

White paper



Autonomous Ships

in association with

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Roundtable Series

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maritime



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Looking for a lightbulb moment?

Shaping a strategy for the future is incredibly complex, but there's a simple step you can take today to improve your odds of success. The Maritime Future magazine from Futureonautics offers analysis, insight and comment every quarter identifying the trends, threats and opportunities shipping's technology-enabled future holds.

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Small, but perfectly informed

Introduction



Are autonomous, unmanned ships the future? Do the efficiencies and savings stack up? Is broader connectivity and technology infrastructure, regulators and insurers keeping up? Or is the unmanned ship a distraction from the far wider disruption taking place?

Futurenautics' mission is to engage, inform, support and inspire the current and future leaders of the shipping and maritime industry. Together with a programme of major industry research projects Futurenautics also publishes a quarterly journal, website, and holds a variety of events and other resources to help contextualise current technology trends for the shipping and maritime industry as it enters its technology-enabled future.

As part of its annual programme Futurenautics holds a global series of high-level roundtable discussions. These small, closed events for senior leaders focus on key trends and developments, promoting the exchange of ideas, best practice and a greater understanding of how shipping's partners, customers, stakeholders and regulators are approaching the technology-enabled future.

Following these roundtables Futurenautics produces a White Paper which it shares with the wider industry to promote discussion, provide information, and encourage and support leaders as they navigate a rapidly changing business environment.

Our roundtable took place in Aalesund supported by Inmarsat and

hosted by Rolls-Royce at its impressive technology centre located in what's been described as 'maritime's silicon valley'. The roundtable took as its theme 'The Autonomous Ship' and brought together a diverse and very senior group of maritime stakeholders from backgrounds as varied as connectivity, finance, insurance, global logistics, cyber security, engineering, ship management and operations, who delivered an engaging and fascinating discussion.

The technology required to produce driverless cars and pilotless passenger aircraft is virtually perfected, and in maritime navies are already sailing unmanned, armed vessels in their territorial waters.

Combined with the aims of the e-navigation agenda which proposes air traffic control type monitoring of ships, the step-change in connectivity offered by high throughput satellites, and the increasing desire of the Millennial generation to spend less time at sea, is the unmanned ship inevitable?

Unmanned ships could potentially offer 40%+ operational savings, whilst enabling more cargo to be carried, providing a major advantage for ship operators who invest in them. Crucially, it is also suggested that these ships will

not just be as safe as those with experienced crew, but even safer.

Is this the future of shipping? Do ship operators really understand how close to a reality the technology required for an unmanned ship is? Do the efficiencies and savings stack up? What broader connectivity and technology infrastructure will the first unmanned operators need? Are regulators and insurers moving fast enough to keep up with the technology? And what will unmanned ships mean for the jobs, lives and skillsets of seafarers in the future?

This high-level roundtable sought to tackle some of those issues and explore how autonomy will impact the maritime industry in the short and longer term.

Shaping a strategy for the future is a major challenge for us all and the Futurenautics roundtable series offers an opportunity for the industry to begin discussing how we do that, where others have identified and met challenges, and where more work is needed.

Those who give their time to take part are helping to drive the industry forward and we take this opportunity to thank them sincerely for doing so.





Participants

Oskar Levander, VP Innovation, Marine
K D Adamson, Futurist & CEO
Stian Ostrem
Joseph Carson, CEO
Christopher Rex, Head of Research
Alex Hjortnæs, Senior New Build Manager
Walter Hannemann, Head of Systems
Ronald Spithout, President
Roger Adamson, CEO
Marcus Lindfors, Claims Manager
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Rolls-Royce
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Wiretrap OÜ
Danish Ship Finance
DS Norden
Torm A/S
Inmarsat Maritime
Futureautics Maritime
The Swedish Club
Satellite Applications Catapult
Rolls-Royce

Autonomous Ships

When Futureautics launched its first magazine issue in October 2013 it argued that autonomous, unmanned ships—like trucks, cars or trains—were an inevitable part of our future. Futureautics' assertions were leant weight in early 2014 by Rolls-Royce's confirmation that its ship intelligence programme was working towards a prototype unmanned vessel within 4-5 years.

At that time the idea met with strong resistance, but two years on the mood in the industry has changed radically. The subject of autonomy, automation, and unmanned operation, and its other necessary cousins—Big Data, enterprise-grade connectivity and analytics—are steadily rising up the shipping and maritime agenda. It seemed appropriate therefore to focus a Futureautics roundtable on the subject of autonomous ships, and nowhere better to hold it than Rolls-Royce's technology and training centre in Aalesund—nicknamed the 'maritime silicon valley'.

The shipping and maritime industry is often characterised as being highly conservative and slow to adapt to change, particularly a change as totemic as unmanned shipping. But how accurate is that assumption? Rolls-Royce's VP Innovation for maritime Oskar Levander—the man who has become synonymous with the subject of unmanned ships and whose comments in 2014 attracted opprobrium from virtually every section of the maritime establishment—was asked for his view by roundtable Chair, futurist K D Adamson.

"I first started talking about the unmanned concept in my previous job, but it didn't create that much attention," said Oskar. "When Rolls-Royce began to push the idea the reactions were, 'no, never on my ships', but that has

The mood in the industry has changed radically with the subject of autonomy, automation and unmanned operation and its other necessary cousins Big Data, enterprise-grade connectivity and analytics, steadily rising up the shipping and maritime agenda.

completely changed today for some owners—not for all, there are still those 'no's'—but it has changed, and now there are a lot of mainstream, really big ship owners and stakeholders in the maritime industry who are really interested."

Acknowledging that the speed with which the idea appeared to be gaining acceptance had surprised her, K D Adamson asked Oskar whether he felt the same. "I am actually a little bit surprised how quickly it has changed," he confirmed. "The feedback we are getting and the interest is enormous, we get it almost daily from companies who want to be involved and do something around this, to the extent that it's a bit of a challenge for us to keep up with it all and evaluate where we want to do things." And Oskar made clear that these companies include major stakeholders.

"That's maybe the biggest surprise for me, that the Flag States are so keen to do it, because I assumed that as the authorities they may act as the brake because of concerns about rules and verification," Oskar told the group.

"The reality is that we have certain Flag States who are keen to be the first. Rather than saying we can't do it, they are telling us that they want to approve unmanned shipping if we can come up with the right technical solution to enable it." Discussion broadened to why the acceptance of unmanned operation

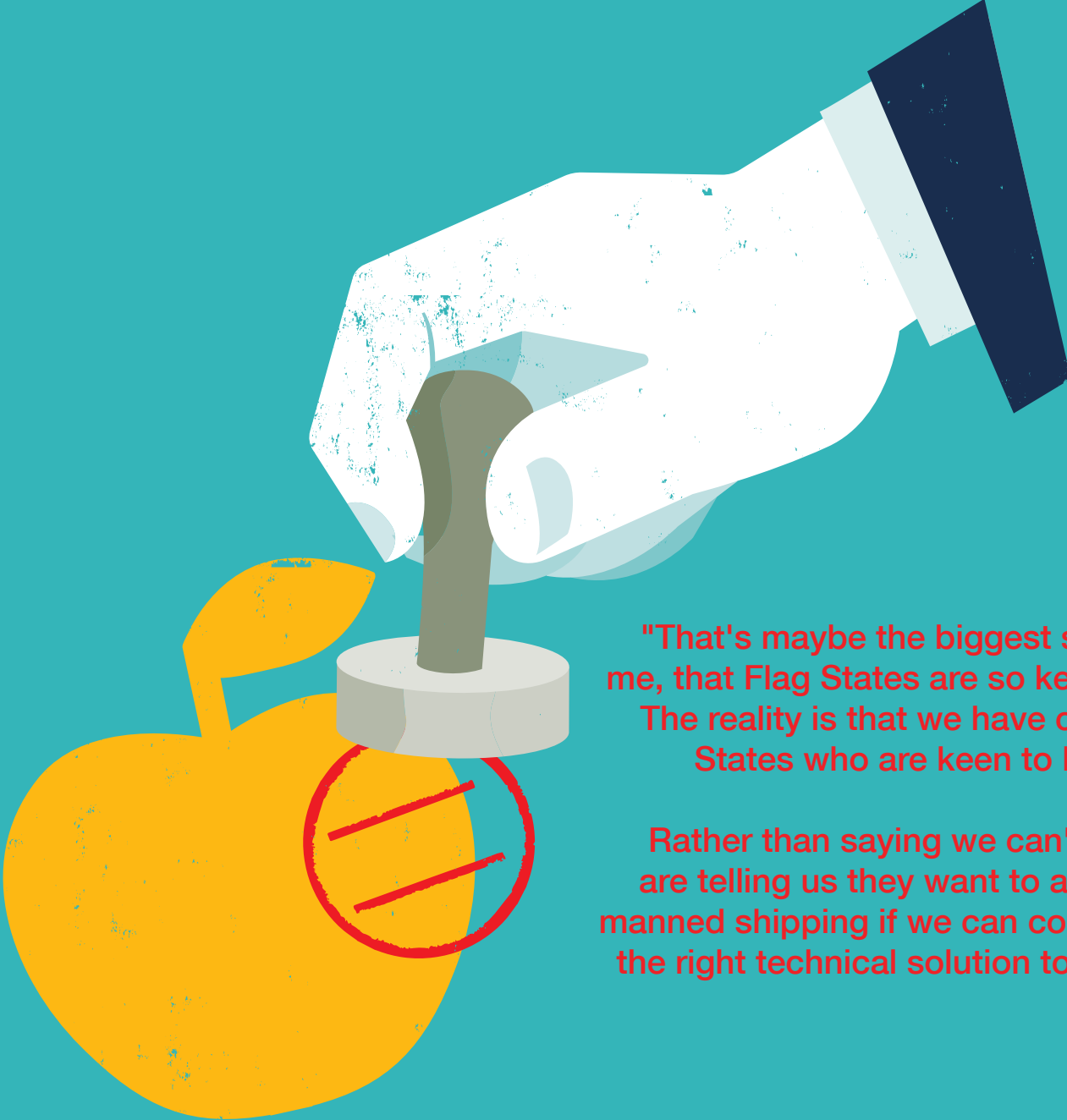
had moved so quickly. The advent of new high throughput satellite solutions such as Inmarsat's GX and Intelsat's EPIC were suggested as one driver, addressing as they did one of the traditional arguments against remote operation, namely connectivity. But for Ronald Spithout, President of Inmarsat Maritime, there was a far more fundamental driver.

"I also think it helps that very large companies like Google and Amazon are bringing the autonomous vehicle closer to the consumer, so suddenly it's in the mind of millions of people," he said.

"Whether it's a car or a plane or a vessel that's a little bit less relevant, but the fact that things are becoming autonomous in general is in the minds of the broader population."

