Technology in shipping

The impact of technological change on the shipping industry
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A Clyde & Co and IMarEST joint initiative

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Technology is reshaping the marine industry. Over the next decade or so, new technologies promise to completely transform shipping: an industry that is the engine of 90% of global trade.

This often invisible enabler to the world economy will become more efficient and, in response to urgent environmental challenges, more sustainable too.

The transformation will invite a cycle of regulatory and legal change: regulators will have to rewrite the rules that have governed how vessels operate safely, efficiently and remotely.

The changes will not happen overnight. Nor will the transition happen evenly. It will challenge traditional business models and companies will be forced to adapt in order to survive and prosper.

Clyde & Co and IMarEST teamed up in a joint initiative to seek insight on emerging technologies from more than 20,000 marine professionals around the world. Within this report we have provided an overview of the impact of emerging technologies today and identify the market’s key concerns regarding operating, staffing, insuring and implementing emerging technologies in the shipping sector.

Introduction

Foreword

While it’s clear that technological change has already had broad and profound implications on business and commerce, to many, it’s equally clear that the biggest impact is still to come. Industries across the spectrum are coming to terms with the fundamental changes that technological advances in areas such as artificial intelligence, robotics, automation and connected devices will have and the opportunities and threats they pose.

For the marine sector, innovation-led change is nothing new. Consider the impact that radar and satellite communications have had in the past one hundred years alone. But the industry now faces a tipping point, where technological developments such as autonomous and smart ships are turning the realms of science fiction into hard fact. At the same time, the sector is facing unprecedented cost pressures and a stricter regulatory backdrop, as environmental restrictions persist and harden.

The emergence of such a high level of innovation and change brings with it new risks as well as huge opportunities. Whether it is cyber attacks on smart ships, a dearth of expertise needed to maintain and run an unmanned ship, or a lack of infrastructure to support new fuel sources and technology, the industry must consider the potential pitfalls that innovation can present.

It’s in this context that we partnered with IMarEST to take the pulse of the industry and understand how they are responding to this changing landscape; how they’re identifying the opportunities and mitigating the risks. The research shows starkly that these new and developing risks are holding back the full embrace of these potentially game-changing technologies. Successfully balancing the risk with the huge opportunities they pose will be crucial to ensuring success in the 2020s and beyond.

As a global law firm that advises its clients on how to navigate today’s complex risk landscape to help them grow, we keep a keen eye on the emergence of new technology. That’s why we’re delighted to have partnered with IMarEST on this report and hope it will prove useful. We look forward to carrying on the discussion in person.

Joe Walsh
Partner, Long Beach
Clyde & Co
How great an impact will shipping technologies have on your organisation

Unmanned ships
21.51
24.73
25.81
23.66

Green technology
22.41
25.86
39.66
12.07

Energy management solutions
17.46
28.57
44.44
9.52

Smart shipping
18.03
24.59
36.07
13.11

Considerable impact
No impact

Which technology will show the most growth in the next 10 years

Unmanned ships 17%

Green technology 63%

Energy management solutions 4%

Smart shipping 17%
Unmanned ships

While cyber risks are acknowledged as an inescapable side effect of technological advancement, over half of respondents believe risks associated with new IT based solutions are manageable.

There is a lack of clarity regarding liability should a vessel be involved in an incident as result of a cyber attack.

There is further uncertainty about the effectiveness and appropriateness of voluntary standards / mandatory regulations to tackle the problem.

The biggest cyber risk perceived remains human intervention – whether it be unintentional interference from employees or malicious attack by negative actors.

The majority of respondents raised concern over how difficult it will be to respond in an emergency on board an unmanned vessel.

Concern was also expressed over a lack of clarity regarding collision regulation.

As for the impact on crew, the transition to unmanned vessels may lead to a long term erosion of seafaring engineering skills.

Smart shipping

Most respondents forecast the introduction of smart shipping in the next 10-15 years.

75% of respondents believe smart shipping will impact their business.

Smart shipping will support crew and improve vessel and fleet performance, however questions emerge about liability when things go wrong.

The ability to better monitor performance and the data collected as part of post event forensics may help to prevent future failures and business interruption.

