Disruptive Technologies in the Marine Sector: 2023 and beyond

Contents:

Introduction

In a 2022 IMarEST survey, over 700 of our members identified technology as one of the main challenges faced by the marine sector over the coming decade and beyond.

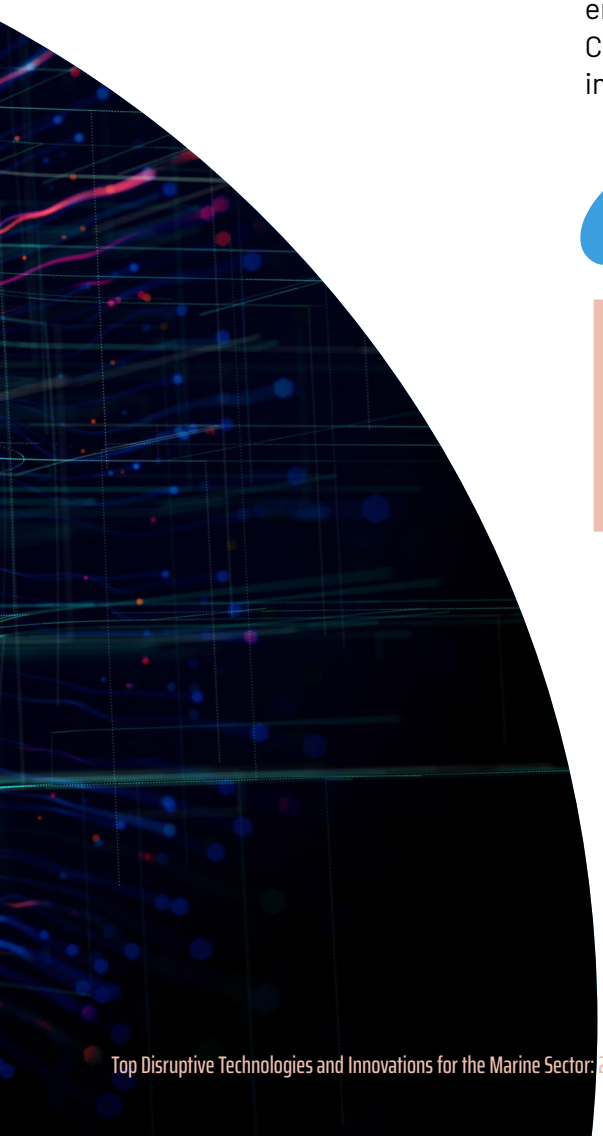
Technologies such as autonomous shipping, digitisation, artificial intelligence, big data, cloud computing, robotics, machine learning, and much more, will gather pace across every cross-section of the marine industry.

In this report, we take a closer look at the top three disruptive technologies. We examine the purpose of these technologies, industry's awareness of developments, the drivers for their introduction, the potential disruptive impacts, and the barriers to implementation.

The top disruptive technologies were identified through a short survey and consultation with the chairs of our Special Interest Groups (SIGs) and the co-chairs of our Technical Leadership Board (TLB). This report is based on their insight and that of their specialist group discussions and knowledge sharing as prominent members of the IMarEST.

This work forms part of our ongoing examination of the challenges the marine sector faces over the coming decade as identified by our members. These challenges include: people and skills, the environment, and technology. You can find out more in our report 'The Challenges in the Marine Industry: 2023 and beyond' which was issued in September 2022.

> ***There will be a need to retrain or replace staff much more frequently. There is a lot of pressure on how the skills are acquired, and maintained, as the pace of change relentlessly increases.***



