ECMAR

European Council for maritime Applied R&D

MARITIME TECHNOLOGY CHALLENGES 2030

NEW TECHNOLOGIES AND OPPORTUNITIES

SAFER, SMARTER, AND GREENER FOR A SUSTAINABLE EUROPEAN MARITIME SECTOR

CONTENTS

A VISION FOR EUROPEAN MARITIME RDI 2030

ECMAR's main objective through Research, Development and Innovation is to achieve a globally connected and competitive European Waterborne Sector, with zero-emissions and zero-accident ships, digitalised shipping and autonomy, to ensure a sustainable marine and maritime economy.

ECMAR's maritime technology outlook for 2030 addresses societal, global, and industrial challenges in order to secure a safer, smarter, and more competitive, and sustainable maritime industry.

Many of the technology areas will need to embrace the application of new disruptive technologies alongside the more traditional areas of research and development. These new technologies, together with digitalisation and connectivity, will be transformative and will make a significant contribution to the competitiveness and sustainability of the European maritime industry.

MARITIME TECHNOLOGY CHALLENGES 2030

FUTURE CHALLENGES AND OPPORTUNITIES

The future poses many challenges but also offers many new opportunities for the maritime sector. Today´s challenges for the sustainable development of maritime transport include maintaining competiveness in a global environment, optimal use of energy sources, and minimising its environmental impacts, particularly with regard to pollutants and greenhouse gas emissions. Satisfying humanity's growing needs for food, energy, water, organic or mineral resources presents another grand challenge.

Technologies can help in solving the environmental challenges for shipping and improving operational efficiency and sustainable technologies will assist ocean space exploitation and protect the environment. The current speed of innovation is rapid, particularly with the introduction digitalisation and the new transformative technologies of cyber physical systems. However, predicting which of these technologies will transform shipping, logistics, manufacturing, and ocean exploitation is a challenge in itself.

MARITIME TECHNOLOGY CHALLENGES 2030

MAIN CHALLENGES

The need for waterborne transport will continue to grow towards 2030 and beyond, primarily driven by population growth and rising prosperity. Population growth is increasing the demand for food, energy and water supply, which will result in an increased need for water transport, renewable energy, and aquatic food production.

Waterborne transport will remain the most cost efficient means for the global transportation of raw materials, finished goods, fuel, food and water. Infrastructure and links to all other transport modes will grow and adapt in response. Maritime transport, including inland waterways transport, will also become an integral part of an efficient multi-modal long-distance logistic chain.

Growth in global waterborne trade and activity will create significant new opportunities for the European maritime industry, with its expertise in delivering high “value added”, sophisticated and innovative products and services.

Connection with all other transport modes, will be seamless. Smart vessels will communicate with smart ports to limit congestion, waiting time and thus costs and will adapt their sailing speed to match harbour slots automatically.
Society’s increasing expectations about health, safety and security and the environmental impact of industry will lead to stricter regulations; this will require the Waterborne sector to improve in this area. Societal expectations will lead to the maritime sector becoming more socially and environmentally responsible by complying with stricter regulations and even adopting voluntary standards.

Concerns about Climate change has led to legislation imposing limits on greenhouse gas emissions (GHG). This will require a reduction of energy consumption by waterborne transport, by measures such as the use of cleaner fuels, e.g. LNG, the electrification of ships, renewable energy sources, and fuel cells.

Monitoring of ship’s emissions is also required with regulatory enforcement by coastal states. Climate change will lead to more extreme weather events and polar ice melting will affect all waterborne sectors. This will require ships and offshore structures that are more robust, to operate in these more severe weather conditions.

THE NEW TECHNOLOGIES

The speed of innovation is increasing, particularly with the rise of new digital industrial technologies known as Industry 4.0, underpinned by transformational technologies of the Cyber Physical Systems (CPS). These systems are combinations of several major innovations in digital technology poised to transform industry. The technologies include cloud computing, the Internet of Things (IoT), Blockchain, sophisticated sensors, data capture and analytics, advanced robotics and artificial intelligence.