Many are taking a “wait and see” approach when it comes to adopting smart shipping technologies.

A key challenge for shipowners is measuring a baseline level of performance against which the output from any newly introduced system can be assessed and evaluated.

Smart shipping could diminish the opportunities to learn from experiences, ultimately to the detriment of crew and the vessels they support.

Energy management

73% believe fuel availability will strongly drive the market’s decision to adopt alternative energy management solutions. Other notable drivers included heavy fuel oil (HFO) price and the capital and/or infrastructural investment required to support alternatives.

The top ranked advantages of energy management solutions include reduced fuel consumption, enhanced efficiency, improved corporate reputation and optimised operational profile.

74% believe port infrastructure is not adequate to support new solutions and strategies in energy management (e.g. shore power).

The majority of respondents do not think that existing regulations will make it difficult to incorporate energy management changes.

LNG is the most attractive alternative fuel source, however renewables (wind and solar) were also popular responses.

Green technologies

67% believe differences in regional and international regulation will impede adoption.

Respondents were divided on how difficult it will be to assess the available solutions for compliance with the 0.50% m/m IMO sulphur limit.

For most, the adoption of green technologies is driven by compliance, particularly for vessels sailing in waters covered by regional and global rules.

The availability of adequate bunkering infrastructure concerns some operators exploring switching vessels to LNG/LPG.

Ballast water management and ecological contamination were only raised as secondary considerations.

Green technologies may put additional pressure on crew who will need to acquire new competencies as well as taking an additional maintenance workload.

Summary of findings
Unmanned ships

The development of semi-autonomous or autonomous vessels is still in its early stages, but as the market begins to explore adoption, it is clear that the legal and regulatory ramifications of such vessels require extensive clarification and this will be a strong determinant in the rate of adoption.

Our survey findings indicate that while managing cyber risks is achievable, there is extensive confusion over liability and how insurers will treat unmanned ships. While flag states and classification societies are developing rules, a lack of consistency threatens further complications, and makes it difficult for shipping companies to set up their own internal approach to safety assurance.

The commercial argument for unmanned operation also appears to be unclear. There will be savings in operational expenditure by stripping vessels of their crew however these savings must be weighed against new expenditures, for example, establishing new shore based infrastructure or the additional ongoing expense of fewer but more highly qualified personnel to operate and maintain the new robotic tonnage.

The 25-30 year lifespan of a commercial ship creates additional challenges. The problem of technology obsolescence is already an issue, and given the pace at which technology evolves compared to machinery systems and established vessel refurbishment intervals, this situation is likely to deteriorate before long-term remedial strategies can be found.

While many countries have adopted domestic laws to protect data, privacy and national interests, the laws that apply to international shipping remain undeveloped. Inaction or simply waiting on the sidelines for rules or requirements is clearly not a viable approach but what exactly is expected of a reasonably prudent shipowner?

Joe Walsh, Clyde & Co, Long Beach

The legal framework does not support the introduction of autonomous technology and underwriters are ignoring the risks.

Survey respondent

"While many countries have adopted domestic laws to protect data, privacy and national interests, the laws that apply to international shipping remain undeveloped. Inaction or simply waiting on the sidelines for rules or requirements is clearly not a viable approach but what exactly is expected of a reasonably prudent shipowner?"

Joe Walsh, Clyde & Co, Long Beach

The legal framework does not support the introduction of autonomous technology and underwriters are ignoring the risks.

Survey respondent
Cyber risks are acknowledged as an inescapable downside of deepening technological integration, however over 55% of respondents feel the risks are manageable. Attitudes towards investing in this management were skewed; some argued that the effort and cost involved in introducing adequate countermeasures against cyber risk might outweigh the benefits of new technology in the first place. Concern was expressed about the lack of clarity regarding liability should a vessel be involved in an incident as a result of a cyber attack. Questions were also raised about the effectiveness and appropriateness of voluntary standards and/or mandatory regulations to tackle the problem.