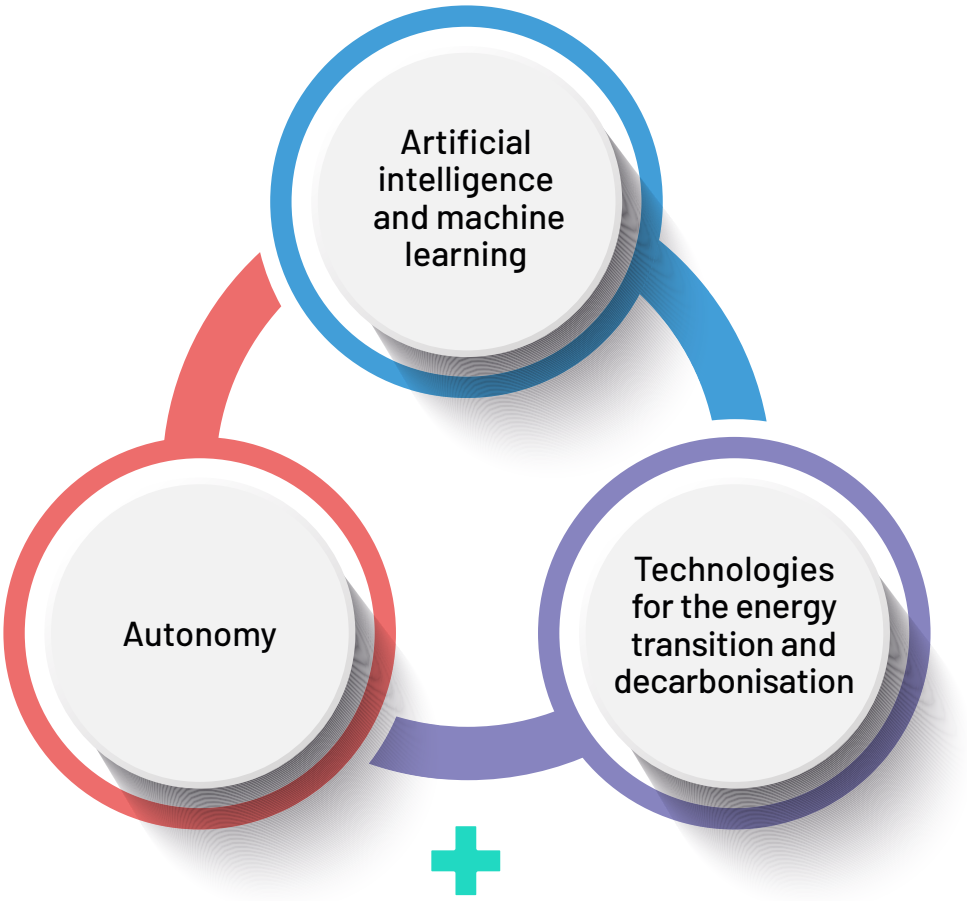
What is disruptive technology?

Whenever there is change, there is potential for disruption on many levels. Disruptive technologies can transform the way people and businesses operate as new innovations come online offering improved solutions to major challenges or, for example, providing opportunities for growth.

Technologies can also be disruptive when they challenge the way in which an existing marketplace works, creating competition, often from an early adopter, newcomer, or unexpected source.

Top disruptive technologies

Insight from the chairs of our SIGs and TLB provides us with an informed view of the top three innovations and technologies likely to disrupt and transform both the wider marine sector and some of the more specific specialist areas. They are:



At individual specialist levels

- **Electrical power and propulsion –** key disrupters for marine engineers specialising in technological advancements.
- **Hull "grooming" systems and performance monitoring –** the main disruptive technologies within biofouling management.

> *In theory these technologies / disruptions will allow the commercial shipping sector to reduce its environmental impact while still moving vast amounts of goods around the globe. However, shipping, consumerism and high commodity use is always going to negatively impact the environment, so its a case of damage limitation rather than damage elimination.*

What can we expect from AI and machine learning

The introduction of artificial intelligence (AI) in the marine sector is already relatively advanced and its adoption is rapidly increasing. In shipping, for example, AI has the potential to increase productivity, while disciplines that rely on large datasets, such as ocean science, will benefit from the opportunity to process and analyse big data sets to an extent that has not been seen before. Other key applications will also allow better prediction modelling and computational science in general.

Initial AI development was fuelled by a technological drive, however, AI is now being driven by commercial use as businesses seek to outperform current best practice strategies. One of the growth areas has been in consultancy around AI as companies race to implement digitisation into their business models to stay ahead of competitors and build a sustainable competitive advantage.

