTA STEEL MIDREX BASED PLANT

The prospects for the Delta Steel Plant were enormous based on the shaft furnace technology adopted

Year	MIDREX®	Other Shaft Furnace	Total
1990	10.73	5.25	15.98
1991	11.96	5.40	17.36
1992	13.26	4.29	19.55
1993	15.91	5.73	21.64
1994	17.83	7.01	24.84
1995	19.86	8.15	28.01
1996	21.03	9.12	30.15
1997	23.08	9.55	32.63
1998	24.82	8.52	33.34
1999	26.12	8.81	34.93
2000	30.12	9.39	39.51
2001	26.99	8.04	35.03
2002	30.11	8.88	38.99
2003	32.06	9.72	41.78
2004	35.01	11.34	46.35
2005	34.96	11.00	45.96
2006	35.71	10.91	46.62
2007	39.72	11.20	50.92
2008	39.85	9.84	49.69

Year	MIDREX®	Other Shaft Furnace	Total
2009	38.62	7.88	46.50
2010	42.01	9.81	51.82
2011	44.38	11.03	66.41
2012	44.76	10.79	55.55
2013	47.56	11.29	58.85
2014	47.12	12.04	59.16
2015	45.77	11.62	57.99
2016	47.14	12.66	59.80
2017	56.65	14.68	71.33
2018	62.10	18.11	80.21
2019	65.37	16.57	81.94
2020	63.07(r)	16.03	79.10(r)
2021	70.85	17.84	88.69

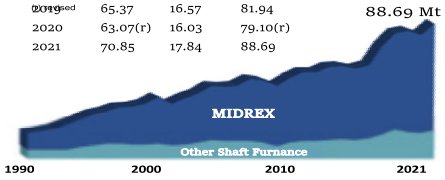

Fig. 7: Shaft Furnace DRI Production by Process and Year (Midrex Tech.)

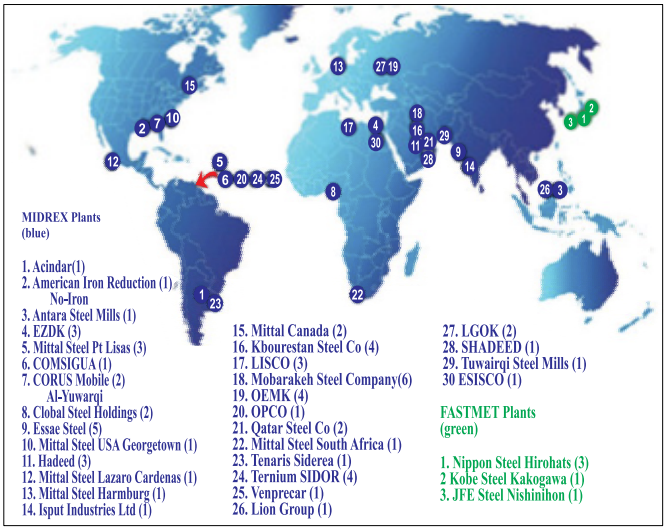

Fig. 8: World Direct Reduction Plants (Kobelco Tech. Review, 2010)

Fig. 9: Pelletizing Plant at Delta Steel Company

Fig. 10: Direct Reduction Plant at Delta Steel Company

Fig. 11: Steel Melting Shop (SMS) at Delta Steel Company

for the Direct Reduction Plant as seen in Fig. 7. At present, Nigeria is not among some of the African countries in the list of major steel producing countries as shown in Table 9.

In a bid to put the Delta Steel Plant back on stream, the Federal Government handed over the plant to an Indian company, Global Infrastructure Holdings in 2005. Fig. 8 shows the map of the world and the Direct Reduction Plants. The Delta Steel Plant which was the only one in West Africa and sub-saharan Africa, was named here as Global Holding. Privatization was carried out to supposedly bring life to the steel industry but unfortunately it turned out to contribute to its eventual collapse leading further to the opening up of a dark chapter in the history of the Nigerian steel industry.