Industry 4.0 will be transformative for managing interconnected systems and will be a key element in both smart manufacturing and shipping and for improving competitiveness. However, predicting which of these technologies will transform maritime transport and blue growth opportunities remains a challenge for the future.
The European Commission has been actively promoting increased automation and better use of ICT.

The core vision is to enable seamless information exchange to streamline transport operations, increase safety, improve competitiveness and reduce the environmental impact.

The use of advanced information and communication technology (ICT) in the maritime transport sector is not a new concept. In the future connection between ships and ship and shore will be seamless.

Digitalisation and communication technologies will create new services to support shipping and logistic chains will become more integrated for all modes of transport . In the maritime transport sector, vast amounts of data that are available will support new opportunities to improve ship operation, safety, security, and logistics.

APPLICATION OF NEW TECHNOLOGIES

In the future more vessels will offer superior energy efficiency through technologies for improving propulsive efficiency, smart and lightweight materials, and advanced hybrid power generation systems, with energy storage to optimise performance . Transformative technologies will lead to advances in ship design, shipbuilding, propulsion and powering, and will undoubtedly improve commercial and operational performance of ship operation.

Digitalisation will spur automation, lead to the development of smart ships and positively impact safety and environmental performance. New cloud technologies will dramatically affect how vessels and their components are: designed, manufactured, and operated. The Internet of Things promises to be one of the most disruptive technological revolutions since the advent of the Internet.

The competitiveness of Europe's maritime industries, and their ability to meet environmental legislation, energy efficiency, safety, security, and human-factor challenges, will need research, development, and innovation efforts at a much more technological advanced level than in the past. This will include digitalisation and the new transformational technologies of Cyber Physical Systems.

The priorities for the EU's maritime transport policy until 2020, given in the Valletta Declaration of 2017, are Competitiveness, Decarbonisation, and Digitalisation to ensure global connectivity, and efficient internal market and an excellent maritime cluster

ECMAR'S VISION FOR THE FUTURE

ECMAR's vision for 2030 is for more energy efficient design and operation for shipping and maritime activities, utilising new technologies and green energy sources. The objective is to achieve a globally connected and competitive European Waterborne Sector, decarbonised and digitalised for a sustainable marine and maritime economy.

Digitalisation will spur automation and positively impact safety and environmental performance. New cloud technologies will dramatically affect the design, manufacture and operation of vessels and their components. The Internet of Things will help to deliver smart vessels with shore-based control. Cyber-security and Human Factors will become important issues with digitalisation and automation.

The next generation of connectivity between ship and shore will help shipowners reduce costs, avoid expensive repairs and improve operational efficiency. Automated processes and the introduction of "big data" in maritime operations will lead to advances in engine monitoring, remote maintenance, and real-time weather data and routing.

The seas and oceans are drivers for the European Blue Growth economy and have great potential for innovation and growth. Given the new challenges raised by the scarcity of resources, Blue Growth will be important for fulfilling the growing needs for food, energy, water, organic or mineral resources etc.

ECMAR'S TECHNOLOGY OUTLOOK FOR 2030

ECMAR's technology outlook for 2030 is for a more eco-friendly, smarter and a safer maritime industry. The priority research areas address societal, global, and industrial challenges to deliver a more eco-friendly, safer, and competitive maritime industry, for a sustainable future. Many of these areas will embrace the application of new disruptive technologies, alongside the more traditional areas of research, development, and innovation.

In the future, more vessels will offer superior energy efficiency with renewable energy sources to reduce fuel consumption, eliminate harmful emissions, and lower its impact on the environment. These improvements will be through measures such as improved hydrodynamic design, the use of lightweight materials, and advanced hybrid-power generation systems, with energy storage to optimise performance. Digitalisation will spur automation, which will lead to the development of smart ships, and positively impact safety and environmental performance.

Transformative technologies will lead to advances in ship design and operation, smart manufacturing, and blue growth. These technologies will undoubtedly improve competitiveness, safety, security and environmental protection for the maritime industry.

GREEN SHIPS AND SHIPPING

Zero-emission ships to eliminate harmful environmental impact.