For Ronald that momentum across society is going hand-in-hand with exponential technology development. "All kinds of technologies are reaching the right level of maturity, devices getting smaller, satellite more broadly covering the globe, higher throughput as well, so everything is coming together," Ronald pointed out, "but I think the most important thing is that people in general accept that things are becoming autonomous. And that's helping us."

More discussion identified several key challenges for unmanned shipping. Regulation is the most obvious, but no less important is both cultural ac-



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ceptance and technological feasibility. Senior New Building Manager for DS Norden, Alex Hjortnæs summed up the view of many ship operators.

"I haven't really heard that much about unmanned ships before I got this invitation, but I have to say that I don't see this happening in even the distant future, the distant future being maybe 25 years," he said. "In our bulk carriers and tankers the crews actively work on board, for example, cleaning tanks and holds during the voyage, and those tasks need to be automated before we can have an unmanned bulk carrier or a tanker vessel."

In preparation for the roundtable Alex told the group that he had asked around his Fleet department about

the feasibility of unmanned operation, and the answer he got was very clear. "They said with the engine rooms we see at the moment, the answer is no, at least not as long as we operate on heavy fuel (HFO)," said Alex.

"It might be different if we went to diesel oil, but then the cost of using diesel oil would be twice that of the crew costs, so from an economic perspective that would not be feasible, so there's a lot of development that has to take place before we can go to an unmanned ship."

Oskar Levander agreed that whilst regulations were being highlighted by many as the blocker, in fact reliability is the biggest challenge Rolls-Royce has identified. "It's not the connectivity or the

actual control systems, and it's interesting that you brought up heavy fuel because it's something MUNIN identified as a difficulty for unmanned operation," said Oskar. "I'm not so sure about that, I think you could solve it, but of course it is easier with diesel. However, a lot of these ships may have LNG in the future and that's definitely an easier fuel to handle."

Oskar went on to outline where Rolls-Royce believes that unmanned operation will most likely begin—in road ferries, tugs and coastal vessels. Firstly because approvals will be easier within one country's borders, and connectivity closer to shore is easier, but also because such ships won't require the reliability and endurance of ocean-going

deep-sea vessels like the ones operated by Alex's DS Norden, and won't be burning HFO. Giving weight to this view, several of the participants noted that both navies and civilian companies, including the US Navy and Singapore-based Zycraft, are already operating unmanned vessels in local waters.

The fragmented nature of the industry also means that unmanned operation is likely to be adopted by different sectors at different speeds, and in some sectors perhaps not for some considerable time. It may be that the public's acceptance of unmanned cargo or container ships won't extend to oil tankers for many years, for example.

Alex's comments on the economic viability of unmanned operation were picked up by Christopher Rex, Head of Research for Danish Ship Finance, "The key question we have to answer before we can proceed is what is the incentive to invest in these new technologies?" he challenged the group.

"We need to have cost savings or a significantly improved value proposition before this will take off, because in most ship segments today we see asset values which have more or less halved and a lot of ship owners are struggling with loan to value ratios. If this is going to be introduced at scale we need to find the value in it."

It was a question to which the group was to return frequently. In an industry where so much technology adoption has been driven by regulation and compliance, and where margins are wafer thin in many sectors, the value that unmanned operation might deliver is absolutely key.

And when the group began to explore where that value might lie, it became clear that the discussion needed to be far wider than regulation or culture, that a broader definition of technology was needed in shipping—and even a broader definition of shipping itself.

"In Rolls-Royce we say that what's really needed is a new philosophy when it comes to designing and creating the whole ship," said Oskar Levander.

"Today we have ships which are quite frankly prototype-like, crude things which are not designed to be as reliable as we would like them to be," he told the group to much agreement. "I am not saying that people make them poorly on purpose, it's just they are not designed and validated and tested to the degree that's possible if you mass

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produce something. We need to get into volume production of the systems on board ships, the steel hulls you can vary, but the systems that go onboard them need to be reliable. They need to be built in larger volumes so that you can really optimise them, design them and validate them and then train them throughout their lifetime so you really can have predictive maintenance and condition management to make them reliable."

It's an area in which Rolls-Royce is investing heavily, delivering condition based maintenance and engine health monitoring to allow it to predict failures well in advance. But for Futureautics Maritime CEO Roger Adamson there are deeper problems with the maritime industry's relationship to technology.

"My observation is that the shipping industry couches technology as engineering, so for most ship owners and operators technology is automatically associated with engines, pumps, maybe even vessel design, but they don't necessarily associate it with IT, communications, data, connectivity and those kinds of elements," he said.

"Is there a gap opening up now between the connectivity, control systems, algorithms available now that we could actually use to control these ships, and the engineering bit of the technology as Alex identified, which is lagging behind? What is traditionally considered technology in shipping, and what probably most of us around this table understand tech-

nology to be, are two different things."

It's an issue perhaps best illustrated by the attitudes to connectivity in shipping. A foundational requirement for the kind of 'technology' that enables digital operations, connectivity is still widely cited as being inadequate.

Indeed, the Futureautics roundtables in both Perth and Oslo saw ship operators and even Class Societies raising connectivity coverage and reliability as brakes on the development of digital operations (*download both White Papers free of charge from the Futureautics website*).

However, drilling down what's soon evident is that 'you pays your money and you takes your choice'. When asked which of the connectivity solutions lacked throughput and reliability, operators soon zeroed in on low-end, low-cost solutions, lending weight to the argument that what's required is an acceptance that connectivity is now so important to the ship operations enterprise that it needs to be enterprise-grade, and budgeted for accordingly.

The reality of the situation however is currently very different, as then Head of Systems, Technical Division at Torm Shipping, now of Dualog, Walter Hanne-mann made clear.

"This whole discussion about connectivity, in most cases connectivity is not there because people don't want it. If you do want it then it's very easy—in the company I work for we spent the last 2 years in a big infrastructure project

"In most cases the connectivity is not there because people don't want it. If you do then it's very easy. If you want to, you can do it. The problem is, who wants to talk about that in this industry?"



and we have 100% reliability in our connectivity, 100% reliability in our server and network infrastructure and a safe wireless network covering everywhere on the vessel. If you want to, you can do it," Walter assured the group. "The problem is, who wants to talk about that in this industry? Basically no one and that is a problem, we have a lack of infrastructure and worse than that, a general lack of understanding about how infrastructure should be created on board. You take delivery of brand new vessels from the yard and from an IT perspective there is nothing on board that would have been out of place in the nineteen-nineties."

Pushed by Ronald Spithout as to why that was the case Walter outlined the root of the problem, "Because no one cares about designing it from the beginning. So typically when vessels are ordered from the yard they talk about hold, engine and stuff like that but no one talks about data communications, that is an afterthought. Then someone thinks, oh, we need satellite communications, so they say OK, just install some satellite communications on board, and that doesn't even have a backup. This lack of infrastructure is because people don't want to pay for it, because they don't understand it's the gateway and don't see the value of it."

Oskar Levander wondered if what the industry was experiencing had generational roots. "Is it an older generation thing, that the people making the decisions have grown up in the world where the engine, the mechanical part was important?" he asked. "That is very much specified, they know exactly which pump they want and which filters, but this thing is something they are not familiar with so they don't specify it."

Describing the DS Norden approach Alex Hjortnæs illustrated the gulf between different ship operators, "We also specify ships that do not include an IT package, but our IT section at the office is almost as big as the fleet department," pointed out Alex.

"We specify the cables that the shipyard should install and close to delivery our IT people will go on board and establish the IT network and connect it to the different communications systems. We do have VSAT on all our vessels and we have backups for that, not a VSAT, but a FleetBroadband, and so we actually consider the IT connection and communication extremely im-

portant." As DS Norden's neighbour in Denmark, Walter Hannemann of Torm agreed entirely, but had a warning about assuming other ship operators took the same attitude.

"Alex, I totally agree but we are neighbours, we know each other, and we know we are in the very top of the industry. I am talking generally, not really on our behalf," he said. "I know we take care of those things but the vast majority do not."

Ronald Spithout reiterated his question to the group, "Why are we ordering vessels which are totally unspecified when it comes to IT?" he asked.

"Is the issue that vessels are built based on requirements and design rather than, as Oskar mentioned, being produced in the way that, say, a BMW is? I can order a BMW and have everything in it, but also I can have the BMW

specified the way I like it." It was a line of thought that prompted closer examination of the costs of building the ship itself and how unmanned operation could change them. Oskar Levander pointed out that the most obvious cost saving most people associate with unmanned shipping is removing the crew cost, but the impact would be far wider.

"Take a bulker, without crew it will use 15% less fuel, just by taking the people off," Oskar said. "No deck house means less weight, there's less energy consumption because you don't need electricity for all the accommodation spaces and all the systems, and you have smaller wind drag, so when you add that up, without modifying the ship, it's 15% saving in fuel. Not huge, but still welcome. But then you have the aspect of building cost, a ship that doesn't have crew can avoid a lot of systems on

board, you don't need water production, sewage treatment, air conditioning, ventilation, galleys, so a lot of the cost of the ship also goes out," he explained.

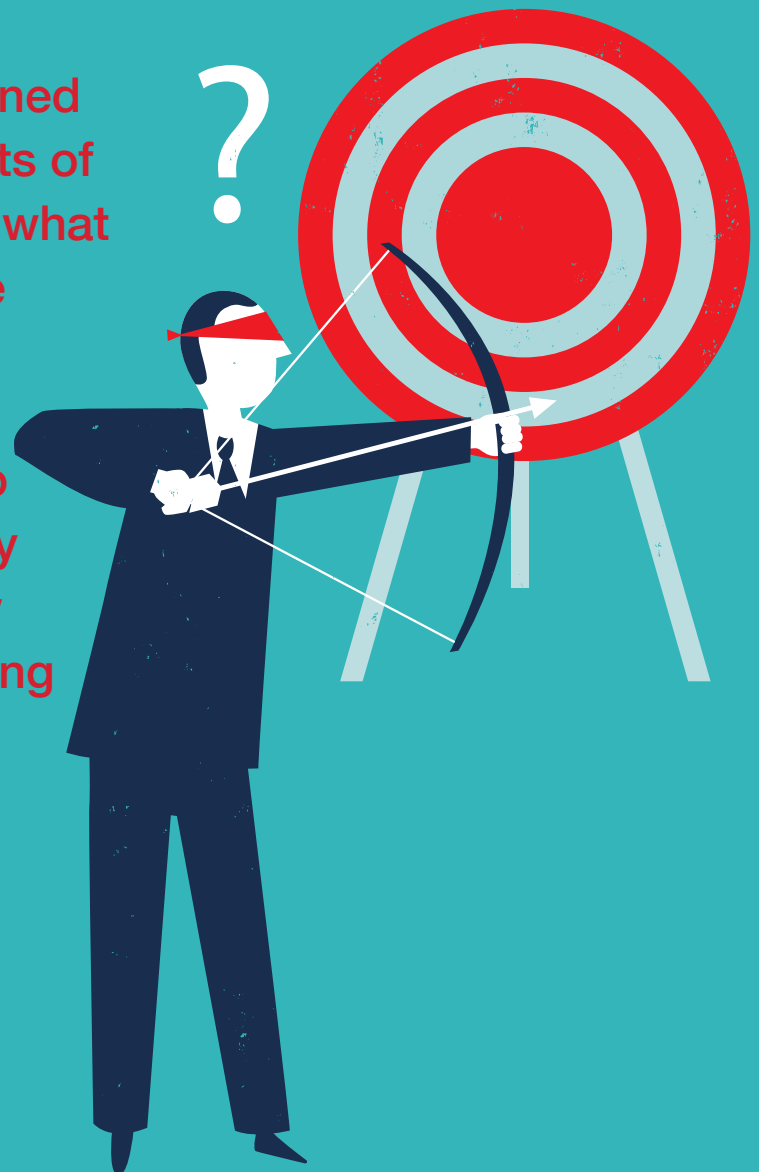
"Therefore the cost of building the unmanned ship will be cheaper than existing vessels," Oskar said, adding the caveat, "Not the first one, or the second one, but when you get this established the ships will be cheaper. So there are many different drivers for actually getting economic benefit, and that's key because without that this will never happen."