Figs. 9, 10 and 11 show the present situation of some of the major units at the Delta Steel Plant after privatization.

The Delta Steel Plant had put Nigeria on the map of steel producing countries. The potential for export of finished products started in 1992 when direct reduced iron made from imported iron ore from Brazil was successfully exported to Spain in the first ever export of the product through containers. This marked a milestone for the country. What followed the successful reduction of iron ore made from Itakpe iron ore was not only the production of steel but the landmark export of direct reduced iron (DRI) made from Itakpe ore to Bulgaria and India in 2007 (Olayebi, 2021). This created an opportunity for Nigeria to earn foreign exchange. It is on record that the Saudi Iron and Steel Company (Hadeed) was commissioned the same period with Delta Steel Company (DSC) about 1982 and both plants were of the same Midrex technology and were constructed on turnkey basis by the same German-Austrian Consortium. Hadeed has currently increased to 5.5mt/yr from an initial installed capacity of 800,000t/yr.

The increase was done in 2 Direct reduction plant modules to 1.76Mt/y in 2007 producing both hot and cold direct reduced iron. The installed capacity of DSC, also from 2 modules, was 1.2Mt/y Cold DRI and production did not exceed 250,000mt/yr when it was eventually run aground in 2011. Hadeed is one

"The enormous gains in having a vibrant steel industry cannot be over emphasized."

of the companies operated by Saudi Basic Industries Corporation (SABIC) and is 70% owned by Saudi Government. In 2014 SABIC, with employment figure of 40,000 as at end of 2014, made N1.2 trillion profit after tax. This means that steel production can be run as strategic enterprise.

The success story of the steel industry in many industrialized nations did not happen without serious efforts and commitment and tenacity from the various governments. For example, during the Korean Miracle period, the government of South Korea identified iron and steel, petrochemical, non-ferrous industries as the backbone of a modern industrial economy. The government continued "to undertake risks that cautious entrepreneurs would tend to avoid by providing heavy capital investment in these industries." Today, South Korea boasts of six out of the first ten largest-shipbuilding corporations in the world. In Saudi Arabia, the Public Investment Fund was established by the government in 1971 to provide financing support in productive projects which are of commercial nature and are strategically significant for the development of the national economy and cannot be implemented by the private sector alone either because of lack of insufficient experience or adequate capital resources or both (Madagua, 2015). It is therefore proposed that the Nigerian Government do the needful by placing the steel industry on the front burner and giving it the necessary attention it deserves.

5.0 CONCLUSION

The enormous gains in having a vibrant steel industry cannot be over emphasized. The initial dream was fueled by the abundance of raw materials and utilities for its actualization. With the abundant quantity of iron ore and non-coking coal in Nigeria, the viability of a proposed Corex process based modification in the Ajaokuta Steel Plant may be worth considering. The secondary units of the Ajaokuta Steel Plant can be made fully functional in the interim, with the use of 100x100mm billets that can be produced through dedicated molds from the Delta Steel Plant which will in turn utilize the Itakpe iron ore for production. The successful upgrading of the sinter grade of the Nigerian Itakpe Iron Ore to a super-concentrate with a higher Fe content to meet the requirement of the Midrex Direct Reduction based Plant at the Delta Steel Company, marked a major milestone in the production of steel from iron ore in Nigeria.

Having successfully entered the export market, through utilization of the local enhanced iron ore from Itakpe, there are enormous potentials for further expansion particularly into the West African sub-region and East Africa. Nigeria had the first and only blast furnace and direct reduction based steel plants in Africa and therefore was to be a trail blazer in terms of iron and steel production in Africa. The completion of the Itakpe-Aladja rail link would have given a further impetus to this. In addition to the major products from the steel plants, there are numerous spin off industries that would aid industrialization and guarantee job opportunities for several hundreds of thousands of persons. The dream regarding the steel industry can become a reality by Nigeria learning from whatever mistakes may have led to the failures that bedeviled the industry by taking advantage of the abundant raw materials resuscitating and revitalizing the steel industry and putting her again on the path to industrialization.

