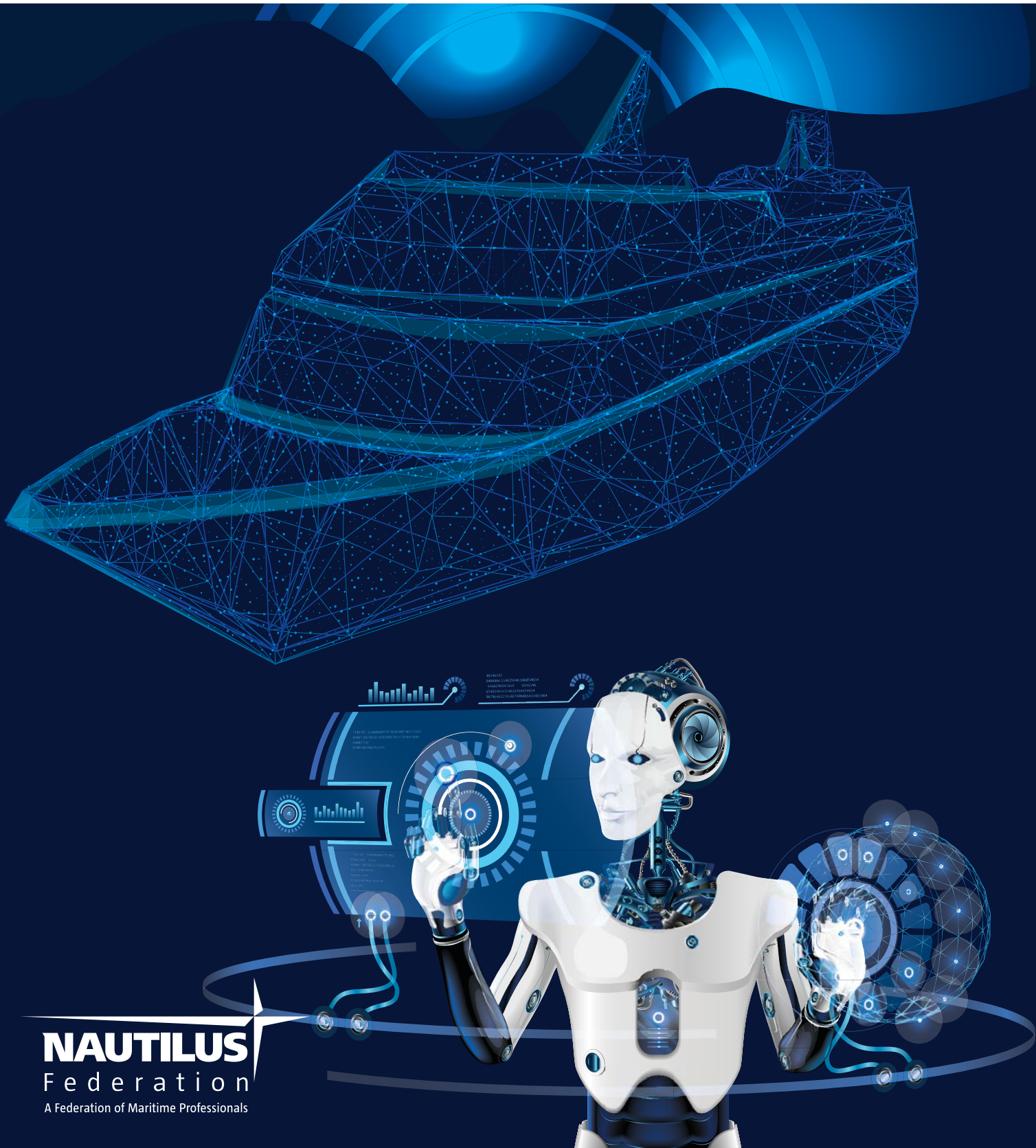


Future proofed?

What maritime professionals think about autonomous shipping



NAUTILUS
Federation
A Federation of Maritime Professionals

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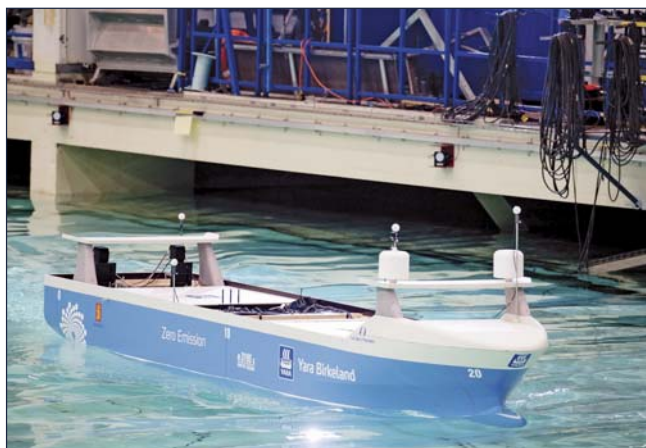
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Welcome

2018 is set to be the year in which the world will witness the entry into service of the world's first crewless merchant ship – the Norwegian vessel Yara Birkeland, which will be deployed on a 37-mile route in southern Norway and will transition to fully autonomous operation over a two-year transition period.



Test model of the Norwegian vessel Yara Birkeland, which is expected to be the first crewless merchant ship

If the plans prove successful, this ship could mark a major step forward for the commercial interests that are seeking to push the concept of remote-controlled vessels into operational reality.

With a host of other projects testing and trialling various forms of autonomous vessels, and with the International Maritime Organisation now embarked on an ambitious project to assess the legal and regulatory framework governing their operation, it's high time for the industry and regulators to listen to those charged with the day-to-day operation of shipping.

This Nautilus Federation report has been produced to ensure that their voice is heard.

The report draws from the views and experiences of almost 1,000 maritime professionals from many major shipping nations around the world and it is my hope that it will contribute to a debate that will keep the vital 'human factor' to the forefront.

Properly introduced, automation and digital technologies could transform shipping in a positive way – eliminating some dirty and dangerous tasks, cutting paperwork and bureaucracy, and generating significant productivity gains. Managed poorly,



however, it could undermine safety and erode the essential base of maritime skills, knowledge and expertise.

I hope the findings from this survey will help to shape a future in which new technologies are used not simply as a crude substitute for seafarers, but as a tool to improve the safety and efficiency of the shipping industry and the working lives of all within it.

Handwritten signature of Mark Dickinson.

Mark Dickinson
Director
Nautilus Federation

Introduction

Survey participants came from the UK, the Netherlands, the United States, Australia, New Zealand, Norway, Singapore, Denmark and Sweden.

30 survey questions sought to address the critical issues around the introduction of autonomous vessels to the sector

Smart ships, drone vessels, autonomous ships – whatever you call them, there is barely a day that passes without a reference to the relentless rise of the ‘robo-vessel’.

