KeSEBAE NEWS

A Publication of Kenya Society of Environmental, Biological and Agricultural Engineers

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DEAR READER

Welcome to KeSEBAE Newsletter.

A fortnightly Newsletter touching on topical issues affecting our environment.

***KeSEBAE NEWS** is a Newsletter of the Kenya Society of Environmental, Biological and Agricultural Engineers (KeSEBAE).*

WHAT'S INSIDE

1.0 Introduction

Engineering as a discipline has developed and branched out in many specialised areas that continue to progress by leaps and bounds today. One of these unique branches is **marine engineering**.

Marine engineering is a branch of engineering that deals with the application of engineering sciences to the design, development, innovation, production, operation and maintenance of the different types of equipment or machinery used at sea (e.g., rigs and other floating structures) and on-board sea vessels such as boats and ships. It combines other engineering disciplines like electrical engineering, mechanical engineering, engineering design and control technology *(these different disciplines help make a sea-vessel an independent power plant).*

KeSEBAE NEWS EDITORIAL

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The field is vast and with spawned fields such as **naval architecture, oceanographic engineering** and **nautical science.**

Naval architecture deals with design, construction, operations and maintenance of sea going vessels. It plays the primary role in all stages of the life of a marine vessel right from the initial designing to advanced type of design, actual construction, testing, operations, maintenance as well as launching and dry-docking of marine vessels. It is also involved in the modification, modernization and repair of old vessels. The discipline also involves in areas dealing with formulation of safety standards, damage control rules and certification of vessel designs. **Naval architecture and marine engineering** combine imagination, artistic instincts, and proven scientific principles, tempered by basic engineering considerations, in designing the means of ocean transportation of the future

Oceanographic Engineering is a multidisciplinary engineering field which solves engineering problems related to the ocean environment, where engineers help oceanographers wisely explore the many vast oceans. It involves the design and build of structures, equipment and instruments that help advance marine science.

Nautical Science is the principles and practices of operating different types and sizes of vessels safely, efficiently and cost-effectively i.e., navigation and seamanship.

Figure 1: Marine Engineering. Source: Global Marine Trends 2030 Report

2.0 Blue/Ocean Economy & Marine Engineering

Blue Economy is sustainable use of ocean resources for economic growth, improved livelihoods and jobs, and ocean ecosystem health.

The Blue Economy encompasses many activities among others, the Maritime Transport. Over 80% of international goods traded are transported by sea and the volume of seaborne trade is expected to double by 2030 and quadruple by 2050 [1]

The ocean also connects cities and countries around the world, driving economic activity and trade for the 38 percent (and growing) of the global population that lives within 100 kilometres of the sea. Submarine cables cross the ocean's floor to carry 90 percent of the electronic traffic on which communications rely. [2]

3.0 Safe passage to the future: The Value of Marine Engineering

Naval Architects and Marine Engineers are vital to the success of the world's "**BLUE ECONOMY**". This could be the design of ships to carry cargo around the world, offshore wind and tidal devices to harvest green renewable energy, autonomous underwater and surface vehicles to explore the oceans, superyachts for leisure and racing yachts.

4.0 Global Marine Technology Trends 2030

The shape of the marine world in 2030 will depend on the interactions between people, economies and natural resources. It will see intense competition for access to resources to power economic growth akin to a competing nations scenario.

[1] **The World Bank, (2017).** Blue Economy. https://www.worldbank.org/en/news/infographic/2017/06/06/blue-economy

[2] **World Bank Group, Pawan G. Patil, John Virdin, Sylvia Michele Diez, Julian Roberts, Asha Singh (2016).** Toward a Blue Economy: A Promise for Sustainable Growth in the Caribbean. Pg.

4.1 Marine Technology Trends 2030 [3]

4.1.1 Big Data Analytics

Big data analytics is the process of analysing this big data to uncover hidden patterns, unknown correlations, ambiguities, market trends, and other useful information.