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TIT-BITS ON ENGINEERING

Engr. Enefiok Ubom, *FNSChE*

1.0 INTRODUCTION

Modern advances in engineering are in areas such as Robotics, Artificial Intelligence, Green Manufacturing, among others. In this presentation, we are focusing on robotics using few examples in Germany and United Kingdom. Another area of advances in engineering is in the application of artificial intelligence (AI). This will also be discussed.

2.0 ROBOTICS

2.1 GERMANY

The use of robotics in the construction industry in Germany is gradually gaining ground. Some Germans are using robots to build houses. They no longer need workers or hire concrete mixers. They can easily construct a house in just 2 days.

What you see in Fig. 1 is a house-building robot developed in Germany that is mounted on a truck. The device is directly mounted on a truck to construct houses. Before building, the model must be pre-designed on a computer, then the entire construction plan is transmitted to the robot and only then can the robot start building the house.

This robot has a 25m long arm allowing it to construct buildings up to 8 storeys high. See Fig. 2.

At the end of the long arm there is a video camera and a laser tracking system that precisely places the bricks in the correct position. If the bricks are too large, they can be automatically cut to the correct size. In summary, everything a builder can do, this construction robot can do 10 times faster.

Traditional house construction requires reinforcement but this robot seems to need none by using industrial adhesive said to be stronger than concrete and has thermal and sound insulation properties. This makes the bricks very solid in just about 40 minutes significantly increasing the overall efficiency of the construction process (Source: https://www.youtube.com/watch?v=wxw4xAixquc).

2.2 UNITED KINGDOM

Nigerian-born British entrepreneur, Dr. Silas Adekunle created the robot known as 'Mekamon'. See Fig. 3. Mekamon offers an unparalleled Science, Technology, Engineering, Arts and Mathematics (STEAM) education experience through advanced robotics and the ReachEdu app.

Adekunle holds a 1st class degree in Robotics and Honorary degree of Doctor of Technology from the University of West of England, Bristol.

Fig. 1: House building robot mounted on a truck

Fig. 2: An Eight-storey building under construction by a robot.

Fig. 3: Mekamon Robot (Source: https://www.mekamon.com)

He co-founded and was the CEO of Reach Robotics where he created the 'Mekamon' robot, a 4-leg robot with life-like movements that combine robotics with augmented reality. The App-controlled 'Mekamon' robot was a hit receiving US$12m from investors including London venture partners and partnering exclusively with Apple to distribute its product in USA and Britain. The robot is also designed to teach users about coding robotics and engineering.

3.0 ARTIFICIAL INTELLIGENCE

3.1 FUNDAMENTAL STATEMENTS ABOUT ARTIFICIAL INTELLIGENCE, AI

Artificial intelligence (AI) is the simulation of human intelligence processes by machines, especially computer systems. *(Source: https://www.techtarget.com/searchenterpriseai/definition)* AI-Artificial-Intelligence

AI technologies, particularly deep learning models such as artificial neural networks, can process large amounts of data much faster and make predictions more accurately than humans can. While the huge volume of data created on a daily basis would bury a human researcher, AI applications using machine learning can take that data and quickly turn it into actionable information.

3.2 STEPS IN APPLICATION OF AI

A number of logical steps are followed before AI technology is applied in enhancing engineering practice in various industries. HOW ARTIFICIAL INTELLIGENCE WORKS

i. Identification of engineering problem: AI is conceived to work to solve engineering problems to meet the business needs.
ii. Collection of Data: Data is a key component of an AI project, as AI systems rely on data to learn and make predictions or decisions using structured data, unstructured data, big data and real-time data.
iii. Modelling the system: This is the process of creating a simplified version of a real-world system using mathematics or computer programming. Usually, the model will be trained on large amounts of data to make decisions or predictions about new data.

iii. Model Evaluation: This is the process of testing how well a trained AI model performs on new data that it has not seen before. This is to ensure the model can work well on new problems and to compare different models to choose the best one.

iv. Model Deployment: Following the successful evaluation of a trained AI model, the model is deployed in the real world. The purpose of model deployment is to integrate the model into real-world applications and ensure it meets performance requirements.