Many identified human intervention as a primary risk to cyber security – be it pirates, hackers or crew members. The negative actors, whether drive-by hackers, organised cyber criminals, rogue nation states or others, will almost certainly be one step ahead. Thus, constant vigilance and defensive posture will be crucial to the successful implementation of new technology onboard ships. Today, crew - or, more specifically, the personal devices they bring onboard - are the source of many of the cyber intrusions that happen at sea. In response to expected incremental automation many are taking steps now to boost the IT competency of their sea-staff, particularly with respect to cyber risk management.

### Cyber security

The lack of clarity on the timeline for both commercial availability of autonomous solutions and regulatory readiness means most shipping companies are yet to initiate concrete preparations for their introduction. Many are, however, keeping an open mind to the idea and are maintaining a watchful eye on developments. Some respondents indicated they are - or intend to - provide their staff with more training and skills development to build understanding of automated systems, in combination with education on cyber risk. Others alluded to taking the possibility of remote or autonomous operation into consideration in the planning of shore based fleet operations centres.

While manufacturers - including a number of major OEMs such as Rolls-Royce, Wartsila and Kongsberg Maritime - are aggressively pursuing R&D programmes by designing, testing and building experimental autonomous and semi-autonomous vessels or the systems that will enable such vessels, the technology is not yet commercially available.

Moreover, there are still plenty of regulatory hurdles to be overcome, although here too maritime authorities and policymakers - at national, regional and global levels - are taking the idea seriously with considerable work underway to investigate what existing rules need to be modified or what new rules might be required. The assumption seems to be not whether autonomous vessels will one day set sail, but when.

<table>
<thead>
<tr>
<th>Top 3 advantages of unmanned ships</th>
<th>There is too much confusion surrounding liability</th>
<th>Transferring the human factor</th>
<th>Industry preparedness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced health and safety risks</td>
<td>Disagree</td>
<td>Agree</td>
<td></td>
</tr>
<tr>
<td>Reduced risk of human error</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Costs savings in overall operations including personnel</td>
<td>Agree</td>
<td>Disagree</td>
<td></td>
</tr>
</tbody>
</table>

77% 77% believe ports and port authorities are unprepared for unmanned ships

78% 78% believe unmanned ships will result in crew reductions and job losses

Unmanned vessels, by definition, promise to eliminate onboard ‘human error’. In reality, they may just shift the errors that formerly occurred on the ship to other parts of the shipping company or elsewhere in the industry. Newly recruited shore based supervisors, for instance, are equally at risk of making mistakes as junior officers on the bridge. Overworked programmers or systems designers may forget a negative sign in a rarely executed section of code, which is only discovered, to disastrous effect, under a set of seldom encountered but safety-critical circumstances.

Seafaring 2.0

Respondents feel autonomous ships are more likely to alter jobs rather than eliminate them and that this, combined with the creation of new types of jobs, will lead to greater prosperity in the long run. Autonomous ships are likely to require constant vigilance and close oversight from a team who can ensure smooth operation, as well as anticipating and planning maintenance requirements. Concerns were voiced that a transition to autonomous vessels may be storing up problems for the future, in terms of skill erosion, as the finely tuned ‘sixth-sense’ so often possessed by experienced seafaring engineers disappears over time. It is important as seafarers often go on to become shore based managers and inspectors. More positively, it was suggested that despite all the additional technology needed on unmanned vessels, they may end up more resilient to risk than conventional manned ships simply because there are no crew.

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### Industry preparedness

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While manufacturers - including a number of major OEMs such as Rolls-Royce, Wartsila and Kongsberg Maritime - are aggressively pursuing R&D programmes by designing, testing and building experimental autonomous and semi-autonomous vessels or the systems that will enable such vessels, the technology is not yet commercially available.

Moreover, there are still plenty of regulatory hurdles to be overcome, although here too maritime authorities and policymakers - at national, regional and global levels - are taking the idea seriously with considerable work underway to investigate what existing rules need to be modified or what new rules might be required. The assumption seems to be not whether autonomous vessels will one day set sail, but when.
Smart shipping

Smart shipping is the inclusive term coined by the industry to describe the digital technologies available for determining and optimising operational efficiency. Tightening margins and the affordability and availability of computing power have met to form opportune conditions for the adoption of smart shipping: weather-routing, voyage planning, fuel consumption, emissions control and predictive maintenance are popular options for improved commercial efficiency as well as meeting new regulatory standards.