Some major maritime nations and many significant technology equipment manufacturers are investing huge amounts of time, energy and money into researching and developing products and systems to enable the deployment of autonomous or remote-controlled vessels – with their predictions that the first fully autonomous ship could be in service by 2020.

Shipping, of course, is not unique in facing these transformational changes. As technology develops at a rapid rate, robots, artificial intelligence and autonomous technology are being applied in many industries and workplaces, in what is being called the fourth industrial revolution. Global sales of industrial robots increased by nearly 20% to \$13.1bn in 2016, according to research by the International Federation of Robotics, while research by management consultants McKinsey found that about 30% of tasks in 60% of occupations could be automated.

The Nautilus Federation – which is composed of 21 unions in 16 countries, together representing more than 90,000 maritime professionals – has been observing these developments with interest, and with some concern. At the start of 2017, the Federation members agreed a policy statement (see Appendix on pages 16-17) setting out its position – and noting in particular that ‘the debate on autonomous ships has so far concentrated on the technological and the economic issues, and needs to shift to social and human factors’.

This report represents the Federation’s attempt to make that much-needed shift in the dialogue. It gathers the views of almost 1,000 maritime professionals in a dozen countries and provides a vital human perspective on the important issues that deserve serious consideration by the authorities as radical changes to the operation of ships are assessed.

People are – and will continue to be – critical to the safe and efficient operation of the shipping industry. Maritime skills and experience should remain an essential component of the way in which shipping works, regardless of the scale of technological change.

However, the Nautilus Federation believes that while such technological change may be inevitable, the industry cannot afford to neglect the human element. Recent accidents involving the inappropriate use of electronic chart display and information systems (ECDIS) have illustrated the potential pitfalls of poorly introduced technology. The aviation industry also offers useful insights into the many issues surrounding the interaction between humans and automated systems.

The history of shipping has been marked by constant change and innovation. Sail to steam, wooden hulls to iron and steel, Morse Code to GMDSS. Throughout the centuries, seafarers have adopted and adapted new working practices in response. So it is vital that they have a say in the way that new technology is introduced, how they are trained and supported through the transition period, and how the benefits gained from automation are fairly shared. The debate starts here.



The survey

This Nautilus Federation report is based on a survey completed by almost 900 maritime professionals from more than 12 different countries. The questionnaire was developed as part of an initiative to gather the views of seafarers and other shipping industry staff on the issues surrounding autonomous technology and its potential effect on the maritime sector, and to give a voice to the maritime professionals who will be affected by the move towards 'smart ships'.

The survey covers a wide and representative sample of maritime professionals, with a significant proportion of highly experienced personnel providing their input. The roles most represented within the survey are captains/ masters (accounting for 254 of the survey responses) and chief engineers (153). However, there was a remarkable variety of positions included within the survey – ranging from deckhands and bosuns, to cadets and cook, marine pilots, superintendents and even a company vice-president.

The majority of the survey participants are employed in the main shipping industry sectors of offshore, deepsea, ferries, containerships and cruiseships. But there were also significant numbers serving on tankers, superyachts, heavylift ships, tugs and windfarm support vessels, resulting a broad and balanced view of opinions from throughout the industry.

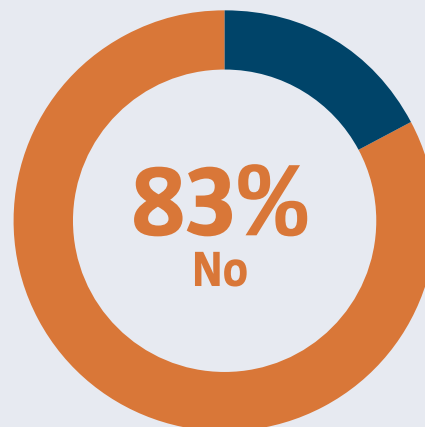
Survey participants came from more than a dozen countries, including the UK, the Netherlands, the United States, Australia, New Zealand, Norway, Singapore, Denmark and Sweden.

The 30 survey questions sought to address the critical issues around the introduction of autonomous vessels to the sector and many respondents took the opportunity to go into more depth about their opinions on the issues, offering frank views and observations based on their professional experience and knowledge.

Key findings

Reaction to the idea of autonomous technology within the sector was generally cautious and largely sceptical, with respondents not sharing the rosy visions of manufacturers for the future. Concerns around job security and safety dominated much of the feedback, with nearly 84% of respondents saying they see automation as a threat to their jobs. However, members were not wholly hostile to the concepts and the underpinning systems – many of them noting the potential to use technology in a way that could improve seafarers' lives by reducing or even eliminating a lot of routine tasks, and to make maritime jobs safer, more skilled and more satisfying.

**Will commercially viable
unmanned/remotely controlled
ships be in service by 2020?**



The survey results demonstrate that seafarers' opposition to autonomous shipping is by no means kneejerk: whilst more than 60% of respondents said seafarer unions should resist automation, many signalled a desire to engage constructively and described the way in which new technology could be harnessed in a positive way. One second mate commented:

'Automation is the future, you can't stop the future. Try to be a part of that future. Current jobs will be lost but new ones will emerge, focus on that. Don't linger in the past, adapt and be part of this new development.'

The **roles** most represented in the survey are **masters and captains** – accounting for more than 254 of the survey responses

Research by management consultants McKinsey found that about **30%** of tasks in **60%** of occupations could be automated

97% of maritime professionals believe the first autonomous ships will be introduced within the next 10 years

However, more than two-thirds of the respondents said they believe that new technologies which replace seafarers are not beneficial to shipping and many expressed a range of concerns about safety at sea arising from automated operations – summed up in one respondent’s comment:

‘Considering the skill required in the offshore field, I fail to see how a fully remote-controlled ship will deal with daily equipment failures.’

Cost is also a recurring theme throughout the survey responses, with many seafarers believing shipowners are driven by a desire to make savings when deciding on the benefits of autonomous vessels and their adoption. Almost 90% said they believed shipowners would only adopt autonomous shipping if it was cheaper than running with crews onboard.

Many participants pointed to the way in which some technology equipment manufacturers are taking the lead in introducing new technologies and the consequent pressure being exerted on the industry to embrace these systems. One respondent pointed out:

‘This appears to be a case of the tail wagging the dog, rather than a pressing desire by shipping for autonomous vessels.’

One officer summed it up thus:

‘Many shipowners don’t want to pay for anything! Minimum safe manning is seen as maximum safe manning. If there were no laws on safety equipment, such as lifeboats and fire-fighting equipment, many owners would not invest in them. You can’t load any cargo in a lifeboat.’

Inevitable autonomy?