The management and analysis of big data will become increasingly important, and we expect it to have a major impact on the marine world. It will be driven forward by the demand for information and the need to handle the variety of new data sources that are likely to appear. At the same time, big data will be subject to other factors that will threaten its adoption, such as the lack of the necessary data analysis skills required to exploit big data.

In the **FUTURE,** we expect new technologies to emerge that will improve big data analytics. Among these will be some of the so-called **'SMART MACHINE'** technologies and computing systems that process data in a manner similar to the human brain.

Figure 2: Big Data Analytics. Source [3]

4.1.2 Sensors

Sensor Technologies are developing rapidly to meet the ever-growing demand for data and information that will enable consumer-driven needs. For example, **The** Internet **of Things**, which allows real-time monitoring and control of systems and processes.

It will address the need for ever-increasing capabilities to measure the ocean (and near-ocean) environment, including biological, acoustic and electromagnetic characteristics. Sensors will be the enabler for infant technology developments like cognitive systems in which devices are able to use natural language processing and machine learning to improve the interaction between people and machines.

The widespread use of sensors already being introduced in areas such as automotive and scientific applications will expand into the **marine/maritime domain**, enabling better situational awareness and vessel management.

4.1.3 Autonomous Systems

Autonomous Systems is a rapidly expanding and diversifying technology.

The focus in the marine industry at present is on improving safety by taking people out of dirty, dangerous and dull jobs. In the future, we expect to see a significant increase in the use of these systems in the marine domain. Alongside **'stand-alone systems'**, we will increasingly see the use of interconnected intelligent systems to the point that completely autonomous surface and underwater vessels become accepted.

In the **scientific sector**, long-endurance sensing will enhance our understanding of the marine environment, supporting sustainable resource usage in areas such as carbon capture and habitat monitoring. For the **global offshore energy market**, the improved ability to gather data and intervene using autonomous systems will reduce risks and costs while opening up exciting new operating environments.

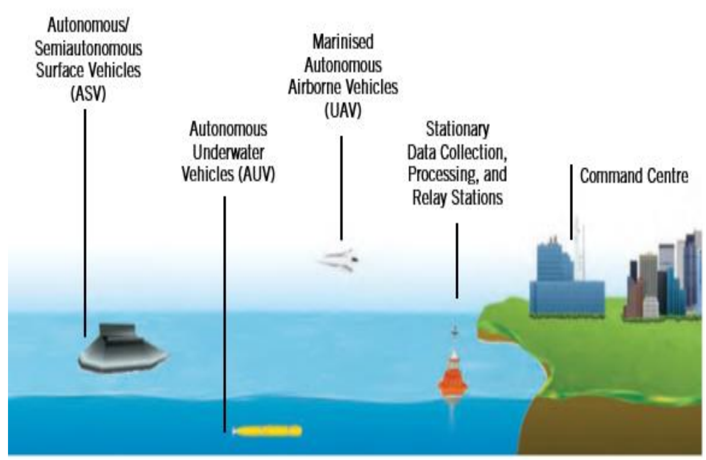

Figure 3: Autonomous Systems. Adapted. Source [3]

[3] **Lloyd's Register, QinetiQ and University of Southampton, (2015).** Global Marine Technology Trends 2030. https://www.lr.org/en/insights/global-marine-trends-2030/global-marine-technology-trends-2030/

4.1.4 Robotics

Assembly, collaboration with humans or machines, inspection, manipulation, and exploration are some examples of tasks that could be programmed into a robot. Robots can conduct different operations, from shipping to space missions. They can be remotely controlled, supervised, collaborative, or fully autonomous. Together with advances in motion control, cognition, sensing, miniaturisation, and robot-to-robot communication, enhanced robotic capabilities will stimulate market prevalence worldwide.

Driven by improving safety, security, and productivity, the widespread adoption of robotics has been observed across various sectors. Investment is likely to continue. The knowledge of technology will be expanded, revolutionising the future marine service and accelerating automation in the marine construction business. Robotics will become compulsory for tasks, especially those conducted in severe working environment, such as deep ocean mining and disaster relief.