The increased use and implementation of AI systems is seen to most likely disrupt the role of professionals working in shipping; including the changing role of designers and engineers.

Both AI and autonomy are seen as supporting sustainability by improving efficiency, whether that's through consistency of operations, or the rapidity of measuring, controlling and reacting quicker than humans to issues and hazards, or the ability to prevent them. However, having a rapid, meaningful interpretation of inputs means that humans can work in smarter ways to mitigate issues in the first instance and solve problems more effectively and efficiently.

Observations from our SIG and TLB chairs suggest there is still a long way to go in terms of developing AI and the policies and regulations facilitating its propagation, as opposed to hindering it, and reducing/ managing its risks. This issue s is that the technology is developing at such a pace that regulators simply cannot stay ahead of it, or at times, keep up with it. In addition, some regulators appear to want AI (and autonomy) to be regulated within "human regulations", i.e., regulations based on pre-existing assumptions, history and norms. This might hinder the development of those technologies, notably into the commercial sector, or steer it into different directions and applications.

Regulations relating to big data are not set up to appropriately deal with the latest technologic developments and enable them to work to their full potential. However, despite being challenged by the depth and breadth of this technology, the regulators seem to have adapted and adopted big data in their own work and to better understand its potential.

> *Processing and making meaning out of big ocean data is a big problem in the ocean science community, largely because of the lack of ability to handle large datasets. These two approaches to data analysis will change the ability to interpret and act on ocean data collected continuously.*

What can we expect from autonomy

The main purpose of autonomy is seen to be the reduction of manning on board, thereby increasing efficiency, reducing risks and improving safety.

The take up of autonomy is not as advanced as AI, due in part to the fact that autonomous operations are mostly still at prototype and early demonstration stages, and there are only a limited number of standard commercial products and solutions available.

The main driver for adoption is the available emerging technology which, where implemented, is already proving disruptive in terms of value creation and usefulness. The commercial drive for greater adoption is expected to increase in the coming years as the technology becomes more widely used and industry awareness grows as to how autonomy can be introduced and retro fitted.

Opinions are divided when it comes to determining autonomy's future disruptive elements. Some see disruption arising from the progression towards a zero-engineering crew, while others stress that the disruption lies in the commercialisation of its various applications.

Autonomy shares many of the same the regulatory issues that impact the adoption of AI, much of it is due to the lack of knowledge around this new technology which is posing a great challenge to regulators across the globe. Autonomy is already being regulated by agencies such as the IMO and its Maritime Safety Committee (MSC). But despite having made good progress we are still years behind in adapting existing regulations to the state of the present technology, and potentially to its future evolution, which could in turn allow for the wider expansion and implementation of safe autonomy solutions.

The IMO's most recent MSC meeting (MSC 106) saw good progress made on the development of a goal-based instrument regulating the operation of maritime autonomous surface ships (MASS). The aim is to adopt a non-mandatory goal-based MASS Code to take effect in 2025, which will then form the basis for a mandatory goal-based MASS Code, expected to enter into force on 1 January 2028.

> ***Autonomy is heavily regulated, more so than automation. The IMO and "net zero" are driving both fuel choice and routing / loading. Technology (the art of the possible) remains ahead of the "art of the acceptable". Commercial drive is there, but not a prime force for autonomy, as the ROI is still a balance.***

What can we expect from the technologies for the energy transition and decarbonisation?

Like many other sectors, the marine sector is looking to reduce its impact on the environment by moving towards sustainable energy, decarbonisation and alternative fuels. To date this has been largely being driven by:

- regulations, such as emission control or biosecurity regulations, which, in turn, are driven by societal imperatives
- commercial factors to identify the most cost-efficient fuels and associated systems.

Disruptive technologies around sustainable energy and decarbonisation are among the most advanced in terms of industry awareness as they are already in use within the a range of industries, facilitated by knowledge sharing and industry collaboration. However, the innovations in these domains remain relatively foreign to the marine sector thus far.