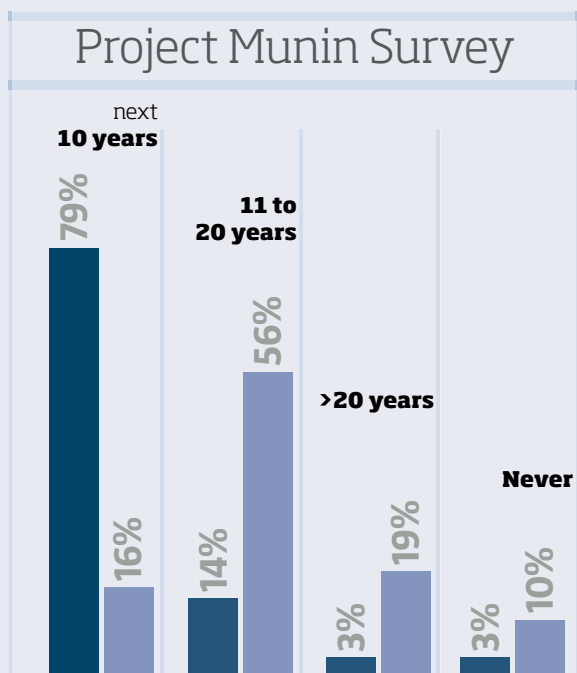
A survey conducted as part of the EU-funded Project Munin – Maritime Unmanned Navigation through Intelligence in Networks – showed that an overwhelming 97% of maritime professionals believe the first autonomous ships will be introduced within the next 10 years and 79% consider that autonomous ships will be commonly deployed in merchant shipping within the next 11 to 20 years.

In contrast, the Nautilus Federation survey showed that seafarers are much more cautious about the timescale within which autonomous vessels will be adopted by the industry. The results revealed that more than 80% of maritime professionals believe autonomous or remotely controlled ships will not be in service by 2020 and fewer than 40% of serving seafarers consider that commercially viable unmanned ships will be in widespread service within the next 20 years.

A significant number of respondents suggested that problematic issues such as legal and regulatory hurdles, equipment and system reliability, security, and cost factors will lead to the very slow introduction of autonomous ships – perhaps not until the middle of this century, if at all.

However, thoughts about the pace at which autonomous vessels will come into service varied dramatically between different sectors. Almost three-quarters of respondents considered that – if inevitable – autonomous shipping operations are most likely to take place on deepsea services, barely 20% considered this to be the case for coastal waters and inland waterways, and less than 7% believed autonomous operations are inevitable within ports and pilotage areas.

Results revealed that more than **80%** of maritime professionals believe autonomous or remotely controlled ships will not be in service by 2020



First autonomous ship expected

Autonomous ships commonly deployed in merchant shipping

The survey showed that maritime professionals have a clear perception of the key factors that are driving the development of autonomous shipping, with lower costs ranked as the most important, followed by operational efficiencies, improved safety and shortages of competent crew. Many said the pressure to adopt new technologies is being increased by equipment manufacturers.

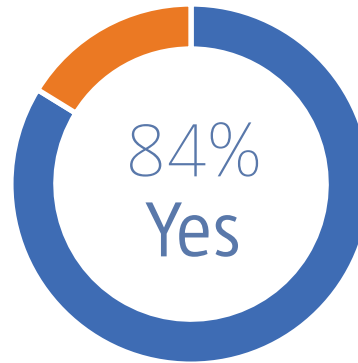
‘These companies are only interested in creating a market for their products and services, and cloaking this in the guise of safety,’ one shipmaster wrote.

Almost 90% of participants said they believed that autonomous or remotely-controlled ships would only be used by owners if they proved cheaper than running with crews. Many respondents questioned the economic viability of autonomous ships, pointing out the crew costs have been driven down by the increased use of low-cost labour supplying countries and through long-term reductions in crewing levels.

However, costs were not regarded as a primary hurdle. Asked **what the biggest obstacles to the adoption of autonomous ships are**, respondents ranked them as follows (on a weighted average in a **scale of 1 to 10**):

	scale 1-10
1 CYBER-SECURITY	8.16
2 Reliability of communications and the data exchange link	7.96
3 Legal and liability issues	7.81
4 Quality of software	7.62
5 Risk assessment and public acceptance	7.5
6 Opposition from seafarers and their unions	7.43
7 Regulatory issues	7.09
8 Technical feasibility	6.52
9 Training and reskilling	5.77
10 Economic feasibility	5.65

Do you consider automation to be a threat to seafaring jobs?



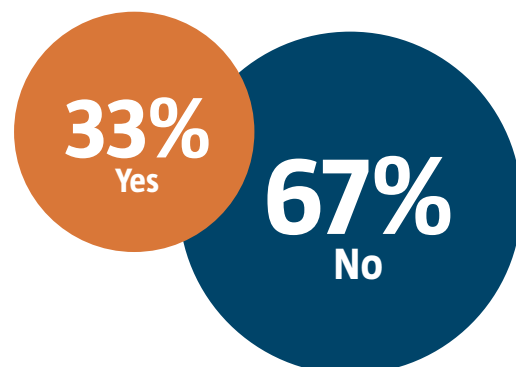
59% said they believed such ships would be a threat anywhere at sea

A threat to jobs?

Unsurprisingly, our survey found the majority of seafarers (84%) consider automation a threat to seafaring jobs. Unmanned, remotely-controlled ships were perceived as the biggest threat to employment.

Conversely, more than 83% said that technology has the potential to improve the quality of work at sea – notably, if used to reduce such perennial problems as fatigue, excessive paperwork, and boredom. Some respondents suggested that technology could, for instance, be used to better monitor hull stresses in real time or that drones could be used for ballast tank surveys to reduce the inherent risks of working in enclosed spaces. Others said that technology could be used to enhance watchkeeping and lookout capabilities, giving a much greater insight into other vessel traffic, sea conditions, and potential dangers.

Are new technologies that replace seafarers beneficial to shipping?



A threat to safety?

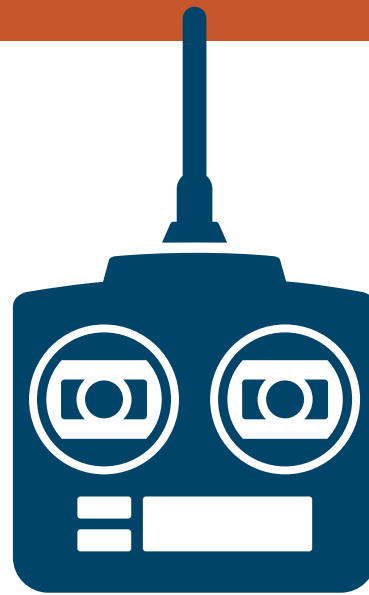
Just over 85% of those taking part in the survey said they considered unmanned, remotely-controlled vessels to be a threat to safety at sea. Barely 18% said they regarded increased automation and the removal of seafarers from ships as a positive development for maritime safety.

Asked where they believed remotely-controlled ships would cause the greatest threat to safety, 19% opted for offshore services, 12% for international waters, 38% for coastal waters, and 39% for harbours and pilotage areas. However, the majority (59%) said they believed such ships would be a threat anywhere at sea.