Voicing what turned out to be a widely-held opinion, Walter Hannemann told the group that, in fact, the ship, and what it costs, is only one part of the picture.

"The whole point is that there are a lot of technologies in a lot of different areas that need to move at the same time,

"Are we trying to justify unmanned operation? We could do all sorts of stuff using this technology but what we're really searching for is the value."

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"To me that's what's really interesting about autonomous ships from the customer's point of view, and I'm here to try and give that. In terms of planning the least reliable mode of transport is shipping. If you are able to introduce automation then you can have automated multi-modular planning as a consequence."

not just propulsion but much more, so I think the vessels are only a very small part of the puzzle, because we have to make sure that everything else is catering for the change," he said. "Otherwise, yeah, it's fantastic, a vessel without people on board, and there may be some intrinsic savings, but they are not enough to drive any change, any real change."

K D Adamson then posed a question to the group, "Are we trying to justify unmanned operation?" She went on to outline how a previous roundtable on Big Data had demonstrated that, "Technology can enable a competitive advantage, but technology itself isn't necessarily the advantage. What we're hearing here is, yes, we could do all sorts of stuff using this technology, but what we're really searching for is the value, we're searching for the business model that allows this technology

to give us the competitive advantage," she said. "Maybe we're concentrating too much on what's technologically possible instead of asking how we change the model of shipping to actually add value."

Ronald Spithout agreed, outlining how, for him the opportunities were far wider. "Maybe the word 'unmanned' is creating the wrong discussion," Ronald suggested. "For me it's much more the automation which is the end-goal, whether it is unmanned or not is much less relevant. I'm an electronics engineer and I just see this whole logistics question as a big system, it's a logistics question in which the vessels or the trucks are pieces in the puzzle, so I think if you make the whole system smarter, where trucks are talking to the railway, to the highways, and to the companies around it, and the traffic systems, and vessels are talking to

each other and to the harbours and to the load and offload systems, we make the whole system smarter, and the unmanned vessel is part of that. It's about getting a smart, intelligent piece of the larger logistics puzzle, and that is key, because then the whole system becomes much more efficient."

It was a view immediately seized on by Stian Ostrem, a global logistics expert and former head within Rolls-Royce's global supply chain.

"To me that's the most important part of it and what's really interesting about autonomous ships from the customer's point of view, and I'm here to try and give everyone that," he said. "In terms of planning, the least reliable mode of transport is shipping, the delivery performance from the global liners can be as low as 60 or 70%, so at best it's unpredictable. But if you are able to introduce automation then you can

have automated multi-modular planning as a consequence."

In fact reliability appears to be worsening with reports indicating the percentage can slip to around 55%, causing even more difficulties for customers. The group then explored how the Smart Ship could become an intelligent part of the logistics chain and what was necessary to make that happen, and concluded that data, connectivity and analytics are key. Unfortunately it seems that shipping is failing to hook the three things together adequately.

"We've seen new vessels coming out with a sea of new sensors, so they collect data, they provide performance data and everything like that, who uses it?" asked Walter Hannemann. "No one. And that is because it's very tricky to drive value out of that if you look at it in isolation, and that's really the problem we have in the industry. So we have a lot of smart vessels providing a lot of data that is never used, for a start because it's never sent to anyone because it's stuck on board because no one wants to use the satellite communications, and then even when it is sent somewhere it's meaningless because no one is actually able to perform the analytics to benefit from it."

Referencing Hans Ottosen, CEO of Danelec's assertion that he could deliver a 'Big Data' programme for US\$1/day, K D Adamson described how astonished ship managers listening to him were by the claim. Agreeing, Ronald, pointed out that Ottosen's next-generation VDR's achieved that by pre-qualifying data onboard before transmitting it, which required an appreciation of what data was required, for what purpose, and for what value.

"That is the key, regardless of what people pay for satellite it's negligible

compared to the operational costs of the vessel," he argued. "As long as they don't see the value they can extract by transferring that data to a point where it will all make sense then always the argument is that satellite communication is expensive, when in fact it is less than a third of a percent of the operational cost of the vessel. So that can't be the argument, it is just that they don't know what to do with it, as you say, Walter."

For Oskar Levander it came back to the value proposition—whether that was unmanned operations, or data. "That's the problem, we talk about Big Data, nobody really knows the value of Big Data," he said. "Owners sometimes say, we want Big Data—well, what is that? We need to talk about the concrete values, and forget words like Big Data, that's just an enabler to get it done."

In Oskar's view, what had to be demonstrated was how you can really improve the bottom line, "If you provide a tool to optimise operations then it should optimise revenue, both the revenue side and the cost side in total, fleet optimisation really. Where should your ships be and at what time to make the most of your fleet? That's one part, then of course you should reduce the maintenance cost of a ship by having the condition based maintenance or health management, whatever you want to call it. Now all of that is dependent on a lot of data, but what we should sell are these systems, not talk about Big Data."

Discussing where automation had impacted other transport industries cyber security expert and CEO of Wiretrap OÜ Joseph Carson cited aviation as an example.

"If you look at the airline industry it's about being able to move more people, the goal is to be more efficient, to be able to do more capacity, to do bet-

ter logistics and fuel savings," he said. Challenging that comparison though K D Adamson suggested that just looking at efficiency and fuel savings was what the industry was already doing. "Isn't that just renovation rather than innovation? That's saying, this is our business model and how do we make it more efficient, but what we need to do is disrupt that business model rather than just looking to make it more efficient."

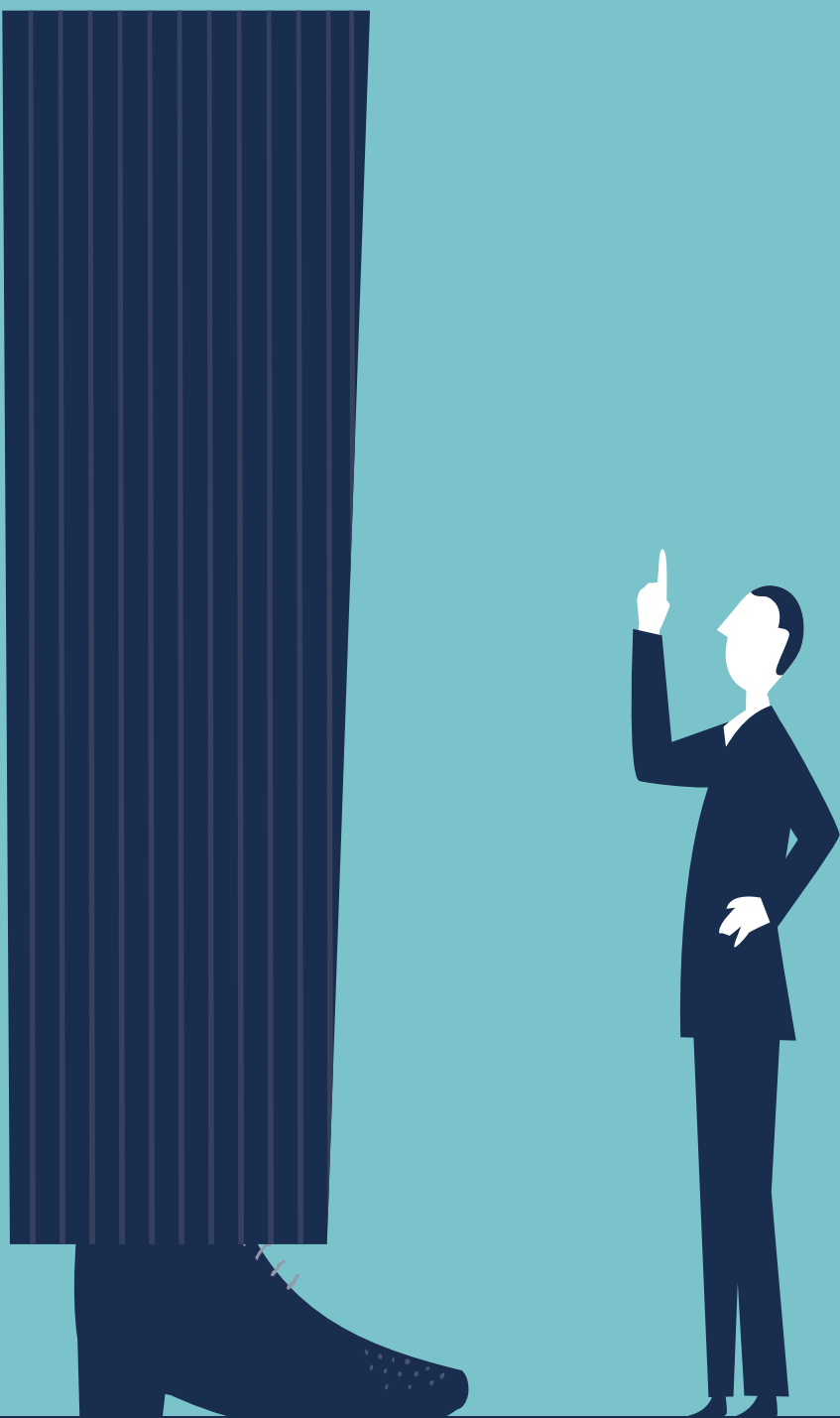
It was a view that Christopher Rex agreed with wholeheartedly from his perspective as an economist. "We are discussing technological disruption in terms of the demand outlook of yesterday," he warned. "The potential of the sharing economy, the circular economy, 3D printing—we have a lot of new trends emerging which are about to re-shape things and change the world in which shipping operates and create value in different ways."