The main challenges for regulators, designers, and engineers will be to move alternative fuels and decarbonisation into the marine industry safely and with the necessary new equipment and processes. These changes also need to receive the necessary approvals which may cause additional disruption. Similarly, sustainable energy will first need to be deemed economically and technically viable in order to be considered for wider use and to drive a true transition.

Sustainable energy is seen both as challenging for and being challenged by regulators. One of the big challenges is innovation in this field, while existing regulations allow for it, they slow the pace of innovation brought to the market. Although these innovations are listed in award criteria for bids and consenting applications, meaning they are accommodated within the industry already, regulators are being challenged by the pace of change required to meet net zero, equally, the depth of work to fully comply with these approaches seems to be underestimated by some stakeholders.

> ***Sustainability is at the heart of the energy transition. The challenges across all marine industry is for technology to be durable in their operating conditions and recyclable, as well as able to be produced at scale and at reasonable cost. Safety and the human element are large parts of this too, and this is where some of the AI innovation is coming in.***

The majority of current regulation applies to the maritime sector rather than the wider marine sector. Recent regulations include the following from the IMO:

The amendments to MARPOL Annex VI are in force from 1 November 2022. The requirements for EEXI and CII certification come into effect on 1 January 2023. This means that the first annual reporting will be completed in 2023, with initial ratings given in 2024.

The measures are part of IMO's commitment under its 2018 Initial Strategy on Reduction of GHG Emissions from Ships to reduce carbon intensity from all ships by 40% by 2030 compared to 2008.

IMO's Marine Environment Protection Committee (MEPC) is to review the effectiveness of the implementation of the CII and EEXI requirements by 1 January 2026 at the latest and develop and adopt further amendments as required.

IMO held the Second IMO Symposium on low- and zero-carbon fuels for shipping: "Ensuring a just and inclusive transition towards low-carbon shipping" on 21 October 2022 to look at the challenges and opportunities that renewable fuel production represents in the context of shipping decarbonization, particularly for developing countries, SIDS and LDCs, while also assessing what other elements could constitute a just and equitable transition.

The next stage for IMO's GHG Strategy:

Member States are working on the revision of the Initial Strategy. The Revised Strategy is set to be adopted in mid-2023 at the Marine Environment Protection Committee (MEPC 80) session in July 2023.

View the IMO's roadmap to addressing climate change

How disruptive technologies challenge themes such as sustainability and the human element

The IMarEST's Special Interest Groups and Technical Leadership Board went on to highlight that artificial intelligence, autonomy and the energy transition are interconnected and have the potential to challenge themes such as sustainability and the human element.

Both AI and autonomy are seen as supporting sustainability by improving efficiency, whether that's through consistency of operations, or the rapidity of measuring, controlling and reacting quicker than humans to issues and hazards. However, having a rapid, meaningful interpretation means that humans can work quicker to mitigate issues in the first instance.

> ***These technologies need to be globally saleable in terms of supply, support and regulation in order to be effective in the global shipping sector.***

Autonomy is also seen as having the potential to benefit sustainability for example by reducing stress and fatigue in those working in the sector. However, conversely, it is also seen as potentially adding to workloads, particularly in remote operations.

Sustainability is at the heart of the energy transition. The role that the human element plays in the energy transition was mentioned by our SIG and TLB chairs in different ways. On the one hand, diverse human thinking is needed for successful innovation, on the other hand, it was mentioned in relation to human safety in the energy transition, which is where AI comes in. Sustainability in the sense of decarbonisation and the energy transition was linked multiple times to AI and automation. The new technologies of AI and automation are perceived as facilitators in the drive towards an energy transition.

Project management's role in implementing disruptive technology

There were a variety of opinions on the challenges that project managers will need to be aware of when overseeing the implementation of AI and autonomy. These included the need to focus on change management and being aware of the possible societal frictions these technologies might create, the importance of adaptive scheduling and methodologies given the pace of change and innovations within this field, and finally being aware of regulations and the challenges posed in meeting them.