Respondents highlighted such safety risks as:

- 1 routine and corrective **maintenance** challenges
- 2 **equipment** and **system** failures
- 3 redundancy and reliability of **shipboard equipment**
- 4 **software** bugs
- 5 **IT** and **communication** problems
- 6 **sensor** failures due to heat and vibration
- 7 **piracy** and cyber attacks
- 8 cargo **security**
- 9 unpredictable **sea conditions**
- 10 on-the-spot **decision-making** in dynamic environments
- 11 the relationship between autonomous ships and conventional vessels during the **transitional period**

There was a strong recurring theme in the feedback about the unpredictable and complex chains of failure which can occur onboard ships, and how simple failures such as leaking pipes or pumps can rapidly escalate into major incidents. Many respondents stressed the poor quality of equipment and components on their vessels, and the way in which this requires high levels of supervision and intervention.

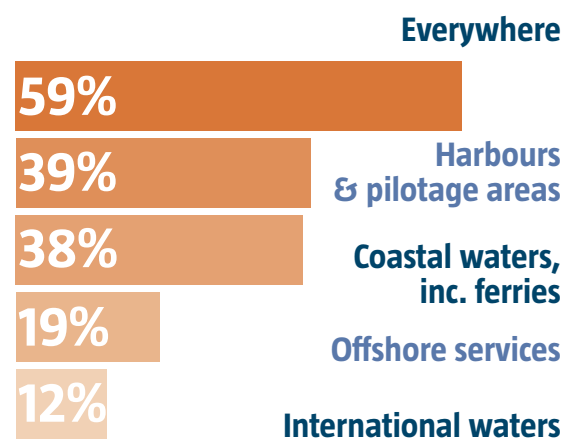


Do you consider **unmanned remotely controlled ships** to be a threat to safety at sea?

85%
Yes

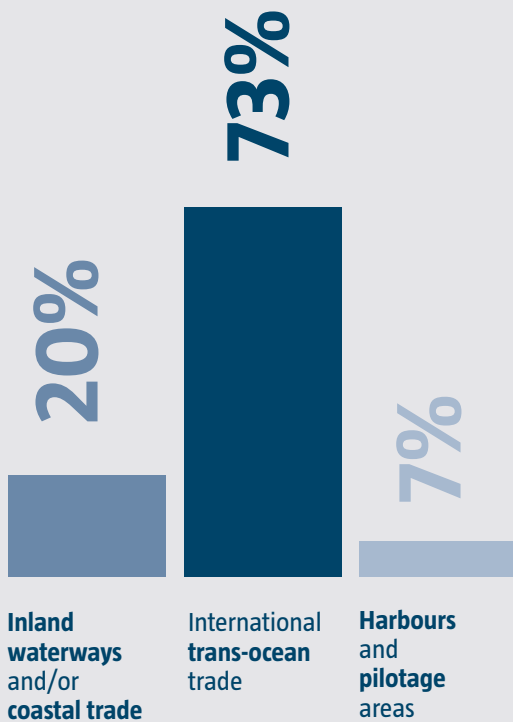
15%
No

If yes, where do you consider unmanned remotely controlled ships to be the greatest threat to safety a sea?



The majority of the survey participants are employed in the main shipping sectors of offshore, deepsea, ferries, containerships and cruiseships

If automation is inevitable, where is it most likely to happen?



Others noted the way in which low-quality fuels can aggravate fuel supply problems, questioning how problems such as blocked strainers could be handled on automated vessels.

One respondent asked:

'How will automation repair a broken fuel line at sea? How about when a fuel pump seal fails and begins to spread fuel across the engine room? Failures happen on almost every leg of a given voyage. We need mariners on board to prevent catastrophic circumstances from occurring.'

A second officer commented:

'Airplanes still have pilots on-board and they get maintained every day. Ships often go two weeks or more between ports, who is going to do the maintenance? My first voyage was in 1976, I've never been on any vessel that has ever gone more than a couple of days without something breaking down that would have disabled the ship within a few days.'

Others questioned how autonomous vessels would operate safely alongside the very varied types of maritime traffic, often in busy and congested waterways, or in reduced visibility and at night:

'Avoiding collisions with small vessels that do not show on radar will, especially in bad weather conditions, always be difficult for computers and remote operators to do safely.'

Concerns were also raised about the dangers posed by semi-submerged objects, and survey participants also questioned how autonomous ships would comply with SOLAS and COLREG requirements – especially in terms of search and rescue responsibilities, the requirement to keep a lookout, the definition of safe manning, and the requirement to prevent pollution after an incident. A number of respondents questioned whether the IMO would be able to overhaul the existing regulatory regime within the next decade.

Fewer than **40%** of serving seafarers consider that commercially viable unmanned ships will be in widespread service within the next 20 years

79% consider that autonomous ships will be commonly deployed in merchant shipping within the next 11 to 20 years

One respondent noted the way in which autonomous shipping has been presented as being safer on the grounds that around 80% of accidents at sea involve 'human factors'. This is a specious argument, he suggested, as human factors are highly complex and often involve elements such as ergonomics and the interaction between people and machines. Another pointed out:

'What this fails to take into account is the number of potential accidents that are prevented by human intervention – and there may be new types of accident that may occur as the nature of the job changes from being practical and hands-on into more of the role of an observer or monitor.'

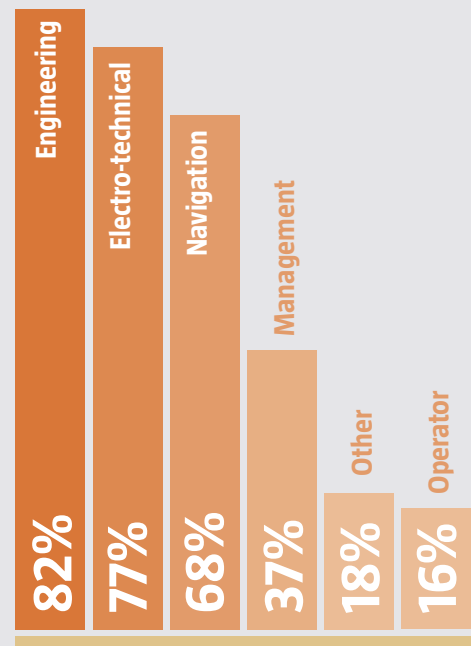
There were suggestions that the shipping industry should pay more attention to the aviation sector to examine the lessons it could provide on the introduction of automated systems – and in particular to examine such factors as the 'startle effect', 'automation bias', 'automation complacency', alert fatigue and information underload, which are all associated with human-system interaction. Some survey participants also questioned how fundamental seafaring and shiphandling skills could be developed and maintained when ships are highly automated or remotely controlled.

Making life better?