Suggesting that what shipping had so far failed to do was to appreciate that data itself was a valuable asset, K D Adamson also pointed to structural issues within the industry which made it hard for operators to access funds for the kind of digital infrastructure investment at sea and ashore—including in data and analytics talent—that was essential. The rigid focus on asset-based lending meant that any investment which didn't materially improve the value of their ships was problematic.

"I agree that your point is particularly important," said Christopher. "We have to see data as a valuable asset, and that being a ship owner is not just about asset play, and being lucky to have your price back on your Japanese-built vessel sold at a high price. Tomorrow's vessel has to be prepared for tomorrow's economy where you need much more information, and data will be a valuable

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"If you look at the trend it's for larger and larger vessels, but is that the way to go? As a customer I see more and more cost. I read about how larger vessels are the answer to everyone's problems but actually I think that autonomous ships might drive the evolution in the opposite direction—smaller ships and more of them"



asset for us, so if you have a high-spec, connected vessel you will have a vessel that is much better suited to the new economy, no matter how many people you do—or do not—put onboard."

The operators at the table, Walter and Alex, acknowledged Christopher was right, but also pointed out how complex the priorities of operators could be. "Alex and I are in a very privileged and actually comparatively rare position within the market, because we both own our own vessels and operate them technically and commercially," said Walter. "But if we look at technical management, commercial management, owners and financing, that is a completely different scenario. Technical managers are expected to run at the lowest possible common denominator in terms of cost, and live up to the class obligations, and that's it. Then the commercial people are expected to spend the least possible amount of money and earn as much as possible. So it's very complicated because the objectives of those two areas are completely different within companies sometimes."

It was a comment reminiscent of George Hoyt of InterManager's assertion at a previous roundtable that operating beyond compliance was simply not worth it for ship operators, but for Roger Adamson it was a small part of a far more fundamental issue.

"This is coming from higher up the food chain, in that a lot of owners speculate on tonnage, that's where they make their money, they're not focussed on moving goods around or serving the customer," he said. "From their perspective, the cost-benefit analysis that I suspect a lot of them are making runs something like—if I spend a lot on my IT infrastructure does that make my asset more valuable, as a re-sale item? Or is this something that we can do without because the ship is new, it's an eco-ship, it's got an LNG engine and fuel consumption is 25% less, therefore it makes it a higher-value asset and actually, IT, technology infrastructure is only a very small part."

Stian Ostrem immediately agreed that shipping was failing to concentrate on the customers it served and ensuring it delivered the kind of service they needed. The most obvious example for Stian was the increasing size of vessels.

"If you look at the trend, it is for larger and larger vessels and we are

"Law and insurance, politics have always adjusted to technology, and we will do the same."

looking at how to solve a range of problems for these large vessels, but is large vessels the way to go?" he asked. "If you look at the vessel itself, the larger the vessel, the more cost-optimised the vessel is and the smaller operating cost you have as a ship operator, but what about the environment, the infrastructure? What about the consequence of these vessels, which have to have large ports, and for some there are only 50 who can handle them."

The urge to make the vessels larger is being driven by the ship operator's search for more efficiency and more margin, but from the customer's perspective things are very different.

"You talk about reducing the emissions on the vessel, but what about the emissions as a consequence of shipping to only larger ports?" asked Stian. "You have to haul the cargo to somewhere else, and long-haulage on land increases your CO2 emissions as a consequence. "If you take away the more typical demand and availability cost, as a customer I see more and more additional cost, they might be small costs, but if you multiply them up they are enormous, and almost impossible to question or relate to in terms of being right or wrong. You see port congestion fee, the low-tide surcharge, the high-tide surcharge, all kinds of surcharges arising as a consequence of these larger vessels. So what's really triggering me in this discussion is that I read all about how larger and larger vessels are the answer to everyone's problems, but actually I think that autonomous ships might drive the evolution in the opposite direction, smaller ships and more of them."

It's a view that even those in shipping are beginning to accept. A study by Drewry warned of the diminishing economies of scale from the new generation of megaships, and the group agreed that this could be an example of the technology enabling a new business

model that created value across the supply chain.

Approaching it from a communications paradigm Ronald Spithout made the comparison with the development of IP technology, where the original circuit switching which meant one conversation consumed the whole communications pipe, eventually became IP where all the bits of a conversation are cut into very small pieces, enabling thousands of people to use the same pipe. The development of Internet then gave rise to hubs which mean two people aren't having a direct conversation, but instead the data is being sent to the nearest technology hub and forwarded.

"You can only do that when pieces of communication are very small and the hubs are talking to each other," he said. "Now that's a communications system, but I don't see any difference with a logistics system. The bigger question is how to get these goods from China to Europe and back in the most efficient way, well maybe the answer is in many more, smaller harbours, many more smaller vessels, all autonomous and talking to each other and making sure that the handovers are more efficient. The answer may be in 20,000 smaller ships, and they can be all unmanned."

It's precisely in the development of new business models such as these that Oskar Levander sees autonomy and unmanned operation as key.

"I agree, unmanned is not the only goal here, we talk about ship intelligence in Rolls-Royce, that's what we drive, and unmanned is one part of that, but remember, there is no one right solution," he counselled the group. "If you go 30 years into the future some ships will be unmanned and some ships will have crew, less crew, there are many solutions that are right but the interesting thing is that this new technology offers these disruptive opportunities to change the business model. If you don't have crew on board a ship you might be

able to drive slower, you might be able to have a totally different set up of your ships, instead of having one big one we have many small ones that go slowly, just for example, but we have to keep in mind that shipping is not uniform."

Ronald Spithout summed up the feelings of several around the table, "For me personally, this is a very exciting journey, because I think the journey itself is more interesting than getting the people off the vessel, the goal is to have a smart vessel."

Smart Ships are becoming a buzzphrase in shipping, but scratch the surface and there is a lack of understanding amongst many of the industry's stakeholders about what that really means.

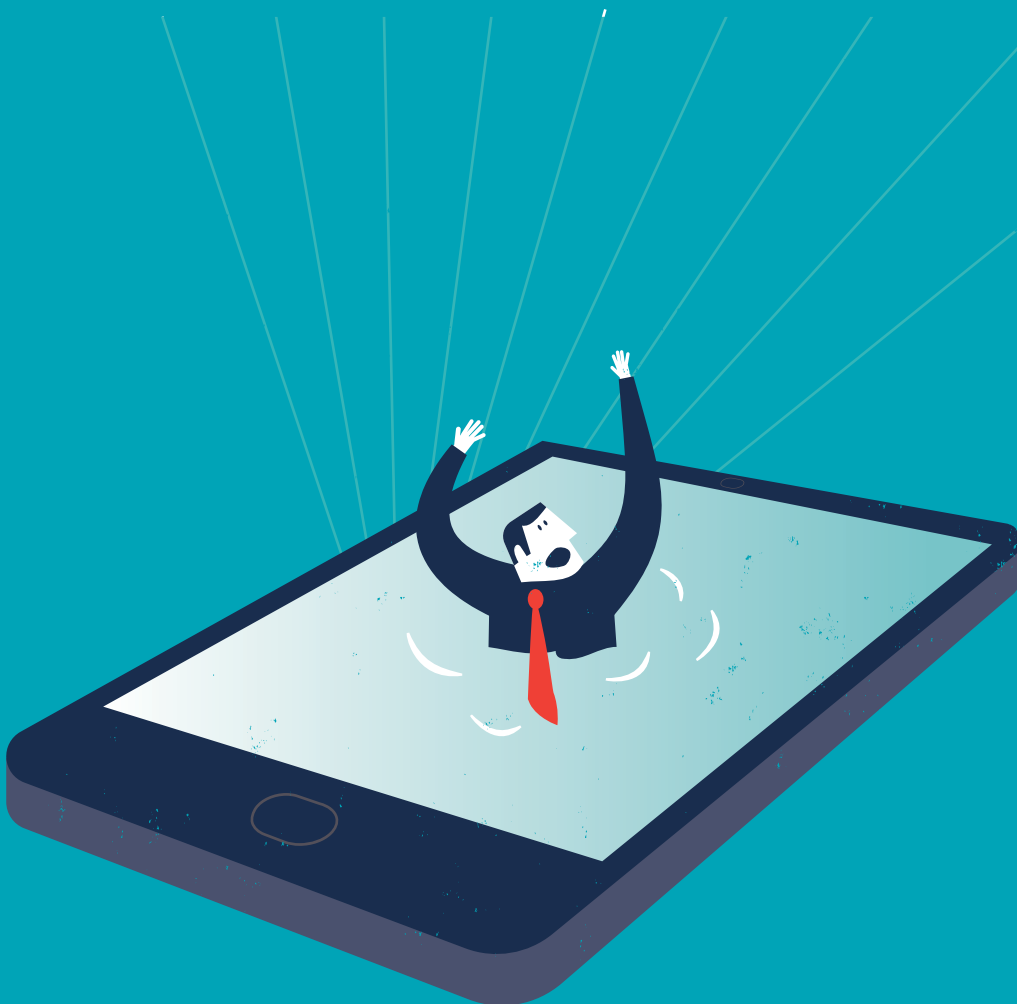
One grey area is the difference between a remote controlled ship and an autonomous ship. Providing enterprise-grade connectivity is available, a ship could be remote controlled from shore in most respects today, but autonomy is something different. Autonomy means a ship which doesn't simply move around without people required to be aboard, it means a ship that is actually capable of thinking for itself, and making decisions based on the data it's received and the parameters it's been ordered to operate within.

That differentiation is often glossed over, but from a legal and insurance perspective it's a crucial one.

For an insurer or regulator, as long as a human being is controlling the ship there is a responsible party, but autonomy brings up some difficult questions. They are no more difficult than those facing other autonomous vehicles, but given the highly regulated nature of the shipping industry, many have claimed that they could severely impact the development of autonomous ships.

Considering those arguments, some of the participants in Aalesund may have been slightly surprised by the reaction of Marcus Lindfors, Claims Manager for P&I club the Swedish Club.

"Is what we really need to be managing in maritime the move from seafarer to operator?"



"Innovation and technology has always been the way forward, for the last 4000 years the human mind has always been driven to find new inventions, that's why we're so successful as humans," said Marcus. "Law, insurance, politics have always followed technology, whether it has been railways, trains, cars, mobile phones, satellites, there's always been a battle for maybe 5 or 10 years, because ground breaking technology needs to be adopted into society, but law and insurance, politics have always adjusted to technology, and we will do the same."