4.1.5 Smart Ship

Smart ships are being widely debated as the shipping industry's next technological revolution. In the **manufacturing industry**, the term **'fourth industrial revolution'** describes how **"smart devices"** will replace the role of humans for the management, optimisation and control of machinery. In **consumer technology**, this is referred to as **The Internet of Things**: using sensors and digital technology, our personal habits are mapped and translated to automation for the purpose of improving our daily lives.

In this context, **SMART SHIPS** are not a discreet technology, but a manifestation of the utilisation and exploitation of technology trends. The application of sensors, robotics, big data, advanced materials, communications and satellites technologies will enable the transition into the **smart ship era**.

Short to Medium Term: **From the Digital Ship to the Intelligent Ship**

> The exploitation of big data acquisition, communications and analytics to introduce intelligent, real-time and proactive decision-making in the design, operation and maintenance of ships

Medium to Long Term: **From the Intelligent Ship to the Autonomous Ship**

> The exploitation of sensors and robotics technology to replace human operators, leading to semiautonomous ships (e.g., engine-room crewless ships) or fully autonomous ships (remote controlled)

Figure 4: Smart Ship. Source: https://marine-offshore.bureauveritas.com/media/153

4.1.6 Communications

Remote operation is the norm in the marine industry. The **marine industry** was an early adopter of some traditional communication technologies, such as radio. The capability to connect, communicate and interact with different parties and systems at sea is unfortunately much more difficult than on land.

Radiocommunications and satellites are examples of state-of-the-art technologies. As the technologies advance, we will begin to see fast market expansion and transition.

People onboard a vessel or on a platform rely on communication technologies to be socially connected to families and colleagues onshore. More importantly, they allow for emergency calls, geo-positioning, marine-life tracking, and disaster warning. The increasing diversity and capability of communication technologies will enable the acquisition and connection of data from different sources, representing a key to open the big data door.

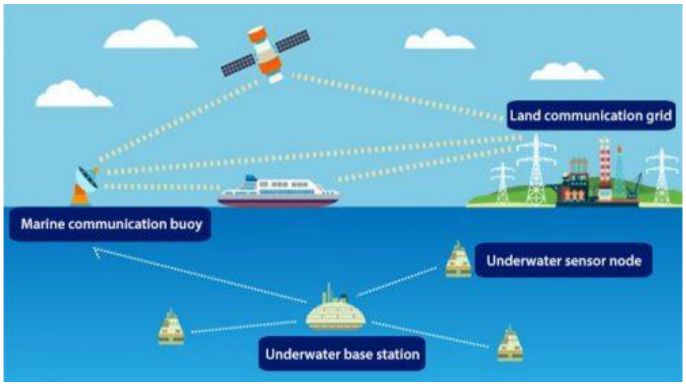

Figure 5: Marine Communication System. Source: MarketersMedia/

4.1.7 Advanced Materials

Advanced materials include all materials engineered to deliver specific physical and/or functional properties in their application.

The structure and properties of advanced materials at the nano-scale is now well understood, and this is leading to the challenge of manufacturing advanced materials to realise capabilities in bulk structures. This is termed nano-engineering and these materials are referred to as **nano-materials**

Desirable functionality, such as environmental sensing, self-cleaning, self-healing, enhanced electrical conductance and shape modification, is anticipated through the development of nano-materials, and, in turn, will deliver performance benefits in the commercial shipping, naval and ocean space industries.

Example of advanced materials includes: Engineered Materials and Structures (Lightweight structures)

4.1.8 Propulsion and Powering

As the demand for sea transportation increases, the global fleet is growing and ships are becoming larger in size. While efficiency has improved in relative terms (due to economies of scale), in absolute terms, the powering demands for the propulsion and power generation of ships have increased. Combined with concerns over future fossil-fuel dependency and our environmental footprint, propulsion and powering will become a key focus of technology development.