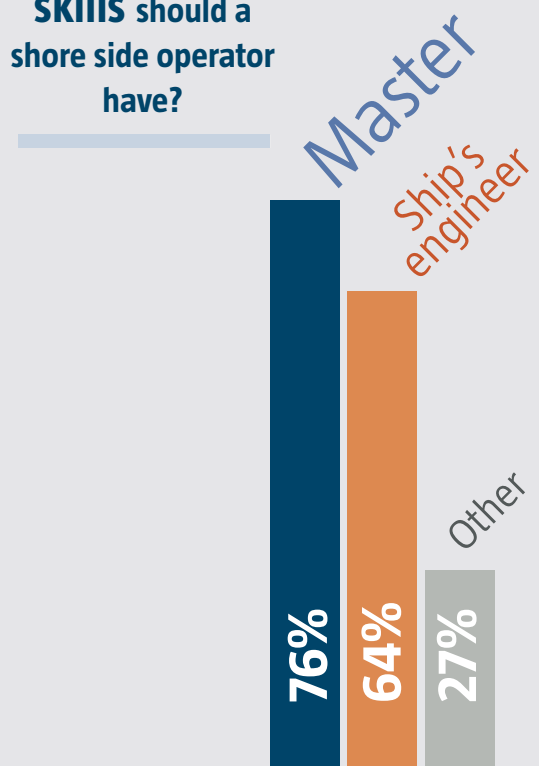
Whilst two-thirds of respondents believe that new technologies that replace seafarers would not be beneficial to shipping, more than 60% consider that technology could be used to improve safety and that automation offers the potential to deliver improved operational performance. In particular, participants suggested the use of new equipment and systems to reduce workloads, ease administrative burdens, eliminate dirty and dangerous work in enclosed spaces, and assist with predictive and preventive maintenance. As one officer noted:

'If higher automation releases ships' staff to monitor more effectively what is happening aboard their vessels, that has to be an advantage since crews on many types of ship are overworked and tired, making poor decisions and accidents more likely.'

With high levels of automation and minimum crew e.g. AL3, AL4, what essential skills are still required to be onboard?



What maritime skills should a shore side operator have?



2/3 of respondents believe that new technologies that replace seafarers would not be beneficial to shipping

40% of serving seafarers consider that commercially viable unmanned ships will be in widespread service within the next 20 years

What level of autonomy provides the optimum level of safety for future ships?

Select from the following autonomy levels (AL) currently recognised by Lloyd's Register

2%

AL 6 Fully autonomous totally unsupervised and decisions made by the system

3%

AL 5 Fully autonomous, rarely supervised and decisions made by system

23%

AL 4 Human in the loop – operator/supervisory onboard ship or based ashore

44%

AL 3 'Active' human in the loop onboard ship

17%

AL 2 On and off ship decision support

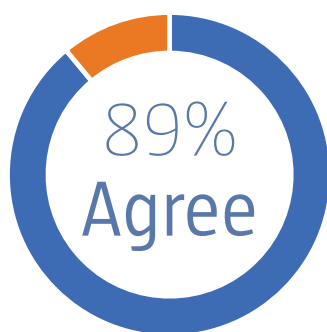
29%

AL 1 On-ship decision support

16%

AL 0 Manual – no autonomous function

Shipowners will only adopt autonomous / unmanned / remotely controlled shipping if it is cheaper than using seafarers?



Just over 80% of respondents said the best way of achieving such benefits would be through the careful introduction of 'smart' systems alongside 'manned' operations. These points were underlined when members set out their views on seven different levels of autonomy for unmanned, remotely operated, remotely monitored and unmanned systems – as defined by Lloyd's Register.

The majority (44%) favoured AL 3 – an 'active' human onboard the ship supervising autonomous decision-making. A significant minority (23%) supported a slightly higher level of autonomy (AL 4) which retains a human over-ride capability but reduces the amount of active human oversight on autonomous decisions. However, very few respondents wanted to see any more autonomy than this, with fully autonomous systems making their own decisions receiving support from only 6% (a combined figure across the two highest levels of autonomy).

Furthermore, large minorities did support lower levels of autonomy – with two levels based around autonomous systems simply offering suggestions to a human decision-maker gaining support from 29% and 17% respectively.

However, only 16% of respondents wanted to see a future with no autonomous support whatsoever. This suggests seafarers remain very open to a more hybrid approach, in which autonomous systems work in a supporting capacity alongside trained seafarers who remain in control.

80% of those surveyed said radical changes in training and certification are required

Is an increased level of automation and the removal of seafarers a positive factor for improved safety?



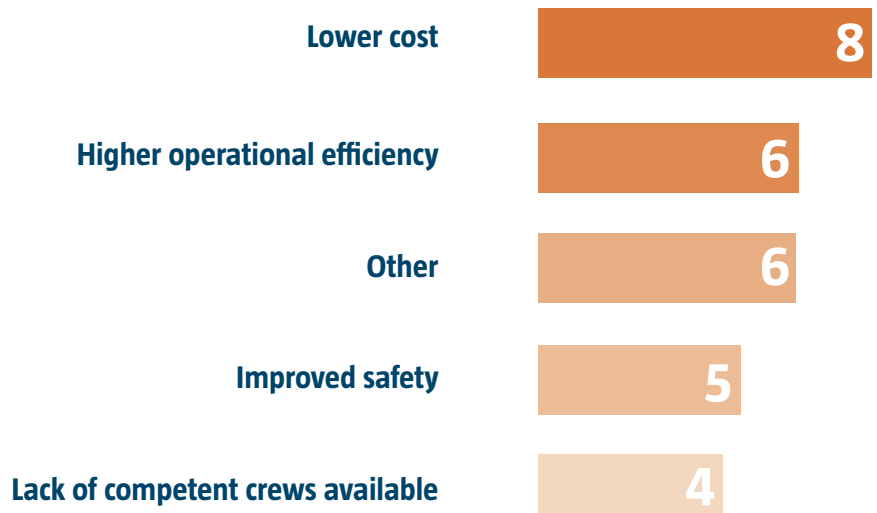
Training for the future?

Maritime professionals taking part in this survey demonstrated a strong desire for improved training to ensure that they are able to take full advantage of the benefits that new technology could bring. Survey participants identified the skills they perceive as the most important in the context of increased automation: engineering and electro-technical – with many respondents stressing the need for in-depth knowledge of electronics and IT systems, together with a requirement for extremely high standards of maintenance if automated systems are to operate safely, reliably and efficiently.

The development of shore-based fleet operations centres attracted a very mixed response from survey participants, with a narrow majority seeing them as a negative factor. Many members called for the IMO to urgently develop training and operating standards for personnel working in such centres, and there was a clear preference for such staff to be highly experienced and qualified seafarers.

On a scale of 1-10 (1=lowest, 10=highest)

How would you rank the most important factors driving increased automation?



A way forward?