Asked by K D Adamson whether autonomous ships are really on the marine insurance industry's radar, Marcus was clear. "Absolutely, we discussed this and we are happy with it," he confirmed. "80% of all insurance casualties are related to human handling—not human errors, but human handling. So we are very happy with this, especially navigation and communications, but maintenance is a concern," Marcus warned. "A capesize spends 98% of its time at sea and that's when the maintenance takes place, so who's going to invest 80 million dollars in a brand new ship and then give it to someone who won't be maintaining it? That, I think is the biggest challenge, to have systems that can maintain themselves. This may sound really sci-fi technology, but what you want is ships that have the technology to maintain themselves," he added.

In fact, as with so many things, intelligent, self-healing materials are just one area of exponentially growing technology competence which could indeed be delivering assets which maintain themselves and their components at a nanotechnology level in the comparatively near future. But until then Marcus was aligned with Alex's concerns. "I mean, you know this much better than I do, Alex, you're knocking rust every day on ships, and the engine room of a capesize ship is just stacked with things that spin and move and pump, so I think we will see small units like in the fjords here, moving goods autonomously within 5 or 10 years, but the bigger vessels we need different solutions for."

But as Roger Adamson pointed out, with smaller fleets of autonomous ships maintenance could easily move to ports, with larger fleets enabling a ship to be scheduled to come out of service for port maintenance as part of the smart logistics chain. It's a vision

that Oskar also shared, pointing out that when unmanned operation is discussed what is often missed is the fact that engineers will still be needed, but just no longer on the ship for long periods.

It was a subject Futurenautics covered in a recent issue, reporting on the project mining giant Rio Tinto undertook in Australia as part of its 'Mine of the Future', programme. The company has introduced autonomous trucks and even the world's first autonomous railway in order to improve efficiency.

"To me, anyway, Rio Tinto is an example of where, instead of searching for answers in the marine industry we need to be open to looking at other industries and seeing what's been implemented there," said K D. Rio Tinto had a similar operating environment, harsh and dangerous, long periods away from home, driving large trucks, and what they've done is take those people and put them into a very comfortable operations centre in Perth, where the people who were drivers have become operators. Is that what we really need to be managing in maritime? The move from seafarer to operator?"

"That's what I took from your article," agreed Ronald Spithout. "The people are better employed, making more money even, and there aren't necessarily less people than before, but the reason it was so successful is because they took the whole chain. It was not only the trucks for the mine but also the transport system around it, the trains even, the loading of the vessels, so the whole chain of logistics was covered by that."

For Rear Admiral Nick Lambert, now an independent satellite consultant for the UK Satellite Applications Catapult, the state of manning in the merchant fleet was already getting close to untenable today, and the potential of automation had already been proved.

"I would argue that ships are pretty much unmanned now, and that's be-

cause of the way the market forces have gone," Nick contended. "You've got these enormous ships with 10-12 people on board, officer of the watch goes off for a call of nature, and it's an unmanned ship. Plus it's already largely automated, because for a long time we've been trying to drive out manpower costs. The result is that we have less well-trained people from all sorts of different countries with language barriers and all the problems of teamwork and leadership that go with it. So we've made operating ships with people inherently difficult, but we have demonstrated that we can automate very heavily, so I don't think it's actually a very great step to autonomy once you overcome some of the technology and resilience issues."

Nick's comments prompted a discussion around manning levels in different sectors which identified that whilst in the container sector it could be argued there is under-manning, in other sectors such as tugs, the vessels are massively overmanned. The group then began to address the widely-held belief that unmanned operation would be inherently less safe. With over 80% of accidents caused by what Marcus described as 'human handling', the suggestion was made that an autonomous unmanned vessel could actually be 30% less safe and still cut accident rates by 50%. As automation improves will it soon be less safe to put a human on a ship than to have the systems control themselves?

"The statistics from Google's autonomous self-driving car in the last 4 or 5 years of operation show that the 11 accidents it's had were caused by human error, when the human intervened with the technology to try and override it," explained Joseph Carson. "The primary cause of those accidents was the human overriding the system. And it's also worth realising that 60% of cyber breaches last year were also caused by human error."

For Oskar Levander, when a fully functioning autonomous system is ready and deployed then the unmanned ship should be safer, "We need to remember who the people injured in marine accidents, are—they are the crew," Oskar reminded the group. "So if we can remove them from the dangerous areas, like we do already—avoiding having people on the deck of an anchor handler because it's just not the safest place to be when you're doing one of these manoeuvres—then the better it will be."

Marcus echoed Oskar's view pointing out that the 1950s and 1960s had seen perhaps 30 men running around shifting drilling pipes on the deck of the rigs. "There were so many people dead and injured, crushed on the deck, but today you can drill in the Arctic, sitting safely in a little sealed booth drinking coffee, with a joystick, where the temperature is 27 degrees," he said. "Huge, huge savings in terms of manpower costs, but more importantly in suffering."

Discussion turned to the current rate of accidents and Marcus was able to give the group his latest figures which indicated that, "40% of the payouts from insurance are related to injuries, illness and deaths. "80% is man controlled, or man-made accidents," said Marcus. "But that may be a pilot, it may be a tug."

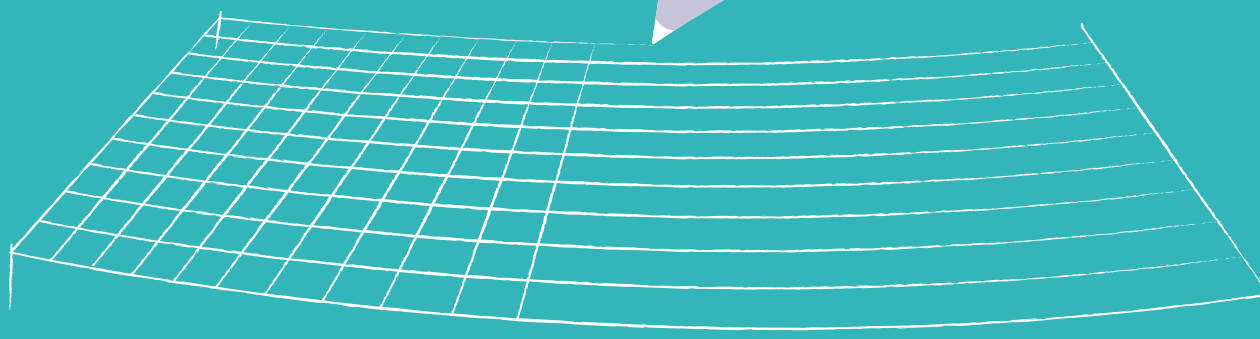
As discussion turned to the quality of training and its impact on the accident and injury rates K D Adamson described conversations with several large ship operators who felt that, despite the large sums of money spent on training and safety, improvements in those rates had plateaued and finding more was proving extremely difficult.

For his part Alex Hjortnæs felt that DS Norden were still seeing improvements, but there was broad agreement within the group with Marcus Lindfors' sentiments. "We know why accidents happen, it's all about loss prevention," Marcus said. "But you can work yourself

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"You can work yourself to death with loss prevention in the ship environment, but in the end we have to accept an element of risk."



to death with loss prevention in the ship environment, you can spend all your time trying to prevent, but in the end we have to accept an element of risk."

An element of risk, yes, but 80% seems unsustainable, particularly in the context of autonomous systems which have the potential to operate at 99% reliability. But things aren't that simple. As Oskar Levander was careful to point out, unmanned, autonomous systems should represent a safer alternative in the context of the current types of accidents, but that doesn't mean other problems might not arise, things which currently haven't been anticipated.

Whilst Nick Lambert acknowledged that technology will generally drive safety, it's a double-edged sword. "What you end up doing is moving the accident to somewhere else," he reflected. "So if you look through the growth of technology at sea we started off with radio assisted collisions, then

we had GPS assisted collisions, now we're having ECDIS assisted collisions because—in my view—we have driven down the quality and volume of training, and as we go into this world of greater automation with fewer people on ships that's going to present a problem."

Taking a slightly different view, Alex Hjortnæs reminded the group that crew onboard may not only be contributing to accidents. "I think in talking about 80% of all accidents caused by human error we should not forget the fact that humans also fix errors, mechanical errors that are on board, and that would be something that we couldn't do on an autonomous ships."

It's an interesting point and one which the industry hasn't really quantified. K D Adamson compared it to the risk departments in banks which aim to stop traders taking dangerous positions. "It's very difficult to demonstrate your value when all you've done is stop

the situation being worse than it would have been had you not been there," she said. "And maybe that's a bit what we have with crew at the moment, maybe it's very easy to see when crew do things that cause accidents, but it's not so easy to see where crew do things that save the day. Perhaps that's something we really need to look at more closely as we automate vessels, understanding exactly where the value of the crew really is. It strikes me that could be a fascinating and very valuable Big Data exercise."

But in order to come to any conclusions accurate data is essential, and, as the group all agreed, the transparency of data provided within the industry—by crew and operators—leaves much to be desired. There were several stark examples of crew 'massaging' data before it was sent ashore and the noon-day reports were described as often being 'a work of fiction'. It's



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a sentiment that's been expressed by many ship operators and suppliers off the record, frustrated that crews are reluctant to have data collected directly from equipment and sent ashore, preferring to intercept the data themselves and perhaps translate it into something more palatable before transmitting it ashore.

It may be a controversial point, but it has huge significance in terms of the development of the Smart Ship. Smart Ships by definition should be talking directly to a range of stakeholders ashore, rather than their data being filtered through the crew. But it's a difficult path to tread when the danger for operators is alienating the crews they've spent so much time and energy training and retaining. Is the message to crew—we value you, but we're going to circumvent you with technology because on one level at least we don't trust you, and on another, the technology does it better?

At an earlier roundtable Tony Field of Lloyd's Register made the point that it was essential in any technology deployment to take the crew with you, otherwise failure was inevitable. Oskar felt

it was all about putting the argument in the correct terms for seafarers.

"In terms of the sensor and reporting data on the ship, you should sell it to the crew, that now you do not need to do this manually, we will solve this for you, because I don't think the crew like any kind of bureaucracy or report burden," suggested Oskar. "But to tell them that we can do your job better? Operating the ship is at the core of what they do, and that is a little bit more tricky."

The group considered whether the idea of having mass buy-in from crew was outdated, and these innovations just needed to be pushed through, or whether there was a real issue about cultural sensitivity, and a lack of technology-savvy within the maritime industry which had to be addressed.

"That's a really interesting one because I've spoken many times to lots of bearded, crusty master mariners and I always ask them, how many people in this room haven't got a smartphone, or a PC and no one puts their hand up," said Nick Lambert. "They're all using the technology shoreside and they all see some benefit in using it day to day,

so I think the trick is to understand why they make these decisions not to install stuff in ships, and I think it's cost. I think it's purely and simply that they don't yet know the value of having data at sea, it's as simple as that, and once they understand the value, that's uncorking it."