3.3 APPLICATIONS OF AI IN ENGINEERING

Artificial intelligence is in use in various fields of engineering such as Civil Engineering, Petroleum Engineering and Chemical Engineering. Some of these areas are enumerated hereunder:

i. Civil Engineering

a. AI is used in optimizing structural design, predictive maintenance and performance analysis in civil engineering. See Fig. 4.

b. AI is used in construction management, resource allocation and quality control in infrastructure projects.

Fig. 4: Civil Engineer working with technology software to ensure augmented reality in work

c. AI aids in geotechnical analysis, environmental impact assessment and soil behavior prediction.

d. AI plays key role in sustainable urban development, traffic management and sustainability assessments. (Source: https://www.udemy.com/course/artificial-intelligence-ai-applications-for-civil-engineer)

ii. Petroleum Engineering

a. AI is used in production optimization. It analyzes data from various sources, such as well logs, reservoir models and production records which help engineers identify opportunities for improving well performance and increasing production rates. AI can be used to optimize production rates and maximize recovery from reservoirs.

b. AI is used in reservoir modeling and simulation to predict future production rates and optimize production strategies. Machine learning algorithms can be used to analyze historical production data, geological data and other relevant information to build accurate reservoir models that can be used to simulate various production scenarios.

c. AI is used in optimizing the drilling and completion of wells, which can help reduce costs and improve production rates.

d. AI is used to predict equipment failures before they occur, allowing for proactive maintenance and reducing downtime. By analyzing data from sensors and other monitoring systems, machine learning models can be trained to identify patterns and anomalies that indicate potential equipment failures.

e. AI is used to monitor safety conditions in real-time and identify potential hazards before they become a safety incident. By analyzing data from sensors and

"Artificial intelligence is in use in various fields of engineering such as Civil Engineering, Petroleum Engineering and Chemical..."