Some warn against the possible limitations of smart shipping. For example, what level of credence is given to the data going into these systems, particularly if the decisions reached by such systems could impact vessel safety or the environment? Others were worried by the ability of the ‘black boxes’ to produce decisions and the potential implications on liability.

Most respondents welcome the prospect of higher quality information on which to base decisions aimed at improving efficiency, reliability and safety. For instance, it was remarked that data collected in the run-up to a machinery or component failure would prove invaluable in post event forensics and investigations to prevent similar recurrences, therefore contributing to improved asset availability.

While recognising that fostering the necessary expertise to perform data analysis and learn from the results poses a challenge in the short-term, the general view was that climbing and overcoming this learning curve offers significant long-term benefits. As one superintendent put it, “the opportunity to deal with hard data rather than basing decisions on supposition, speculation, or gut feel will make ship management much easier.”

Richer data and sophisticated analysis tools will help investigate incidents and potential claims.

Senior Surveyor, a global provider of marine surveying services

It is natural for corporations to focus their resources on advances in technology and how best to employ these advances to cut costs and to increase profits, but it is important to give consideration to the legal implications and how the new technology fits within the existing contractual and legal framework.

Chris Metcalf, Clyde & Co, Singapore
Many respondents are taking a “wait and see” approach, preferring to let other players take the initiative. Improving margins is a strong driver in the adoption of smart shipping and not surprisingly it was evidenced that a key challenge for any shipowner considering data-centric operation is to measure a baseline level of performance against which the output from any newly introduced system can be assessed and evaluated.

Those taking a more proactive stance are increasing training in information and communications technology (ICT) for staff working at sea and on shore, thus paving the way for a gradual transition to a more data-centric mode of operation. Others are still conducting preliminary research into the available solutions and doing trials, with a view to exploiting the benefits of data gathering and analysis in the near future, and/or are specifying equipment that can allow data to be ‘switched on’ at a later date, thus future-proofing their operations.

Some queried whether the satellite communication (satcom) services currently available to the shipping industry offer the necessary capacity to really maximise the potential of data-centric vessel operation, or sufficient resilience for its use in mission-critical applications. It should be noted that most smart shipping solutions available today do not take always on high capacity connectivity for granted and can function independently. However, resilience and failure modes will grow in importance as systems become more sophisticated and dependent on the availability of a network connection.

**How prepared is the industry?**

<table>
<thead>
<tr>
<th>Respondents’ top 3 barriers to smart shipping</th>
<th>When do you think it is likely for the industry to be able to introduce smart shipping?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infrastructure requirements – 26%</td>
<td>Less than 5 years – 48%</td>
</tr>
<tr>
<td>Cyber threats – 14%</td>
<td>10 - 15 years – 17%</td>
</tr>
<tr>
<td>Interface with new/existing regulations – 12%</td>
<td>15 - 25 years – 12%</td>
</tr>
<tr>
<td></td>
<td>25+ years – 75%</td>
</tr>
</tbody>
</table>

75% believe smart shipping will impact their business.

**When do you think it is likely for the industry to be able to introduce smart shipping?**

- Less than 5 years – 48%
- 10 - 15 years – 17%
- 15 - 25 years – 12%
- 25+ years – 75%

75% believe smart shipping will impact their business.

**Shifting skillsets**

The overall impact of smart shipping isn’t expected to affect the size of crew and technical support teams, however it will affect the skills and competencies needed in the occupation. Most were broadly optimistic about the benefits of the technology as a tool to support crew and improve vessel and fleet performance. Successfully shifting to data-driven operation requires a complete change in mindset from the boardroom, through shore-based support teams, to the crew at sea.

Many foresee a de-emphasis on traditional hands-on mechanical engineering roles, while knowledge of electrical, electronic and/or software systems will grow in importance. Crew will take a more supervisory role, while superintendents may have an increased workload and/or have to accept greater responsibility, particularly in the initial stages of roll out.