Financial, regulatory, and societal pressures will continue to encourage shipping to lower its environmental impact and improve its safety record. In the future, more vessels will offer superior energy efficiency through measures such as improved hydrodynamics, use of lightweight materials, and advanced hybrid-power generation systems, with energy storage to optimise performance. Vessels will also have a reduced environmental impact due to the use of alternative fuels and renewable energy.

Shipping is the most energy efficient mode of transport, but there is room for significant improvement in energy efficiency and emissions. Despite recent progress in a number of energy efficiency related technologies, the full potential of the green technologies has not been realised.

There is still the need for a more comprehensive holistic energy saving approach, which would integrate all the advanced tools and concepts. For example, Big Data Analysis will lead to a better assessment and management of a vessel's energy consumption.

Renewable energy sources, associated with energy storage and distribution systems can help reduce noxious gas emissions by integrating them with the main power sources. Another special area of importance is the shift to alternative fuels, including electric and hybrid vehicles. Fuel cells are also a promising technology in the context of clean power sustainability.

SAFETY AND SECURITY

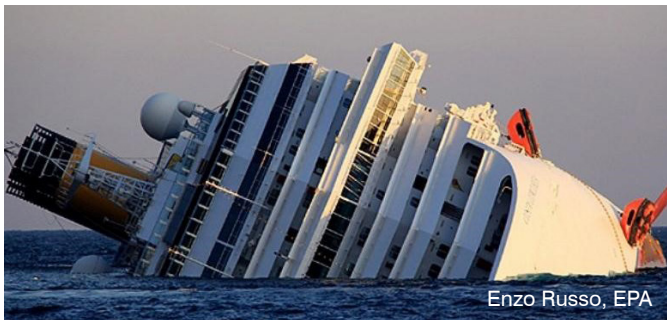
Zero-casualty shipping with improved incident prevention, and improved vessel security measures

Safety, security and pollution prevention are of the utmost importance for maritime transport. Serious incidents at sea show no sign of abating, despite significant investments and the application of new technologies.

The consequences of serious maritime incidents, leading to loss of life, environmental pollution and cargo loss, directly affect European society and the economy. Human factors and training are essential to reduce incidents at sea and to manage the applications of new technologies, particularly the interaction between man and machine.

IMO's extended Goal-based Standards (GBS) approach will include the Safety Level Approach (GBS-SLA) as the future means to improve maritime safety. However, it is widely acknowledged that the implementation of GBS-SLA will require the development of a procedure to determine future risk levels and a procedure to relate risk levels to particular ship functions.

Terrorist threats shows no signs of decreasing and both ships and ports will continue to face the threat of terrorist acts. Furthermore, very serious concerns about cyber-security, acts of piracy and armed robbery at sea persist. The EU Maritime Security Strategy (EUMSS) and Action Plan provides an overarching strategy against all challenges from the global maritime domain that may affect people, activities or infrastructures within the EU.


Enzo Russo, EPA

CONNECTED AND AUTOMATED MARITIME TRANSPORT

Autonomous ships, robots, shore-based control, and fully autonomous port operations

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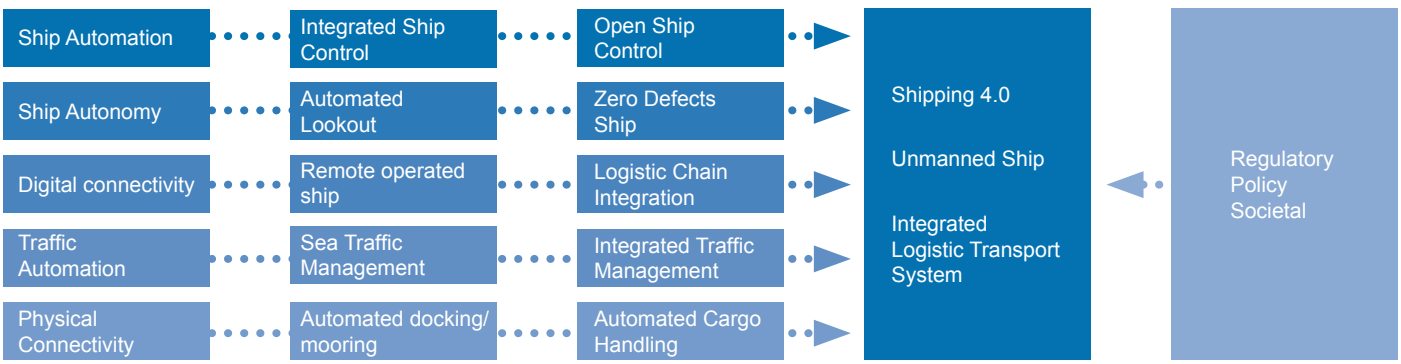
The next generation of connectivity between ship and shore will help shipowners to reduce costs, avoid expensive repairs and improve operational efficiency. Digitalisation, sensors and automated processes and the introduction of "big data" in maritime operations will lead to optimising energy use and fuel efficiency, vessel performance and condition monitoring, and real-time weather data and routing.