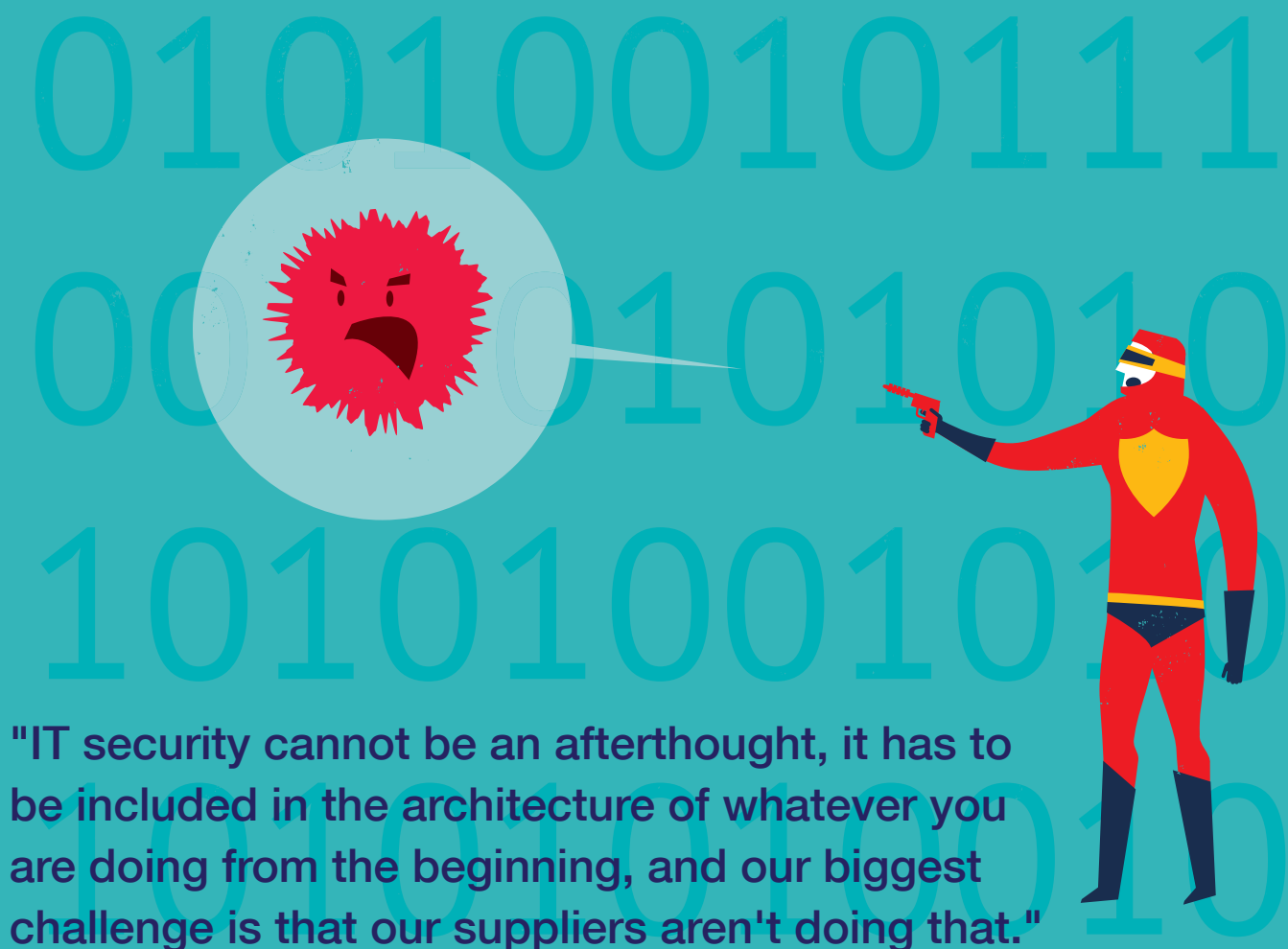
But giving the customer's take on things, Stian Ostrem didn't pull any punches. "My experience working with most shipping companies and logistics service providers is that actually they don't want the transparency. There are too many potential benefits in keeping this as contained as possible. Maybe they say yes to having smartphones, PCs, online customer portals and whatever, but I'm not sure they understand, or at least are willing to share, the value of the transparency that these things might generate. Or perhaps they are afraid of what it might bring?"

It's a charge that many have made before about the shipping industry, often couched in terms like 'conservative', but perhaps the reality everyone has to start acknowledging is that—as provocative as it might sound—shipping doesn't necessarily want people knowing what it's doing.



Instead of just focussing on the cheapest rates do charterers need to reassess what they want from shipping as part of their supply chains, and start looking for value propositions?





"IT security cannot be an afterthought, it has to be included in the architecture of whatever you are doing from the beginning, and our biggest challenge is that our suppliers aren't doing that."

"Transparency is complicated," said Walter Hannemann. "It starts from each unique vessel that is not transparent towards the charter party, or the technical party has different objectives. The funny thing is that all this transparency—or the lack of it—is supposed to protect their earnings. But as everyone's losing money, it's obviously not working. I think we need a real change in mindset when it comes to transparency because doing it this way doesn't work."

But speaking to other ship operators, the dangers of transparency are very real. Examples of charterers who will put the ship off-hire because it is fulfilling its MLC obligations are widespread. But on a more basic level, as Alex Hjortnæs emphasised, if things become cheaper and more efficient the fear is that charterers will then just drive rates down.

So is what's necessary not just a change in mindset from ship operators but from charterers too? Instead of just focussing on the cheapest rates, do charterers need to reassess what they want from shipping as part of their supply chains, and to start looking for value

propositions from ship operators as opposed to just cheap rates?

"I think so," agreed Stian, "and I think that unmanned ships is just a part of the equation about transparency. We also need co-operation and collaboration, but you're not talking to us." Asked whether charterers are responsible for the increasing size of ships because of their focus on cheaper rates, Stian accepted a degree of responsibility, "Well, I am creating the demand in a way because I am always asking what's the cost of shipping this from A to B, but then I have to factor into the price I am paying that I will get perhaps 60% reliability and no consistency."

Joseph Carson took the discussion back to the Rio Tinto example, a project in which he had been involved on the data side. "One of the biggest efficiencies that was gained from that was consistency, and every vehicle now operates at the same speed at a certain location, everything's predictable, there are no human interventions, it's all consistent, it flows, like clockwork," he explained. "And that's where you gain a lot of efficiencies and a lot of improve-

ments."

In fact, as Oskar Levander pointed out, automatic cargo handling had been demonstrated in the maritime industry more than ten years ago, but his take on Stian's issues as a customer was an interesting one. "Looking at a big container vessel, 20,000 TEU, perhaps 15,000 in practice on the ship, that's too many," he said. "15,000 loads is too high, the cargo unit is too small, what we need is a new cargo unit in the world, but it's hard to introduce that into society because of the existing road and rail networks. The point is that we have already outgrown the current container."

But if a larger cargo unit wasn't an immediate option, for Stian Ostrem the technologies underpinning the autonomous, smart vessel certainly could be game-changing.

"For example, one of the reasons you can't really utilise short-sea shipping is because there isn't enough vessel availability. So what if deep sea vessels were being built smaller so they could manoeuvre in more shallow water and smaller ports, with the appropriate technology on board to create the

"I was shocked at the number of systems that were old, not updated, that had open ports I could have connected a USB stick into and didn't ask for any kind of authentication."

transparency you need as a customer to be able to utilise the full range—not just the deep-sea shipping part, but all of it?" he asked the group.

Stian went on to describe how in major ports like Singapore acres of containers are stacked, about which the shipping company or the logistics service providers have little knowledge—in terms of ownership, contents, or the required delivery time.

"One of the larger vessels takes for example 6 weeks, and onboard you have goods with lead times ranging from 4 to 8 weeks, so eventually something is going to be delivered too early or too late," he said. "Now what if the ship was intelligent, what if it knew what was onboard and what the situation with port congestion was, so it knew when to increase and decrease speed in order to arrive on time, instead of just turning up and waiting and passing the cost onto the customer? I think if you start asking all of these questions in a broader aspect, the answer may not necessarily be in unmanned ships but these intelligent ships, and connectivity, we need connectivity."

That our customers expect the kind of connectivity that they access in every other area of their logistics chains shouldn't surprise us, and there really aren't good reasons any longer, as Walter Hannemann described, for ship operators not to have proper connectivity and infrastructure onboard. But for all the manifest positive aspects of connectivity and the digital operations it enables, there are also downside risks which have to be managed. Cyber security is essential, but former Symantec executive and cyber security expert Joseph Carson says the industry is, "Absolutely underprepared, it's actually quite scary."

Some of the first vulnerability assessments Joseph did in the maritime industry were an indication of deeper

problems. "I was shocked at the number of systems that were old, not updated, that had open ports I could have connected a USB stick into and didn't ask for any kind of authentication," he told the group. "They were just open systems I could plug anything into. Even last week at a tradeshow when I went around looking at different companies' products, I was seeing old versions of operating systems—and this is new technology which is completely vulnerable. A device which is measuring fuel efficiency has USB ports all over the front of it. In the security industry we're unplugging those because we know the risks of exposing them, we know the risks of putting them in a location where somebody could go and plug in a phone, or an e-cigar or something to charge a device and upload malware."

It's precisely that type of security breach which has already taken place in the shipping industry. The first ever maritime cyber security survey conducted by Futurenautics Intelligence found that 88% of a sample of 3000 crew had not had any cyber awareness training. 43% said they'd sailed on a vessel that had experienced a cyber breach, whilst 61% of board level executives in ship operators and maritime suppliers said they believed they'd had an undetected breach in their system in the last twelve months. Of those—frighteningly—only 36% said that they considered cyber security implications as part of a risk assessment.

For Walter Hannemann it was suppliers failing to build security development lifecycles for their products, or even in some cases the most basic security features, which worried him.

"IT security cannot be an afterthought, it has to be included in the architecture of whatever you are doing, you need to include that from the very beginning, and our biggest challenge is that our suppliers aren't doing that,"

he warned. Giving a concrete example of a laptop designated to run the main engine of a vessel which was delivered with instructions not to connect it to the network, but which had no anti-virus, and no firewall, Walter explained, "I had to go to these guys and say, you are completely divorced from reality because you are simply not taking our security seriously. The point is that there is a total lack of understanding of IT and IT security from some suppliers, and it's not even visible to most IT departments in the industry that they have this huge vulnerability on board."

It's a major issue and one which could potentially act as a brake on the development of the Smart Ship, the autonomous ship, and the applications that companies like Inmarsat are trying to deliver as part of its GX platform for use at sea. How do we broaden the opportunities for products and services to be delivered to ships, but at the same time educate those that are developing them that the environment on the ship is not like the environment in an office, and make them safe and reliable?