The survey clearly showed that maritime professionals regard the drive towards autonomous ships as a negative factor for safety. However, it also demonstrated that many consider there are areas of automation which have the potential to make the industry safer.

A lot of respondents emphasised the need for adequate training to ensure that they are well equipped to work with automated systems – and 80% of the survey participants said radical changes in training and certification are required in response to the rapid advance of new technologies and new ways of working.

One respondent commented:

'It is quite possible that the shipping industry will change so that the role of the mariner will be that of an operator/supervisor/technician, but for the time being I prefer knowing that there are humans on-board making the final call, even if the day to day business could be conducted remotely or with a human in the loop. We will not be able to stop the evolution of shipping, but as a contributing part in the development we can ensure jobs, safety and security.'

One shipmaster stated:

'It has been my opinion that we are still far away from fully unmanned vessels. Automation systems on shipboard vessels need to be dramatically improved. I do however see a trend towards more powerful automation on vessels afloat, providing that operators are given the proper training for both operations and repairs to said equipment.'

Are radical changes in training and certification required to reflect the technological advances at sea and to better equip seafarers to work with automated systems?



Another respondent commented:

'The technology is here and will evolve. It needs to be embraced with seafarers at all levels learning and being involved in its development wherever possible to ensure that technology does not over-rule safety and society's benefits for commercial gain of technology companies.'

Some respondents expressed the view that the technological developments are inevitable and training seafarers will help retain jobs in the industry:

'Accept automation as a fact and get in front of the trend - make the Union the centrepiece of retraining existing members to operate these modern fleets and become indispensable to the industry. Don't stick our heads in the sand on this inevitable topic!'

Capturing the sentiment of many respondents, a second engineer responded to the survey:

'We aren't Luddites. Technology to aid ship operation is fine; it's taking operational control out of human hands that poses the danger. This is not driven just by job security fears. We have a genuine concern for the dangers automation poses. Automation is driven by the desire to squeeze profits at the expense of great risk.'

Engage with unions

to consider the most beneficial ways in which technology should be introduced

Conclusions

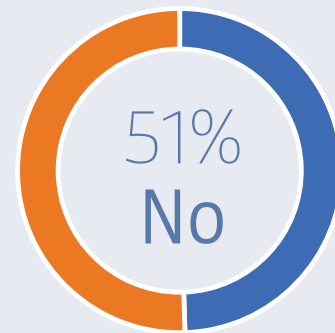
The overwhelming majority of maritime professionals regard autonomous shipping as a threat to job security and two-thirds believe that unions should resist the process. However, the survey also shows that despite the generally negative attitude towards automation, 83% of maritime professionals still believe that technology has the potential to improve the quality of work at sea.

The survey demonstrates that seafarers are not completely opposed to automation at sea – but rather that they would like it to be integrated into existing working arrangements instead of being used to cut crewing levels further or to replace seafarers altogether. Their views on technology vary according to the way in which its use is planned – with the concept of completely unmanned remotely controlled ships attracting the most opposition, and relatively few seafarers completely against automation in any form whatsoever.

The feedback gathered also makes a compelling case for regulators and decision-makers to ensure that they give urgent and thorough consideration to the issues of safety at sea, the questions around liability, insurance and regulations in the transitional period, and the recurring themes of equipment failure, the impact of relatively simple issues like pump and pipe failures leading to unpredictable and complex chains of failures, as well as fuel supply problems and the poor quality of some shipboard systems and equipment.

It is clear from the survey that many maritime professionals feel their experience and knowledge has not been taken into proper consideration during the debate so far on the introduction of autonomous shipping. There are profound concerns that new systems may be introduced in a damaging way, and that this could prove to be highly counter-productive to safe and efficient working practices.

Is the creation of fleet operations centres, involving extensive shore-based monitoring and direction of ships, a good development?



What about seafarers?

A number of other industries are well ahead of the shipping industry in managing the transition to more autonomous operations. This survey showed that maritime professionals want the experiences of sectors such as aviation to be given appropriate attention, and for a much greater focus to be placed on the way in which seafarers will be expected to interact with new technology.

The survey showed that seafarers are willing to embrace the changing face of technology, but believe more should be done to ensure that it is used to benefit their working lives. There is a clear demand for structured training and support to ensure they are well-equipped to handle any changes that could affect their roles in the long-term. The importance of such a strategy is underlined by the recent World Economic Forum report on the future of jobs, which warned that – without retraining – only 2% of workers would have a good chance of moving to better jobs and 16% would have no chance at all.

Feedback

gathered also makes a compelling case for regulators and decision makers to ensure that they give urgent and thorough consideration to the issues of safety at sea

What next?

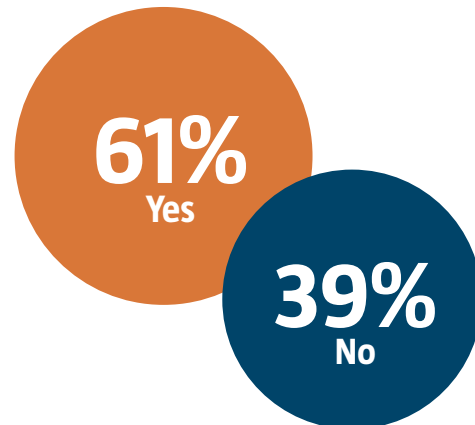
The shipping industry should:

- 1 use new technology to enhance productivity, jobs, and wages rather than reducing employment levels
- 2 engage with unions to consider the most beneficial ways in which technology should be introduced
- 3 substantially reduce excessive workloads, cutting fatigue and reducing paperwork
- 4 ensure that workers have a say in the introduction of technology at shipboard, company and regulatory levels, with new forums to bring unions, employers and regulatory authorities together
- 5 develop new training and qualification programmes – in particular for shore-based staff working in fleet operations centres
- 6 examine ways in which new technology can be used to enhance maritime skills and to create new roles in operational oversight and control, analysis, research and development
- 7 introduce retraining programmes for those facing redundancy due to industrial change

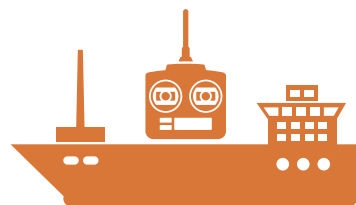
There is a real need for a greater understanding of the way in which the shipping industry will apply autonomous technology, and a more proactive approach to assessing its impact on seafaring jobs.

The industry is used to adapting to the changing nature of technology, but the technical, operational and social concerns identified in this survey deserve urgent and thorough attention.

Do you think automation has the potential to make the shipping industry safer?



In which way could automation make the shipping industry safer?



20%

Through using **unmanned** remotely-controlled ships



80%

Through using **autonomous** shipboard systems on **manned** ships

Should seafarer unions resist automation?