A higher degree of systems automation, the availability of smart sensors and global networks for data transfer between ship and shore will promote remote controlled, and semi or fully autonomous operation of assets, e.g. autonomous ships and smart ports. Interconnectivity between sea-based operations and shore-based operation centres will enable increasing support and control from the shore. This will require systems and operations to be secured against cyber-attacks.

Digitalisation has also enabled more far-reaching concepts, such as Big data, "Internet of Things", Blockchain, and cloud computing, which will provide the shipping industry with new ways to collect, process and exchange valuable data in real-time.



HUMAN FACTORS

Human factors, which contribute up to 80 percent to marine casualties and incidents, defined as acts or omissions, intentional or otherwise, adversely affect the proper functioning of a particular system, or the successful performance of a particular task.

The causes of human error in a ship's operation are numerous: fatigue, stress, poor qualifications, negligence, language, and cultural differences on board ships etc. Understanding human factors therefore requires a study and analysis of the equipment design, the interaction of the human operator with the equipment, and the procedures followed by crew and management.

The changes in human behaviour needed to interact with autonomous ships and the associated support systems will be significant. The maritime human-machine interface and the associated human factors will therefore be critical, particularly in high-risk and complicated operations.

As the risks associated with cybersecurity are likely to rise with the introduction of automation and autonomous ships, an international effort will be required to address this topic.

INTEGRATED TRANSPORT LOGISTICS

Secure and safe shipping, digitally connected and integrated into the global transport systems

An integrated logistics and transport system represents the final integration of the new and emerging waterborne transport system into the other transport systems and the supply and production chains. The focus in the context of waterborne transport is on physical and digital connectivity to the supply and production chains.

The main challenge that logistics service providers face is that transport and logistics services sectors are heterogeneous and fragmented. This currently limits the integration of services and the combination of resources, especially in "door to door" logistic chains. An integrated ICT infrastructure for transport and logistics will be imperative for all modes of transport.

In the maritime transport sector, vast amounts of data are available that could support new business opportunities to improve the logistics and ship operation. Value added services for better management of intermodal freight transport would improve safety, security, environmental performance and competitiveness.

There are numerous potential advantages in better exploiting available data and the use of information and communication technologies in transport and logistics, such as improved traffic management in ports and at sea, and reduced administrative cost of regulatory compliance.

Connection of maritime transport with other transport modes, including inland-waterway transport, will eventually be seamless. Smart vessels will communicate with smart ports to limit congestion, waiting time and thus costs. Smart vessels will then adapt their sailing speed to match harbour slots automatically.

MATERIALS AND PRODUCTION

More resilient ships and offshore structures, for more extreme weather conditions

Materials and structures as well as their production, assembly, outfitting, repair, retrofit and recycling processes have an important impact on life cycle cost, environmental impact, and the safety of modern ships.

Future ships will see an increasing combination of different materials in structural as well as outfitting applications. By using smart materials and design solutions, vessels will become more flexible and efficient. New materials for maritime application are highly promising for both weight reduction and environmental protection. This will offer significant efficiency gains, which will reduce hull resistance. The use of “big data” will also help to make maritime products more suitable for new and extreme operational conditions.