"We started developer conferences and there are hundreds of people who are building maritime applications coming to us, so the developer conference is just one of the means to get more applications at sea," explained Ronald Spithout.

"But it's also forming part of the Certified Applications Programme, where we are opening our network on an applications level utilising a Cisco programme inbetween the satellite network and the end-user. It gives developers an applications interface and the goal is to make the application more reliable—essentially you know that if you have a certified Inmarsat application on board it will work reliably over the satellite links. Because a lot of the applications are not optimised for satellite at all, let alone cyber security, and

the reliability of the application is key if it's mission critical."

Asked his view of the cyber threat to unmanned vessels Oskar Levander pointed to the fact that the autonomous vessel would deal with cyber security on a different kind of level due to there being no requirement for human access on board. "In Rolls-Royce we have extensive knowledge from the aerospace side and there is a lot of cyber security expertise we access which is crucial for building up our marine systems," explained Oskar. "What I understand is that we can prevent them getting into the system, but the jamming issue is a trickier thing."

However Joseph Carson took issue with that view, "Most of the intent today has been from financial gain both internal and external, supply chain, financial fraud, criminal organisations," he said. "Cyber crime is a \$1 trillion business, but then you get terrorism activities which is about manipulating the data for transportation of illegal goods, that's a big threat, lot of ships, and containers don't really understand what they're carrying in many cases, and we could be seeing more of that."

Joseph went onto explain the latest thinking in cyber defence and how distributed systems were the key. "Distributed systems are a good way of cyber prevention at least from a service perspective, because the more you distribute yourself, the more difficult a target and more unpredictable you become," Joseph told the group. "That's where some of the cyber defences come into play, so I get concerned when I hear about a lot of centralisation in the industry."

But it's a complex problem and one which speaks to the digital maturity of the industry. A clear message from ship managers at a previous roundtable was that no one had the time to go around and 'package up' all the digital and connectivity suppliers. What ship managers want is for suppliers to do that for them, providing end-to-end services and solutions, preferably those which include connectivity as part of the package.

In an industry where digital competence and infrastructure is lagging others, distributed systems may actually present added danger. Both the major maritime network operators Intelsat and Inmarsat put cyber security at the heart of their businesses, Intelsat recently underwent a Service Organisation Control

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3 (SOC3) review of security controls, validating the security of its environment, and Inmarsat has spent £1.5 billion building its global coverage system with 3 highly secured double teleports. Both have encouraged ship operators to connect their vessels and have a clear responsibility to secure the link, but do they also have a responsibility to educate their customers about the importance of cyber security?

"From the beginning Inmarsat spent a lot of time and energy doubling all our systems, and so far the main driver for that was safety at sea, but whether it is safety or [cyber] security, these are two sides of the same coin, so that is now an added driver," explained Ronald. "So yes, we are definitely taking a higher profile on cyber security, which goes in fact beyond the communication links provided. We can keep the link and applications safe, but that alone is not giving you cyber security, as you say it needs to be an integrated part of the IT strategy of the company."

Listening to the discussion K D Admson reflected that what was really

emerging once again was the transition of IT from cost centre to strategic enabler.

"We say that IT is no longer a functional silo, IT is a strategic activity and today really does put that into context," she said. "What you do with your IT systems is not necessarily about making sure someone can fire up a laptop or get online, it's actually strategically about the future stability, health, competitiveness etc. of your business and cyber is a constituent part of that."

Developing that competency and the ability to qualify and certify the actors we use in our supply chains is only going to become more critical, but the sense from the group was that shipping was likely to find that more of a challenge than other industries. "For the land-based big organisations like Inmarsat, IT is a subject of board level and executive discussion on a very, very regular basis, but I'm not sure if that is commonplace in the shipping industry," reflected Ronald Spithout.

From Stian Ostrem's perspective there was a far broader issue though,

"Listening to this about centralisation and security, we should remember that disruptions in the supply chain is the factor that has the highest impact on the stock market value, the share price of a company," he said. "When you listen to Joseph talk about the risk of centralisation in terms of security, then you think about the development towards more centralised harbours, larger ports, larger vessels—I'm thinking, this is not exactly going in the right direction is it?"

It was a remark which prompted considerable laughter around the table, but also a serious evaluation of how that current direction of travel could be addressed. Nick Lambert was clear about what he wanted to see. "I agree with Kate's question, what are we trying to achieve here?" he said. "Are we trying to achieve an unmanned ship just to show we can do it, and all the things that Oskar has described, or are we trying to be disruptive across several sectors—what's the opportunity?"

In Nick's view the opportunity was to look more broadly at the whole business of transmodal logistics, and his

vision was to see some sort of demonstration ecosystem which integrated the disparate elements and showed how value could be driven right through the supply chain.

"What I have in my mind is a sort of demonstration ecosystem, because we don't yet have an amazing relationship between the people who run ships from shore and the people who run ships at sea and they tend to rub up against each other only if they're lucky," he said. "So I would like to suggest that we do something in a complex sea space like the North Sea using a port like Rotterdam, an autonomous vessel and road hauliers, so you could think about that linkage between operations at sea and operations ashore, and demonstrate that you could do something about the bottom line, drive value into it."

But more than that Nick felt that the maritime industry was missing an opportunity when it came to the development of autonomy—that the industry should be creating its own version of the Google car—a concrete example of autonomy in action which could be sailed around the world. But as Anette Bonnevie Wollebæk pointed out, Rolls-Royce is in the process of creating exactly that.

"Wait and see," she promised Nick. "We are doing it," going on to explain that the project on which Rolls-Royce and Inmarsat were collaborating aimed to develop just that kind of prototype as an output. Whether or not it will eventually put to sea on the kind of global grand tour Nick described isn't certain, but the underlying objective is in line with his thinking. Urged by Nick to push ahead with the project as fast as possible, Oskar Levander agreed that such a concrete example was what the industry needed, and that it was important for the partners involved to be the first to deliver that. "But if we want to be the first to do it then we have to move now."

The project will give vital insight into the type of applications that ship operators are going to want and need to deploy in the future which makes it a really interesting project for Ronald Spithout. "As a technology partner to the project, for us it's important to understand which applications will really feed the bottom line improvements for ship managers and ship owners going forward," said Ronald. "At Inmarsat we call ourselves an enabler of innovations and solutions but to continually deliver that we need

to be able to identify which applications are going to be key and help to make them possible, either with the communications link itself, or with an application link. But for us, being the enabler of this kind of innovation from a communications point of view is very important—it helps us to target our effort, so that's why we're in."

Discussing the idea of a demonstration ecosystem which could allow the industry to develop autonomy in a 'sandbox', learning how to mitigate risks, integrate the maritime and land-based logistics chain, and even examine new business models, the group agreed it was an intriguing concept.

But as Nick Lambert pointed out, "It's going to require some sort of money in to build the demonstrator, and find the value to then extrapolate into the wider sector, it's not going to be done because someone immediately sees value in it

and therefore puts money in it."

With so much of shipping struggling to turn a profit and the plethora of development projects and initiatives trialing every kind of maritime technology around the world, where is that money likely to come from though? In K D Adamson's opinion there's a much more likely scenario. "Or, you're going to get a highly disruptive start-up look at all this, pile into shipping, wipe a lot of people aside, and just do it," she warned the group.

Joseph Carson agreed, suggesting that what was on the horizon was an 'Apple of shipping', but whether or not every participant agreed with that thought, Ronald Spithout's sentiments were held by everyone. "What is for sure is that this is only just getting started."

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"Or, you're going to get a highly disruptive start-up look at all this, pile into shipping, wipe a lot of people aside, and just do it."



Key Takeaways

"It must have been a really good discussion because I am leaving with more questions than I had before I came in.

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The theme of the morning's discussion had been the autonomous or unmanned ship, but the ground the group had covered in reality was far larger. As the man known as 'Mr Unmanned Ships', one might have perhaps anticipated Oskar Levander would have had the least to gain from the discussions, but still found some useful intelligence to take away. "A lot of these things have been discussed before, but for me maybe the new things that I will takeaway is the advantage of distribution," said Oskar. "I liked your comments there, Joseph, so that's something that I think we will have a little bit of a think about, how we can apply it in different aspects and in different areas."

Acknowledging—to much laughter—that finding something he could take back and implement that afternoon in the office would be a challenge, Stian Ostrem did focus down on how broad the impact of autonomy will be, and the positive change it could drive. "It's been very interesting because I think there's some sort of step-change needed," he said. "Large changes are now required but too often when you read articles about this the customer is never mentioned, so it's really good to be here representing customers. It seems a little abstract to talk about the autonomous ship, but it is coming in small steps but what it brings with it, for example in terms of transparency, whether the industry likes it or not, that will happen."

Whilst agreeing with Stian that discussing the autonomous or unmanned ship was quite abstract, Christopher Rex took away a strong sense of the potential of autonomy, ship intelligence and cyber security to enable new types of ships. "My head is filled with the kind of changes across the industry that could drive, from new kinds of ships to new kinds of business models," he said. "It has been really valuable to talk in those highly strategic terms."

Joseph Carson too found the strategic discussion of value. "I've found it very useful, particularly from a security perspective," he said. "I'm always thinking about confidentiality, security, availability, insurance of systems, and some of the comments today I'll take back and research in more detail, they will inform the way we approach our services."

As one of the ship operators in the

group Alex Hjortnæs began the session knowing little on the subject, by his own admission. By the end though, his takeaway was the need for a demonstration autonomous vessel. "I'm a practical guy, I would find it interesting if we could establish a project for designing the driving part of the vessel for a commercial vessel, to see how it would look in an unmanned version," he said. "Identify all the systems that we could do away with, simplify the rest, and make it sufficiently reliable to be able to operate at least six weeks without any stops. To see what that would look like, and even better have a shipyard tell us how much this would cost—if the savings of 15% together with reduced build and operating costs in addition might really make it feasible for a ship operator to go into this, that would be a really interesting project. I'm not sure I see this in the very near future, because I'm not sure we're ready to do it, but listening to the discussion today I think it would be a very beneficial project."

Fellow ship operator Walter Hanne-mann had a broader takeaway. "It's clear to me that we cannot do it alone, you cannot develop an unmanned ship just because you want to," said Walter. "Of course, technically speaking you can, but it will only be feasible if a lot of other actors are working in concert with you. It starts with the cultural changes that we need in our own back yard, and then the value chain that we have to sell, it's in a lot of places, but I totally agree with Oskar that the 15% is only a small part of the potential value, that's only fuel savings," Walter pointed out. "The greater value still will be when the whole thing is optimised, and we should look to that as the goal, the lighthouse if you like, but there will be so many technologies and processes and methods necessary to get there, and they will spin off a lot of other different things that will be really valuable, way before we reach that ultimate goal of the lighthouse. Those building blocks of technology could stack up to make the industry look very different in the future and give huge benefit well before IMO finally say, okay, you can sail your ships unmanned."