In terms of technology application, this varies depending on the ship type due to two main reasons:

Technical Compatibility: some energy-saving devices (ESDs) are not suitable for low design speeds, disqualifying the majority of the tanker/dry bulk fleet.

Commercial Compatibility: High capital expenditure (CAPEX) technologies are more suitable to niche, high-value assets (e.g., cruise ships, passenger ships, offshore support vessels).

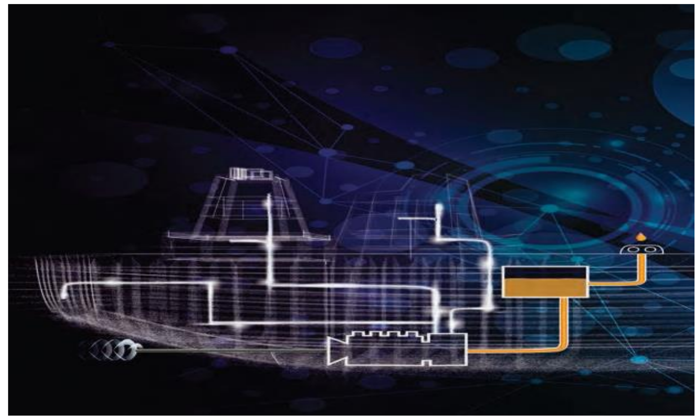

Figure 6: Propulsion and Powering. Source: Adapted Source: Global Marine Trends 2030

4.1.9 Shipbuilding

Global competition in the **shipbuilding industry** will remain intense. Such competition will drive advances in shipbuilding technologies, which are often propelled by innovation in the production process and the creation of new designs.

4.1.10 Advanced Manufacturing

The development of innovative technologies and materials, coupled with the rise of consumer demand, has led to a transformation of manufacturing, its processes and, more importantly, its economics.

Technologies such as additive manufacturing, coupled with the use of robotic systems for assembly, offer the opportunity to bring back manufacturing to high-value economies through increased productivity and competitiveness.

As the technologies develop, the size and complexity of components are expected to increase. Trials are already underway to conduct 3D printing onboard ships. Future developments such as 4D printing, coupled with nanotechnologies and robotics, are expected to lead to the printing of autonomous vehicles that can suit specific mission needs in-situ.

4.1.11 *Human Augmentation*

Human augmentation technologies include power assisted suits or exoskeletons that enable paraplegics to stand and walk; ocular sensory substitution devices to enable improved vision; and cochlear implants to enhance hearing.

In the future, human augmentation technology will eventually merge the human body with the machine. Research is currently looking at device architectures that resemble the body's own musculoskeletal design, actuator technologies that behave like muscle, and control methodologies that exploit the principles of biological movement.

Human augmentation's promise of improved human performance and the need for future navies to operate more effectively with fewer crew members will drive the technology's adoption. We can expect exoskeleton technology to be at the forefront of this adoption, but intrusive bions and neuroenhancements will appear much later.

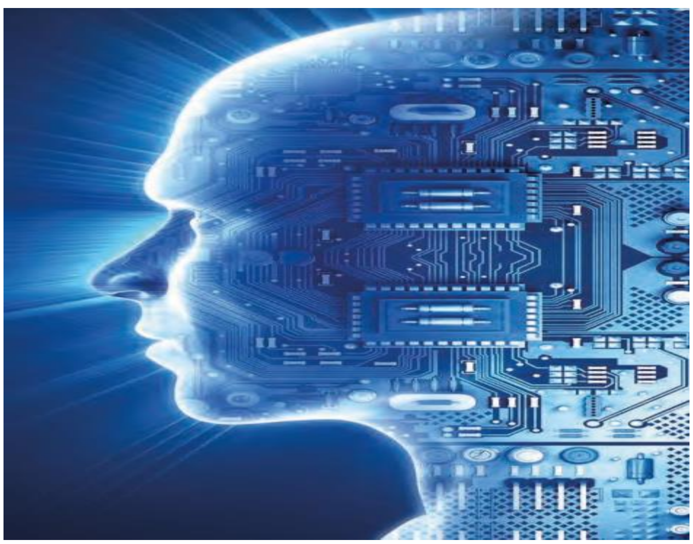

Figure 7: Human Augmentation. Source [3]

4.1.12 *Human - Computer Interaction*

Human–computer interaction (HCI) is the study and design of the interface between people and computers.