65%
Yes

35%
No

Appendix

Autonomous or smart ships – the Nautilus Federation position

Autonomous or Smart ships are part of a wider debate within society about the impact of technology and the consequences of automation in the workplace. Particularly for shipping and seafarers. A 2016 report from the World Economic Forum warned that the rise of robots will lead to a net loss of more than five million jobs in 15 major developed and emerging economies by 2020. Technology's erosion of the traditional link between increasing productivity generating increased employment threatens to create even more inequality – and this process will accelerate as technology replaces ever-more skilled jobs, presenting profound challenges to the world's socio-economic systems.

Inland waterways transport is similarly confronted by considerations regarding autonomous vessels and indeed the first experiments are taking place, building on the introduction of new technologies in the wheelhouses and engine rooms. This has brought with it calls for reviews of manning requirements but also for workload analyses as work becomes increasingly intellectual rather than manual and as 24/7 operating time becomes more widespread. However, the dense traffic conditions on the major waterways along with the effects of tides and currents call for complex operations to ensure safety for persons and free-flowing traffic. The predominance of small owner operators with underfunded enterprises is also a limiting factor to a widespread of rapid introduction of smart vessels.

The Nautilus Federation recognizes the rapid advances being made in shipboard technology, information and communication data exchange and shore-based support systems. We believe that technological change is inevitable and that advances in information and communications technology, and robotics, will affect the future of the shipping industry, just as they are re-shaping the nature of work ashore.

The Federation believes it is important to find ways of ensuring that such developments are human centered and to result in improve safety and bring about high quality employment and training for maritime professionals. Much of the discussion so far has been driven by equipment manufacturers and potential service suppliers and has concentrated on technical systems, rather than their potential human element issues and social impact.

While shipping is often said to be a conservative industry and slow to change, history – including recent history – shows that there have been sweeping transformations, such as the shifts from sail to steam to diesel, from coal to oil, the development of automated engine control systems and navigation equipment, including the gyro compass, radar/ARPA and terrestrial navigation systems. And, the adoption of containerization has changed the world's economy and created globalization.

More recently, the International Maritime Organisation (IMO) has moved to embrace the mandatory carriage of new technology, including GMDSS, VDR, AIS and ECDIS as well as a complex set of requirements for power and control systems, along with the ongoing development of a strategy for e-Navigation. Many of these advances have been supported by trade unions representing seafarers, and most notably where they have been shown to deliver improvements in safety or living and working conditions on board ship.


However, it should be noted that the introduction of new technology can be a disruptive force that is not always painless and not all technologies have met the challenges of economic and technical feasibility. The shipping industry, and those who regulate it, need to exercise caution in the move toward the operation and regulation of autonomous ships – acknowledging that changes should be evaluated as experience is gained at every stage of its development.

There is also a need for a definition of what stage of automation is being discussed to reach a common understanding of what issues have to be addressed. Lloyd's Register has proposed six stages or autonomy levels (AL's) for shipping, depending on the technology, systems and operating procedures involved. These should provide clarity as to what stage of automation is being discussed. These range from AL1 for ships with data collated for onboard decision making, through to AL6 which denotes a fully autonomous ship with no access required for its operation.

This process should begin now, with analysis of the existing impact of automation – and most notably to assess it as a factor within accident investigation reports. There is an urgent need for research now, not down the line, to assess these critically important factors. Too often, accidents are written off as being the consequence of 'human factors' when, in reality, issues such as ergonomics, distractions from information overload, equipment design, over reliance on automated systems, and training are of crucial significance.

It could be argued that automated ships are already a reality, with 'smart' ROVs and Unmanned Autonomous Vehicles being used in such areas as marine research, defence and in the oil and gas industry. However, it should be accepted that the operation of such vessels – largely for limited periods and in closely controlled circumstances and nearby operational areas – is very different from the complex operations and support required for autonomous deep sea commercial shipping in distant waters.

Nevertheless, the potential for further radical change in shipping operations is clear: for example, there are several EU-funded research projects examining the issues, equipment manufacturer ABB has already opened a number of shore-based remote engine monitoring centres, and Rolls-Royce has revealed plans to build a remote-controlled offshore service craft by 2018.



The speed at which autonomous shipping is embraced by the industry is likely to be driven strongly by economics. Fully autonomous ships and the supporting infrastructure will require huge amounts of investment and savings on labour may be marginal, given the relatively low cost of many seafarers in the global maritime labour market. And, many functions carried out by onboard seafarers such as cleaning tanks, servicing equipment, minor repairs, maintaining condition of cargoes, and mooring operations do not lend themselves to remote operations. The Nautilus Federation also contends that economics should not be the core criteria influencing the adoption of autonomous systems – it should be safety and the protection of the marine environment.

Fully autonomous cargo ships may be a potential reality as onboard systems are increasingly automated – and while there are legitimate concerns that this could de-skill seafarers or reduce employment opportunities, the Nautilus Federation believes that these developments could offer opportunities for a new generation of maritime professionals, underpinned by the demand for new skill sets and aptitudes from seafarers. There is a compelling case for the industry to change its collective mindset, and to come to regard seafarers as a resource to invest in rather than an operating cost that must continually be reduced or eradicated.

This is illustrated by the well-fought rear-guard action undertaken by unions as GMDSS began to take effect – keeping the case for an electronic specialist very much alive, and resulting in the 2010 ‘Manila Amendment’ certification requirements for an Electronic Technical Officer (ETO) included in the Standards of Training, Certification and Watchkeeping Convention.

The work done by the seafarer unions to formally recognise ETO skills and training provide a model for the essential work that lies ahead to ensure that there is appropriate training, skills and knowledge to safely operate new systems and to provide the necessary underpinning seafaring expertise for automated maritime operations. Indeed, the ETO’s role is of increasing importance in today’s shipping industry – and, in the years to come, the need for a technical specialist onboard will accelerate further. The shipping industry must respond to this, and the carriage of ETOs should be a requirement within the safe manning certificate of highly automated ships.

The Federation believes that human centered automation has the potential to improve the nature of work for maritime professionals – emphasising the ‘high tech’ nature of the sector. To harness that potential, however, will require the industry to take a more far-sighted approach to its seafarers than it has done in previous years. The complexities of human interaction with automated systems and its role in operational decisions deserves intense scrutiny – as the maritime environment is one in which assessment and judgement based on experience and training are fundamental to correct decision-making, often in high-pressure circumstances.

Whilst automation in the aviation model is often held up as one that shipping should aspire to, it should be noted that the airline industry has a very different operating environment. And, it has also been confronted with the problem of deskilling of airline pilots. Many no longer have the experience and judgment to make the right decision in emergencies because most in-flight decision-making is undertaken by computers. Shipping may also find itself having to deal with the issue of seafarers suffering ‘shock and startle’ in the same way as airline pilots have lost the skills to react appropriately in emergencies due to the high levels of cockpit automation.