We may see a shift in power from those on board ships to shore-based roles as it becomes unrealistic to expect a small crew ship to possess intimate knowledge across multiple technologies. Some worry that this elevated level of cooperation between ship and shore may have an adverse effect on vessel self-sufficiency, particularly if lines of communication are lost, and that this could pose a new risk.

As found with unmanned ships there was a view that smart shipping solutions may lead to an erosion of competency: a reliance on computing to control ships may reduce crew’s understanding of how and why a ship is operating under certain digital instructions.

**3D printing & advanced materials**

Commercial ship operators may benefit from the emergence of cost-effective and reliable 3D printing. It would reduce the inventory of spare parts stored on board and could be particularly helpful in the case of difficult to obtain components for older or obsolete machinery. However, it is predicated on the availability of datafiles for these components. There could be potential warranty or liability issues if equipment is repaired using 3D-printed parts not endorsed by the original manufacturer.
Energy management

Conversations on the adoption of energy management solutions centred around three key themes: the reliability of technology, regulatory constraints and cost.

Fuel accounts for as much as half of the operating costs for the shipping industry making the cost of fuel a major driver behind steps to improve energy efficiency. The cost of heavy fuel oil (HFO) - the fuel most commonly burned in ship engines - has remained relatively low over the past decade, at least by historical standards. While the cost of HFO remains low relative to energy management solutions, the benefits will likely be outweighed by the level of investment required to engage alternatives.

Current regulation accommodates and encourages the adoption of fuel alternatives and solutions that diminish environmental impact. While the commercial incentives may be key drivers of change, the unpredictable future of regulation such as EEDI should offer incentive for ship operators to be proactive in this area.

Andrew Preston, Clyde & Co, London

Fuel cells are the way forward. The hydrogen they use is a fuel that can be produced with renewable energy, so it is a true net zero greenhouse gas fuel.

Marine Engineer at a global oil tanker fleet operator
Energy management

Regulatory drivers

Commercial imperatives can be – and often are – overridden by directives imposed at a global level by IMO and/or regional regulatory bodies, such as the EU. To date more than 2,400 ships have been certified to meet IMO’s mandatory Energy Efficiency Design Index (EEDI), which sets a minimum standard for vessel energy efficiency. A more stringent EEDI is set to be introduced in 2020. A third target is under review and may be phased in as soon as 2022. A fourth phase cannot be ruled out. These later targets will be informed partly by data on fuel consumption that internationally trading commercial vessels will have to collect from 2019. Meanwhile, from 2018, the EU Monitoring, Reporting, Verification (MRV) regulation requires shipowners and operators to annually monitor, report and verify CO\textsubscript{2} emissions for vessels larger than 5,000 tonnes calling at any EU port.

The commercial benefits of better energy management mean vessel operators and other stakeholders are almost without exception closely monitoring developments. Respondents emphasised the need to keep abreast of the evolving regulatory landscape for alternative power arrangements. The majority of respondents don’t recognise regulation as a hindrance to adopting fuel alternatives but recognise there should be a focus on crew and shore based personnel to have the necessary competencies to safely use and maintain new equipment.

Top ranked advantages of energy management solutions

- Reduced fuel consumption
- Enhanced energy efficiency
- Improved corporate reputation
- Optimised operational profile

Evaluating energy management options

Fuel availability will strongly drive the market

- Disagree
- Agree

Port infrastructure is not adequate to support new solutions and strategies (e.g. shore power)

- Disagree
- Agree

Alternative compliance solutions and strategies will see the most growth

- Disagree
- Agree

Scoping the alternatives

Unsurprisingly, liquefied natural gas (LNG) was the clear first choice among our respondents. The attractions are self evident: it burns cleanly and is abundant and hence cheap. Moreover it is a known quantity: the technology is proven, and the risks are well understood with regulatory instruments (such as the International Gas Code) in place and plentiful guidance to ensure safe operation when using it as a fuel.

It should be remembered that LNG naturally boiling off from gas cargo has fuelled LNG carriers for decades. The transition to other ship types began in Scandinavia in 2000, particularly among ferries and short-sea vessels. This initial regional success can be attributed partly to a lack of bunkering facilities at a global level. The geographic spread of refuelling stations and other infrastructure is now expanding and the indications are that vessels are following.