By 2030 we can expect a number of new HCI technologies to replace or augment those we currently use, both in fixed locations and when on the move. These technologies will enable us to interact with computer systems in new ways and will be smart enough to recognise our requirements and our personal preferences.

Also, technologies likely to make an impact over the next decade include **brain–computer interfaces** and **intelligent personal assistants.** The latter are software entities that are designed to act like personal secretaries, observing our behaviour and learning about our needs, so as to support us in our everyday lives.

Figure 8: Human - Computer Interaction. Source: Madhuri Hebbal, 2017.

4.1.13 *Cyber and Electronic Warfare*

Threats to systems in commercial shipping and the ocean space also exist.

The dependence of many activities on global navigation satellite systems (GNSS) for precision navigation and timing will drive the development of alternative precision positioning systems

Figure 9: Cyber and Electronic Warfare. Source [3]

4.1.14 Energy Management

The technologies associated with the whole energy management systems are particularly important in naval vessels where the demand for 'high-capacity surges' from energy intensive systems will continue to grow between now and 2030.

In energy production, the technology will be driven by environmental legislation and the need for lower predictable operating costs. In energy storage, the development of lightweight, high energy density fuel cells will continue.

Increasingly flexible and adaptable power system architectures will enable improved power availability to allow the rapid allocation of power according to the dynamically changing operational roles and mission dependencies of naval vessels.

Figure 10: High Energy Density Fuel Cells. Source [3]

4.1.15 Marine Biotechnology

Oceans are vast reservoirs of food, energy, and other resources, representing a unique opportunity for innovations in pharmaceuticals, development of industries, and sustainable solutions. Marine biotechnology seeks to harness this potential through the application of technological tools, in order to deliver products, services, and knowledge. Due to its interdependence on the fragile maritime environment, this technology must be used with particular consideration for preserving and nurturing the marine ecosystems.

One of the most promising of the possible future advances in this area is the large-scale use of algae. These marine organisms, representing a vast variety of species, may be used to treat waste water, obtain biomatter usable for food, livestock feed and fertilisers, produce biodiesel, and release oxygen. Such potential, combined with the availability of space and renewable energy offered by the oceans, will allow for a whole new industry to be developed and interlinked with already existing processes, such as fish farming or waste processing.

Figure 11: Marine Biotechnology. Source: https://www.prosyscom.tech/digital-science/global-marine-biotechnology-market-2018-marinova-neb-biotechmarine-glycomar-marine-biotech-nofima-sams-tech-science-tech-science/

4.1.16 Deep Ocean Mining

Deep ocean mining addresses the recovery of resources from the ocean floor for commercial purposes. Offshore operations will involve the extraction of minerals such as nickel, cobalt, zinc, copper, silver, gold, and manganese nodules using specialised subsea equipment.

Advances in technologies deployable in deep oceans, as well as growing concerns about the supply of minerals from existing onshore mines, will drive the investment required to establish deep sea mining as a viable market. The global turnover of deep ocean mining is expected to grow, where 10% of the world's minerals will be sourced from the ocean floors.