Production based on Cyber Physical Systems, such as digitalisation, augmented reality, simulation and optimisation, human-robot interaction, and IoT, have the potential to transform conventional shipyard processes, leading to significant changes for employees and manufacturing for shipyards of the future. These systems will enhance life-cycle management and proactive maintenance.

ACOUSTIC AND UNDERWATER NOISE

The consequences of noise and vibration emissions from the ships (propeller and cavitation noise etc.), include a disturbance for both passengers and harbour area residents, and possibly health issues for the crew. Prolonged exposure to high noise and vibration levels cause fatigue, reduces effectiveness in work, and can lead to hearing degradation.

The IMO Code on noise levels on board ships, adopted by resolution MSC.337 (91), recognised the need to establish mandatory noise level limits for machinery spaces, control rooms, workshops, accommodation and other spaces on board ships, and entered into force on 1 July 2014.

Work is now underway in recognition that international legislation is required for under water sound, as a pollution aspect. For example, ISO are developing international standards related to sound from ships and pile driving. However, further work is required, as the available experimental data on underwater noise and emission levels is still very limited.

ARCTIC OPPORTUNITIES

Safe and sustainable operations in Arctic regions, with zero environmental impact

Maritime transport in the Arctic has attracted widespread attention because of the region's growing strategic importance. Global warming and the resultant reduction in ice have made the Northern sea route more feasible. Technological development for enabling operations in hostile and remote environments has also offered the prospect of new transport routes in Arctic regions. There will also be new opportunities in economic sectors, such as in fisheries, oil and gas, transport, and tourism as tourist cruise vessels are likely to visit both Polar Regions more frequently.

These economic activities will require new developments in monitoring systems, emergency response systems, and search and rescue services in harsh waters.

Vessels and structures operating in extremely low temperatures and subjected to abnormal loads and forces will need appropriate design, construction, and equipment for operating in weather conditions that are frequently subjected to rapid changes, and address the human system interface challenge.

Extremely low temperatures are also a consideration for the materials, equipment, the environmental systems involved; it also affects ship operation, the crew, and the related human factors. The particular human-system interface challenges in Arctic regions will also need to be addressed.

Real-time ship monitoring and ice movement predictions in combination with Met-ocean data will provide reliable decision making for safe and efficient Arctic voyages and other activities.This integrated information will also help with oil spill incidents and search and rescue operations.

BLUE GROWTH

Sustainable Blue Economy to meet increasing demand for food and renewable energy

Given the new challenges raised by the scarcity of resources and land available, the oceans are the only way to fulfil humanity's growing needs for food, energy, water, organic or mineral resources, etc.

This promotes the need for significant industrial activities at sea and the provision of supporting services. Although current economic activities at sea relate mainly to maritime transport and oil and gas exploration, these are not part of the Blue Growth Economy.

Blue Growth activities are more diverse and include: renewable energies, aggregate mining, shallow and deep sea mining, offshore oil and gas, shipping, yachting and marinas, cruise tourism, coastal tourism, fisheries, maritime security, biotechnologies, desalination, aquaculture, fish farming, etc.

Smart and adaptive materials and structures are required to improve the vessel or offshore platforms ability to operate in ever-changing environments and conditions.

Many of these new economic activities are extremely risky and of marginal profitability at the outset. These risks can however be mitigated by combining various activities at a single site, while safeguarding safety and Shipping.

Blue Growth is the long-term strategy to support sustainable growth in the marine and maritime sectors as a whole. The seas and oceans are drivers for the European economy and have great potential for innovation and growth.

Blue Growth is the maritime contribution to achieving the goals of the Europe 2020 strategy for smart, sustainable and inclusive growth. It offers an essential contribution to tackling today's longer-term challenges, such as globalisation and competitiveness, global warming and climate change, increasing scarcity of natural resources, urbanisation and concentration in coastal regions, and demographic change.

ECMAR - The European Council for Maritime Applied R&D
Rue de la Loi 67, B-1000, Brussels, Belgium
www.ecmar.eu