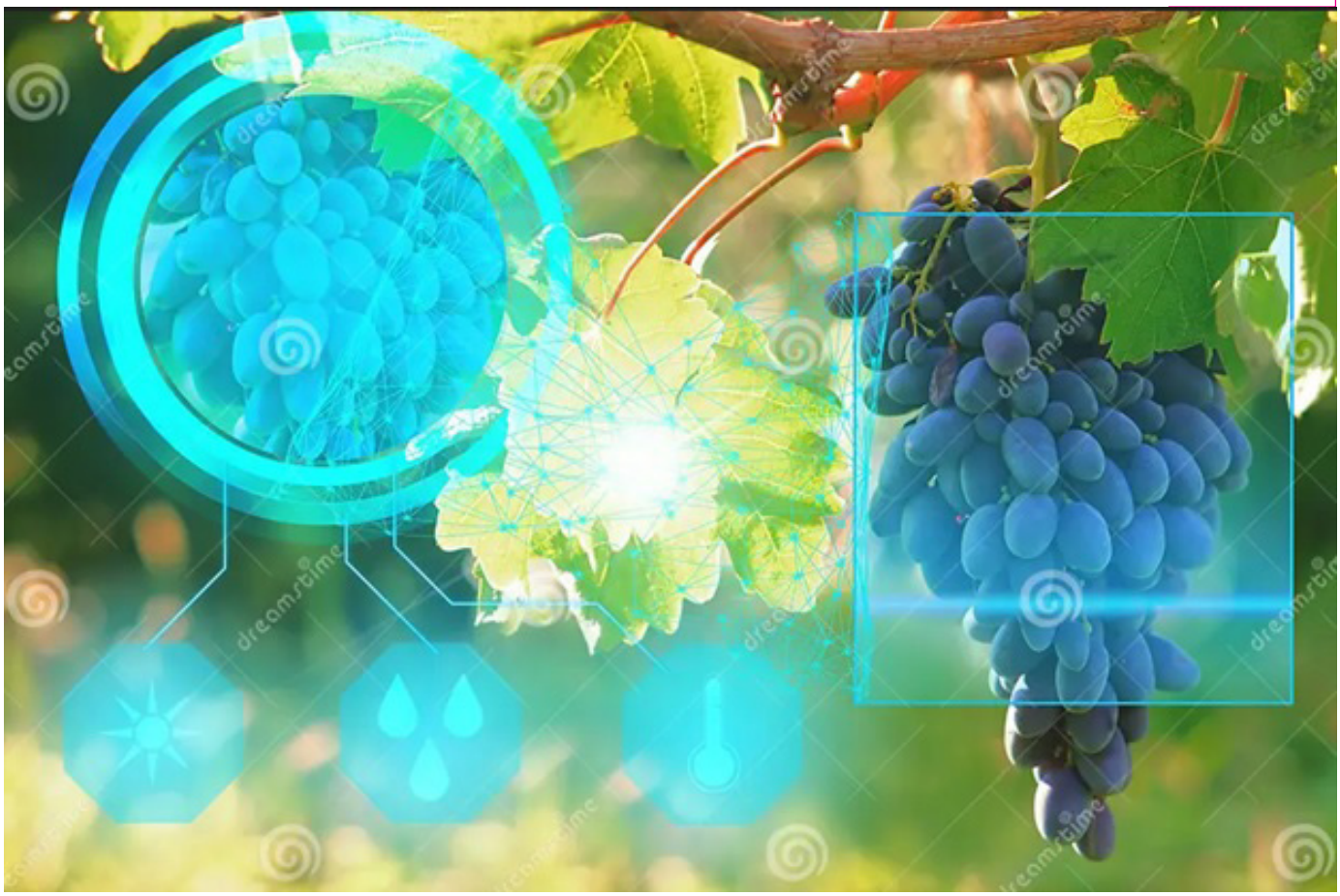

Fig. 5: Scanning of grapes using AI prior to production of high-quality wine

> ***"Robotics will continue to evolve in various applications in... engineering. The creative potential of man has..."***

other monitoring systems, machine learning models can be trained to identify patterns and anomalies that indicate potential safety hazards.

f. AI is used in real time monitoring and control of reservoir performance.

iii. Chemical Engineering

a. Quality control is an essential aspect of industrial processes. AI technology is a handy tool in fast and effective analysis of data. This is useful in prompting corrective action to maintain the quality of products. See Fig. 5.

b. AI is used in process optimization in the chemical process industry. AI technology has the capacity to identify and correlate data that serve as input to achieve optimization in chemical processing.

c. Safety and risk management is enhanced through the deployment of AI in the chemical process industry. AI can analyse data from process sensors and safety systems which practically adds value to safety and risk management.

d. Production efficiency and flexibility can be achieved through the deployment of AI-enabled smart manufacturing systems. AI can optimize production processes using its smart tools. The optimization includes improvement in the use of energy resources.

4. CONCLUSION

Robotics will continue to evolve in various applications in the practice of engineering. The creative potential of man has always been seen to lead to advancements in technology. It is crucial to apply new technologies in enhancing the welfare of mankind and not otherwise.

Similarly, the application of artificial intelligence in Civil Engineering, Petroleum Engineering, Chemical Engineering, among others, has significant potential to improve the efficiency, safety and sustainability of industries.

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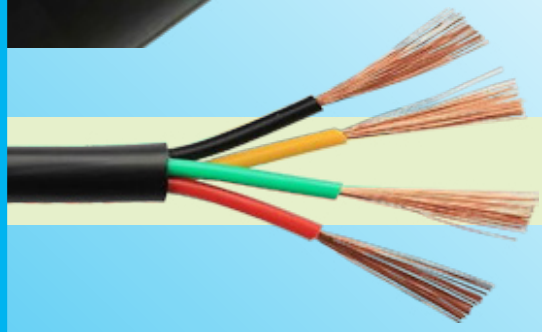

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