Nevertheless the growing popularity of LNG as a fuel could pose new risks. It was suggested that having novice or less experienced crew working with such a highly volatile fuel might lead to incidents.

Batteries and renewable energy

Renewables, especially solar and wind, were well represented as energy alternatives. While both can contribute to auxiliary power requirements, neither currently offer sufficient energy density to dependably satisfy the power needed for ship propulsion.

Another approach is indirect exploitation whereby electricity generated by land based renewable energy plants charges batteries for use at sea. Battery technology has improved considerably in recent years, driven by the automotive industry, but it is unlikely that standalone battery operation is feasible for transoceanic voyages. There is hope for smaller operations: an emissions free fully electric car ferry entered operation in the Norwegian fjords in 2015. The energy costs of the 80m long ship are reported to be 60% less than a conventional design.
Green technology

The priority for most vessel operators is to ensure they stay up to date and in compliance with incoming environmental regulation. This can be onerous when vessels must be prepared to sail in waters covered by differing regional as well as global rules.

Additional hardwares such as exhaust gas scrubbers and ballast water treatment systems lead to additional pressures on crew, who must be offered training and acquire new competencies to safely operate it.

A few operators indicated a keenness to switch vessels to alternative fuels, including LNG and LPG.

A major criteria here is the availability or not of adequate bunkering infrastructure. Many are also keeping an eye on new innovations (such as Flettner rotors) and the potential of renewable energy sources.

It is prudent to keep an eye on voluntary compliance programs, since they can develop quickly into compulsory programs, complete with fines, penalties and potential civil liability exposure as well. An example is ballast water treatment.

Conte Cicala, Clyde & Co, San Francisco
Green technology

Prioritising green technologies

When considering the adoption of green technologies some took a near term perspective, preferring that priority is given to proven solutions such as LNG or solving the challenges posed by imminent regulatory change, in particular, IMO’s global cap on sulphur content in ship fuel. Others considered a medium term horizon, with particular emphasis on pushing the development of energy storage (batteries and fuel cells) and hybrid power arrangements. The transfer of harmful aquatic organisms into new ecosystems by ships’ ballast water or hull biofouling was raised only as a secondary consideration. This is perhaps explainable by the fact that a regulatory framework is already in place and technical solutions are forthcoming.

68% believe differences in regional and international regulations will impede adoption

52% believe green technology will impact their organisation

It will be difficult to assess the available solutions for compliance with the 0.50% m/m IMO sulphur limit

Strongly agree

Agree

Disagree

Strongly disagree

No answer

The inconvenient truth

In certain circumstances, solutions aimed at mitigating one type of pollution may cause other problems. For example, improving the combustion efficiency of ship engines to reduce carbon dioxide can result in increased NOx emissions. Therefore, it is important to take a holistic view of a particular solution’s overall impact. Attention is especially needed when any additional plant affects a vessel’s total energy requirements, such as the extra electrical load needed to run ballast water treatment systems or the use of scrubbers to clean exhaust gases. In addition, storing consumables onboard may reduce cargo or passenger carrying capacity, which affects both operational and commercial efficiency.
Survey metrics

We would like to thank all of our survey respondents for taking the time to participate in this research. Respondents came from a variety of companies, regions and roles, providing comprehensive insight on the market’s perception of technological adoption.