Certain sectors of the industry are more likely targets for the fully autonomous model of operations and the transition period is also likely to see a continued need for seafarers in such operational phases as servicing equipment, preparing for and managing cargo, mooring, navigating busy sea lanes and pilotage.

As with the first industrial revolution, there is an opportunity to create and develop new specialist skills. Integrating the human into communications systems – ‘augmented reality’ – has the potential to upskill to a degree not yet realised. However, there will be a continued need for a deep-rooted knowledge and experience of seafaring and attention must be paid to the ways in which this need can be met. The industry and regulators must also take a proactive approach to the training needs – identifying the complex demands of interaction with new systems and ensuring that adequate resources are devoted to developing and funding appropriate courses to equip seafarers with the necessary knowledge and skills.

New technologies offer significant potential to improve safety – with intelligent use of sensors and diagnostic tools being of considerable help to deck and engineering departments in supporting decision-making and situational awareness.

The Federation also believes that the debate on autonomous ships has so far concentrated on the technological and the economic issues, and needs to shift to social and human factors.

Many pressing safety issues also need to be addressed, not least the legal and liability implications, the regulatory regime (UNCLOS, COLREG and SOLAS being critical), the extent of shore-based control and direction (VTS), and system resilience, software quality, the reliability of communications and data links, and cyber security.

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Australian Maritime Officers Union (AMOU)
www.amou.com.au

ACV – Transcom – Belgium
www.acv-transcom.acv-online.be

Seafarer's Union of Croatia (SPH)
www.sph.hr

Fédération Générale des Transports et de
L'Environnement (FGTE-CFDT)
www.cfdt-transport-environnement.fr

Danish Maritime Officers
www.soefartensledere.dk

The Finnish Ship's Officers' Union
www.seacommand.fi

Merchant Navy Officers's Guild – Hong Kong
(MNOG – HK)
www.mnogk.org

Nautilus International (NL)
www.nautilusint.org/nl

New Zealand Merchant Service Guild (NZMSG)
www.nzmsg.co.nz

Singapore Maritime Officer's Union
www.smou.org.sg

Singapore Organisation of Seamen (SOS)
sosea.org.sg

Officers' Union of International Seamen (OUIS)

International Organisation of Masters, Mates and
Pilots (IOMMP) – USA
www.bridgedeck.org

Marine Engineers' Beneficial Association (MEBA)
– USA
www.mebaunion.org/MEBA

Sjöbefälsföreningen Maritime Officers' Association
www.sjobefalsforeningen.se

Nautilus International (CH)
www.nautilusint.org/ch

Unión de Capitanes Y Oficiales de Cubierta (UCOC)

Unión de Ingenieros Marinos (UIM)

Norwegian Union of Marine Engineers (NUME)
www.dnmf.no

Other important organisations

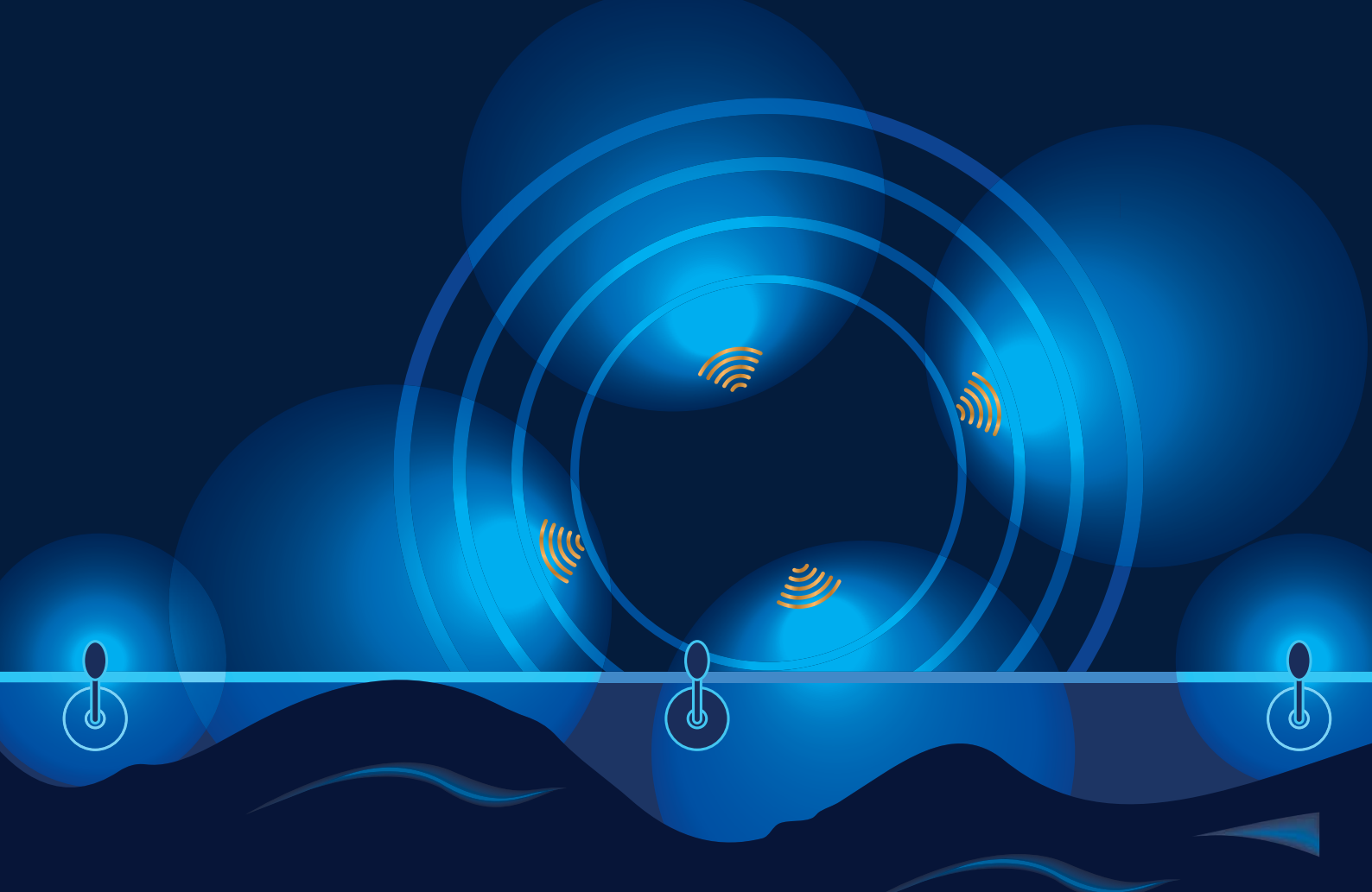
International Transport Workers' Federation (ITF)
www.itfglobal.org

European Transport Workers' Federation (ETF)
www.etf-europe.org

International Association of Ship Masters
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What maritime professionals think about autonomous shipping



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