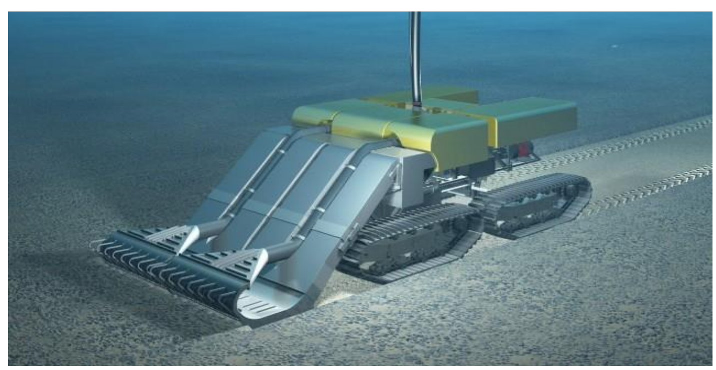

Figure 12: An artist's rendering of a deep-sea vehicle designed by Dutch company Royal IHC to harvest polymetallic nodules from the seabed. Source: Royal IHC

4.1.17 Sustainable Energy Generation

Marine energy carried by ocean waves, tides, salinity, and ocean temperature differences can be harnessed to generate electricity to power homes, transport and industries. A novel form of sustainable energy is the use of hydrogen as a fuel. Using the abundance of the oceans, it is possible to split seawater and harvest hydrogen for use on land.

4.1.18 Carbon Capture and Storage

Carbon capture and storage (CCS) involves capturing carbon dioxide (CO2) emissions, caused by human activities, ideally before they enter the Earth's atmosphere, then transporting and storing them securely in geological sites.

5.0 The Future of Marine Engineering - Biggest Changes to Expect

Over the last 150 years marine engineering has become dramatically more efficient and effective. MARINE INGENUITY is need to relive the pressure on the planet earth in order to build a better world.

The following are the biggest changes to expect based on data mining, artificial intelligence, machine learning etc.: [4]

1. The results of marine engineering projects as coastal protection, dredging and renewable energy will be **tangible for everyone around the globe.**
2. Data driven, **remotely operating 'ROBOATS'** will work on engineering projects all around the world.
3. Innovations that lead to **sustainable productivity will be adopted rapidly** by government and businesses. This will be the new norm!
4. **3D maintenance and spare-parts** production will be done on site. This will save up to **70% time and lots of energy.**
5. Revolutionary **hybrid tide, wind and solar fields** will be present in all oceans around the globe. Providing **clean energy** to billions.
6. Generation Z believes that **better and cleaner** is always possible. So, organisations will have no choice but to accept that **sustainability is new reality.**
7. The first **sun & moon laser collector** will deliver emery **24/7.** It will be used charge **huge battery fields** at sea.
8. Since 70% of its surface is covered by $H^{2}O$, the **earth will be renamed** and called **WATER.** New solutions for **creating a better world** will mainly be based on this resource.

6.0 Conclusion

Three important messages are apparent to the future of marine engineering:

Firstly, there are strong opportunities for growth in the commercial shipping, ocean space, and naval sectors in the future if businesses can harness the scientific and industrial capabilities required to take advantage of the technologies and innovation identified.

Secondly, the commercial shipping, ocean space, and naval sectors will undergo a rapid transformation as competition intensifies and technologies mature in other sectors.

Thirdly, there continues to be a critical need for a stable, coherent framework of regulation and support, so that the private sector has the confidence to invest.

Marine Engineering

[4] Royal **Van Oord, (2020).** The Future of Marine Engineering https://www.dredgingtoday.com/2020/02/07/the-future-of-marine-engineering-video/

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b. Are relevant to the application of engineering and technology in agriculture, the environment and biological systems

c. Have not been previously published elsewhere, or, if previously published are supported by a copyright permission

d. Deals with theoretical, practical and adoptable innovations applicable to engineering and technology in agriculture, the environment and biological systems

e. Have a 150 to250 words abstract, preceding the main body of the article

f. The abstract should be followed by the list of 4 to 8 "Key Words"

g. Manuscript should be single-spaced, under 4,000 words (approximately equivalent to 5-6 pages of A4-size paper)

h. Should be submitted in both MS word (2010 or later versions) and pdf formats (i.e., authors submit the abstract and key words in MS Word and pdf after which author uploads the entire manuscript in MS word and pdf)

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Ass.Member	1,000	1,000	2,000
Aff.Member	500	1,000	2,000
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