Which picked up on the comments made by Inmarsat's Ronald Spithout at the outset, that what the industry was embarking on was a journey and that—in the words of the old adage—it is sometimes better to travel than to

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arrive. In the same way that the space race delivered products like WD40 to the general public, the kind of benefits that will fall out from the development of autonomy and ship intelligence along the way could be game-changing in themselves.

"There will be all sorts of spin-offs on the way that benefit the industry," said Ronald, agreeing with Walter's point. "I think my main takeaway from today is that it must have been a really good discussion, because I am leaving with more questions than I had before I came in," said Ronald, to much agreement around the table. "That's great because it broadens the horizons and challenges our minds. I also takeaway that as we step on this journey towards the smart vessel, rather than only focussing on the communications within the company, or the management company, or the owners it places the vessel within a smarter community, where the whole infrastructure is getting smarter and more efficient. That raises the question, what exactly does it take to make that vessel smarter, and I don't know that, that has to come as part of the journey. But out of all those hundreds of applications developers who want to have their applications certified by Inmarsat, maybe there are one or two that really do make the vessel smarter than it is today, give that step-change. But which one of them that's going to be I really don't know yet, so it's been very valuable today, and I leave with more questions than answers."

Marcus Lindfors agreed wholeheartedly, "Yes, definitely more questions than answers, but I just feel that there is no drive to get us to autonomous ships," he said. "Already today

we have autonomous aircraft, autonomous submarines, and the reason for that is there was a competition to find that technology, a push. I don't feel that we are being forced to innovate and develop, there is not the hunger for advancement that competition drives in other industries. Without it you don't get the innovation. A lot of Leonardo da Vinci's inventions were war machines, because the wars forced creativity and innovation."

Asked whether necessity was the mother of invention Marcus agreed, but warned that waiting around for the necessity was dangerous. "Disruptive competition could come from an angle you don't expect today, it may not come from shipping."

Nick Lambert took away several observations, the first of which was the importance of identifying the value. "Where's the value, what are the levers, how do you change the business models that have been so cleverly described today," said Nick. "And I'm always fascinated by the dichotomy between the amazing innovative ideas on the one hand and the culture and the way that the industry currently works and how fragmented it is. Even though very realistic, rooted, grounded people can come in here and talk about the innovation and really want to go and do it, they have this realistic understanding of why it's not happening. So that fragmentation and that need for demonstration of business value to get something moving is the takeaway, together with the fact that there are Flag States pushing this, that's another important takeaway."

Futureautics Maritime CEO Roger Adamson agreed that the morning had

been fascinating. "My key takeaway is one that reinforces what we've always said at Futureautics. We've viewed the autonomous ship as a great vehicle for bringing together and contextualising a lot of the technology trends we see happening in the world," he said.

"That can be anything from 3D printing and connectivity to standardisation, cyber security and new business models. From that starting point sitting here today we've already redesigned the port infrastructure, redesigned and simplified the ship, integrated haulage companies into the maritime logistics chain, addressed cyber security, value, started to discuss how we engage our customers better, asked how we get ship owners out of asset plays and into the business they should be in which is moving stuff around the globe at a profit on time, on behalf of happy customers, questioned where we need people and where we don't, whether a more distributed physical network is required," Roger reminded the group. "Now that may sound a little futuristic, but actually that's exactly the kind of discussions that shipping hasn't had, and which it needs to have, because it's bringing some cognitive diversity, around how do we change this, how do we make it better, and the person, the people for whom we have to make it better at the end of the day is the people who ship stuff around the world, which is the customer."

The importance of optimism was Anette Bonnevie Wollebæk's main takeaway. "From my perspective working in communications for Rolls-Royce I think it's key for us to stay optimistic on behalf of maritime technology, and what Oskar and his team are trying to

achieve," she said. "We call this area the 'Silicon Valley' of the marine world and it's vital to nurture that, but on the way there are customers on the other end and everything we do has to be focussed on delivering for them, because Alex has to have profit from his vessels, and we need to have profit from our side too. The products that we create on this journey will do that, but for now it is important for us to maintain the optimism, because there are so many parties interested in unmanned shipping. Many are negative voices saying we can't do it, but we can. We can at least do part of it. How it will look and how it will end

up, I don't know but we need to stay focussed and optimistic as we continue our journey."

Rounding up the session Chair K D Adamson picked up on the fact that people were leaving with more questions than answers. "I think it was Voltaire who said you should judge a man by the questions that he asks, rather than the answers that he gives, and I think that's very true in this context," she said. "I would argue that shipping and maritime has spent too long confident that it has asked all the relevant questions already and more importantly, has all the answers. The reality is that we need to

shape the highly disruptive future we're entering, and that means shifting the paradigm completely from what we're used to, and really innovating, not just renovating existing business models, solutions and services. The danger, as Christopher identified, is that we're looking for value in outdated business models serving a global economy which is fundamentally changing around us. The opportunities are massive, equalled only by the potential dangers for incumbents who aren't agile enough to adapt."



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Conclusions

Autonomous Ships



Projecting how widespread unmanned shipping will be in 15 or 20 years misses the point. The real disruption that digital will bring is ships tightly integrated into the global blue logistics system which the roundtable participants began to plan out in Aalesund.

To view the autonomous ship as a mode of transport may be accurate in simple terms, but what they're becoming is more than that. Whether you call them a touchstone, a lighthouse, a smoking volcano, or the tip of the iceberg, their advent will be transformative because they are a physical manifestation of so many of the disruptive technology trends at work in the world.

The drivers for their creation are already gathering pace—recent reports from Drewry and others have identified that the economies of scale that gave birth to the mega-ships are being thrown into reverse. One analysis from McKinsey calculated that slow steaming had added around 3 days to transits, costing shipping's customers \$5.7 billion in additional annual inventory and obsolescence costs worldwide.

Things have to change for the better, and creating intelligent ships could be the catalyst for change on a mas-

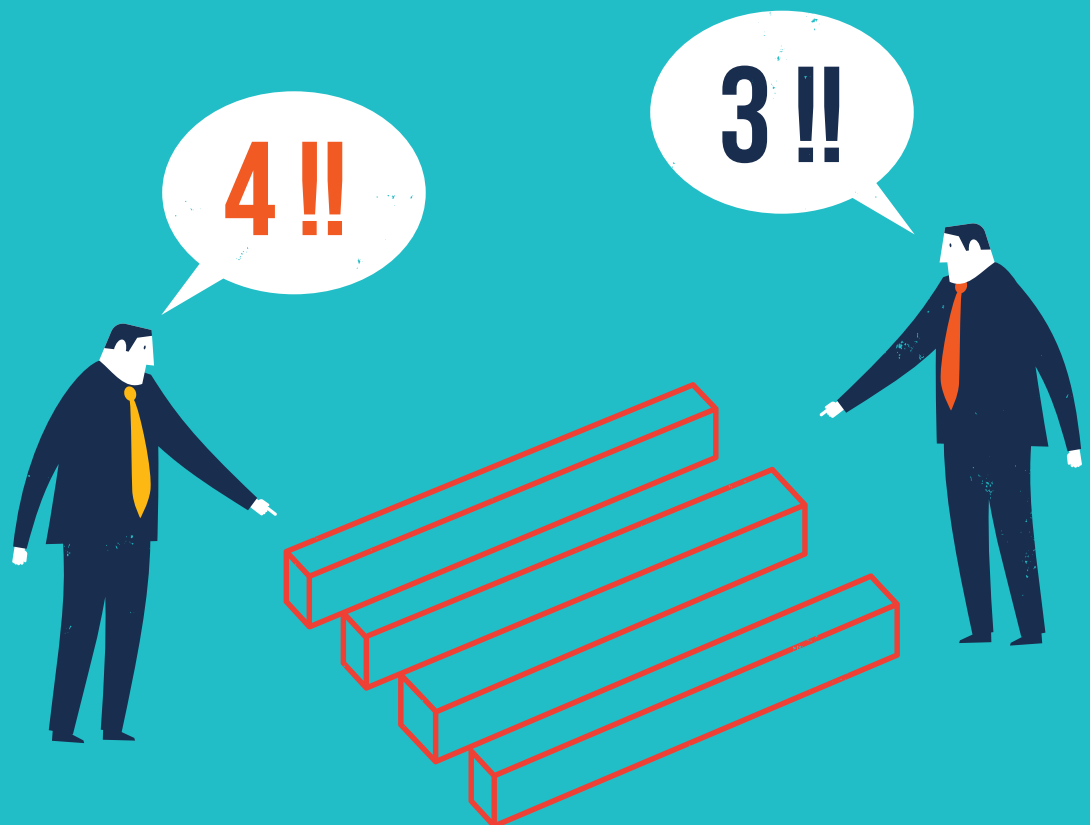
sive scale. That's why to concentrate solely on how many, how soon, how expensive or how safe the unmanned ship will eventually manifest is a sideshow. Unmanned ships represent for shipping what e-books represented for the global publishing industry. The fact that print books are still being produced is cited by some as some kind of victory—or perhaps deliverance—but the reality is that the publishing industry has changed almost beyond recognition. What e-books drove was new business models, entrants and value chains, and the autonomous or unmanned ship is set to do the same in maritime.

Projecting how widespread unmanned shipping will be in 15 or 20 years' time misses the point. The real disruption that digital will bring is ships tightly integrated into the global blue logistics system which the roundtable participants began to plan out in Aalesund. Capturing the opportunity requires a fundamental understanding of that, and

those who fail to grasp it will end up arguing the relative merits of manned versus unmanned, as the industry around them transforms into something unrecognisable.

"Man is the best computer we can put aboard a spacecraft...and the only one which can be mass produced with unskilled labour," said Wehrner von Braun, inventor of the V2 rocket, the US Saturn V and the first space satellite. In the 1950s that probably sounded like an eternal truth, but automation and autonomy driven by the underlying exponential growth of computing power is changing that.

The challenge for shipping is to focus on the tectonic plates that digital is shifting under the industry, and not get sidetracked by the heat and light of the unmanned ship volcano they'll give rise to. No matter how spectacular an eruption it's going to be.



Capturing the opportunity requires a fundamental understanding of the far wider disruption at play, and those who fail to grasp it will end up arguing the relative merits of manned versus unmanned, as the industry around them transforms into something unrecognisable.

Following the autonomous ships roundtable some of the participants take the opportunity to try out Rolls-Royce's state-of-the-art simulator. Despite decades of seafaring experience on the bridge, somehow an economist ends up driving the ship.

Top- Christopher Rex in command. Bottom- Walter Hannemann, Nick Lambert, K D Adamson, Ronald Spithout and Alex Hjortnæs cross their fingers. With thanks to Inmarsat and Rolls-Royce.