<table>
<thead>
<tr>
<th>Industry sector of respondents</th>
<th>%</th>
</tr>
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<tbody>
<tr>
<td>Shipowner/manager/operator</td>
<td>26.02</td>
</tr>
<tr>
<td>Equipment supplier and/or integrator</td>
<td>17.07</td>
</tr>
<tr>
<td>Classification society, surveyors and other technical services</td>
<td>16.26</td>
</tr>
<tr>
<td>Marine authority or regulatory body</td>
<td>8.13</td>
</tr>
<tr>
<td>Ship design, construction, repair and decommissioning</td>
<td>6.50</td>
</tr>
<tr>
<td>Other</td>
<td>6.50</td>
</tr>
<tr>
<td>Maritime training and education</td>
<td>6.50</td>
</tr>
<tr>
<td>Academia &amp; industry associations</td>
<td>4.88</td>
</tr>
<tr>
<td>Offshore energy (including oil &amp; gas, and renewables)</td>
<td>4.88</td>
</tr>
<tr>
<td>Marine professional services (insurance, finance, legal)</td>
<td>3.25</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Length of service in the industry</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 5 years</td>
<td>4.26</td>
</tr>
<tr>
<td>5 - 10 years</td>
<td>7.80</td>
</tr>
<tr>
<td>10 - 15 years</td>
<td>10.64</td>
</tr>
<tr>
<td>15 - 20 years</td>
<td>6.38</td>
</tr>
<tr>
<td>20 - 25 years</td>
<td>9.22</td>
</tr>
<tr>
<td>25+ years</td>
<td>50.35</td>
</tr>
<tr>
<td>Preferred not to state</td>
<td>11.35</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Size of organisation (employees)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - 40</td>
<td>28.21</td>
</tr>
<tr>
<td>40 - 100</td>
<td>10.26</td>
</tr>
<tr>
<td>100 - 250</td>
<td>9.40</td>
</tr>
<tr>
<td>250+</td>
<td>52.14</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Level of responsibility</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>I am responsible for decisions in one or more specific areas</td>
<td>49.66</td>
</tr>
<tr>
<td>I am frequently consulted</td>
<td>21.38</td>
</tr>
<tr>
<td>I am occasionally consulted</td>
<td>8.97</td>
</tr>
<tr>
<td>I have little to no involvement</td>
<td>6.21</td>
</tr>
<tr>
<td>Preferred not to state</td>
<td>13.79</td>
</tr>
</tbody>
</table>
About

Clyde & Co

Clyde & Co has the largest shipping practice in the world, with over 150 specialist marine lawyers based in trading hubs around the globe, on call and serving clients’ requirements in all time-zones at any time of day. Shipping is at the heart of Clyde & Co’s business, we enjoy a strong legacy in the industry and we are committed to staying at the front of the market on emerging issues facing our clients – technology as a prime example. No other law firm can match Clyde & Co’s combined size of practice, in-depth industry knowledge, specialist shipping expertise and global reach. Wet or dry, contentious or non-contentious, our cradle-to-grave approach means that we stand alongside clients through the full corporate lifecycle, from establishment and financing through to dispute resolution and corporate exit options. It is this depth and breadth of experience that enables us to routinely advise on high-profile, ground breaking cases in the industry.

We act for all players in the maritime industry – shipbuilders, owners, charterers, salvors, financiers, banks, finance leasing companies, port authorities and government, P&I Clubs and insurers. We also serve clients across the broader trade and commodities and energy sectors.

Our trusted team of specialist lawyers, a number of whom are multi-lingual, and our network of international offices allows immediate access to multi-jurisdictional expertise and local support. We are focused on providing pragmatic commercial solutions, and understanding the issues affecting our clients so we can best service their interests.

IMarEST

The IMarEST is an international membership body and learned society that brings marine engineers, marine scientists and marine technologists together into one multi-disciplinary professional body. The largest marine organisation of its kind, it spans 128 countries and works to promote the scientific development of marine engineering, science and technology, providing opportunities for the exchange of ideas and practices and upholding the status, standards and expertise of marine professionals worldwide. Members are able to gain professional registration through the Institute (such as Technician, Incorporated, Registered or Chartered status). Its learning arm, MLA College, delivers marine education and training courses through distance e-learning.

The IMarEST is an NGO with consultative status at the International Maritime Organization (IMO) and observer status at the Intergovernmental Oceanographic Commission, International Hydrographic Organization, the London Convention/London Protocol (LC/LP) and the Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP).

It has special consultative status with the Economic and Social Council of the United Nations (ECOSOC), which facilitates its access to other international intergovernmental meetings where its specialized marine expertise is of particular use, e.g., the United Nations meetings on Areas Beyond National Jurisdiction, the Intergovernmental Panel on Climate Change (IPCC) and the work of the International Seabed Authority on marine mining.

If you have any questions regarding this report, or would like to speak to a member of the Clyde & Co team about how your business is adapting to technological change, please contact techinshipping@clydeco.com.

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