For management of projects related to sustainable energy, our SIG and TLB chairs identified a willingness and readiness to adapt to deal with unforeseen setbacks which can arise at any time. The challenge of regulators and regulations was also raised, along with the issue of keeping up with the pace of change.

> ***Pushback to cultural change will be the main obstacle so change management and the identification of the sources of friction within the organisation will be critical.***

> ***If the project is long (eg HS2, Thameslink) technology will change during the course of the project. This makes it very difficult to plan, and manage. Adaptive scheduling, methodologies, etc likely to be important.***

Disruptive technologies and skills

The skills needed to innovate, create, adopt, and implement disruptive technologies include both specialist and transferable skills. Employers need to consider the skills they need not only in the present, but also in the medium and long term.

Artificial intelligence (AI)

- AI
- Data analysis
- Business modelling
- IT skills
- Interdisciplinary knowledge

Autonomy

- Systems engineering
- Functional safety
- Software development
- AI
- Human Factors
- Communications
- Cyber-security

Artificial intelligence (AI) and Autonomy

- A breadth of vision
- Willingness to change
- Enthusiasm for innovation

Sustainable energy and decarbonisation

- Multi-disciplinary and strategic thinking
- Hazardous process and safety training
- Design and integration in a systems context

Project lifecycle of skills

Whether we consider AI, autonomy, or sustainable energy, all skills need to be reflected through all life cycles across designers, constructors and operators, and in each case, they need to be focused on the immediate task in hand, with an informed awareness of what has gone on before and what will come after in the asset lifecycle.

AI AND AUTONOMY

Awareness training

Willingness to teach and learn new methods and new thinking

A range of technical skills

Adjust training content focus to avoiding failures.

Improve digital diagnostic skills.

Focus on business modelling.

Awareness of reuse and recycling options.

ENERGY TRANSITION

Leadership

Strategic thinking

Commercial awareness

Technical skills

Process safety knowledge

Project management

Negotiation

Technical and nontechnical communication

Planning

Reporting

Auditing

Conclusions

> ***In electric power and propulsion the basic know-how has been around for 40 years. Batteries technologies are now available as retrofit options.***

The marine sector is at the start of a journey of embracing the next generation of disruptive technologies. As a result, the sector looks set to benefit from increased efficiency, improved safety, greater interconnectivity, and being better able to meet the environmental goals our biosphere needs, including the regulations to achieve net zero carbon.

However, there are challenges to overcome, including the need for regulations to keep pace with technological development and encourage innovation. Regulations are there to keep us safe, to protect the environment, they must support, rather than hinder, ongoing innovations and iterations of technological solutions. The marine sector and its regulators are not alone in this challenge. There are opportunities to learn from other sectors, such as the airline industry which successfully regulated fly-by-wire technologies, and the car industry which is currently working its way through regulations relating to driverless and fully autonomous cars and trucks.

Another essential element in embracing disruptive technologies is the impact on people. Highly skilled employees are at the heart of marine businesses. As employers, and we need to ensure that our employees are part of the technological transformation process. We need to consider how best to recruit, retrain and retain employees to ensure we have the expert and talented workforce to take us into the future.

Two important aspects of this are ensuring we foster an inclusive workplace that welcomes everyone and supports their development. Greater diversity and inclusion equals greater innovation and employee satisfaction, thus reducing staff turnover and the loss of expertise. Secondly, we need to ensure we provide opportunities for those whose roles may be impacted by these disruptive technologies so they can continue to flourish within our businesses and our businesses to not lose their specialist knowledge and skills.

> ***Hydrogen is a sustainable clean commodity which, once made economically and technically viable, transform our energy and transport system.***

Leaders must understand disruptive technologies and what they mean for our businesses, our sector, our marketplace and our customers. Understanding helps us to identify their impact, spot new opportunities, prepare for challenges, recruit and upskill employees with the skills our businesses need now and in the future, create new products and services to meet our customers' demands, meet regulatory requirements, and ultimately, understand how best to embrace the transformation they offer.

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