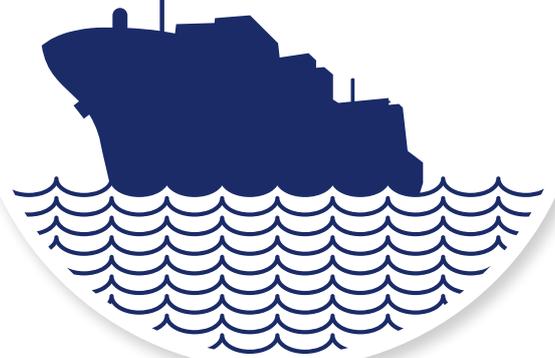


A dark blue background featuring a world map with a grid of white dots. Overlaid on the map is a complex network of white lines representing shipping routes, connecting various ports and regions across the globe.

**sustainable
shipping
initiative**



Signals of Change

Looking at the potential impact of emerging signals of change on the future of sustainable shipping

– **March 2015**

Prepared by

 **forum for
the future** | futures
centre

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Foreword

The Sustainable Shipping Initiative (SSI) brings together some of the biggest names in the maritime sector to plan how it can contribute to – and thrive in – a sustainable future.

We live in a world of increasing dynamism and volatility, where global drivers such as climate change, growing demand for limited resources and increasing hyperconnectivity are re-defining the way we work. To monitor the key trends in the shipping industry, SSI launched the Blue Skies working group in 2012 to focus on identifying emerging big innovation ideas that may have a long-term impact on the shipping supply chain. Since then we have been exploring developments including future fuels, advances in new eco-ship technology and emerging economic drivers for 'zero fuel cost' ships for low-GDP economies.

Our new report focuses on “Detecting early signs of change” through scanning trends in the macro environment and evaluating how the innovations that are largely outside of or adjacent to shipping could have an impact on the sector.

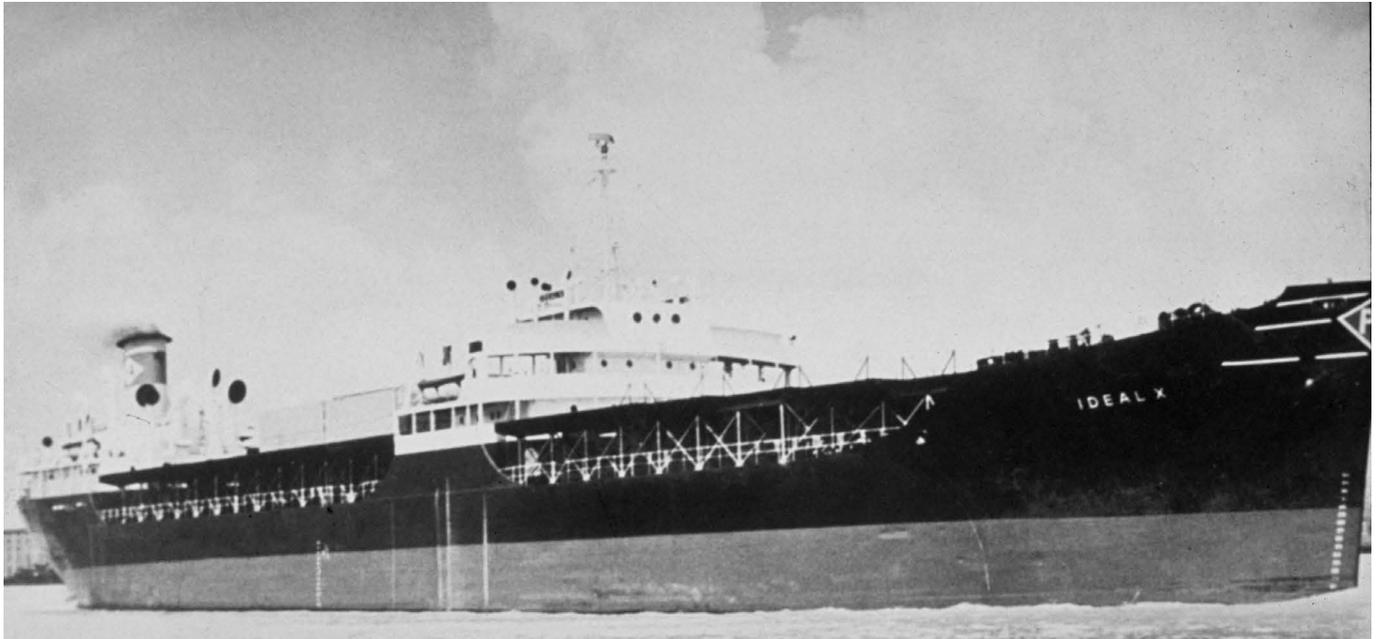
This report presents fifteen “weak signals” whose potential implications on the future of the shipping industry are evaluated. Three common themes emerge from this analysis that need broader industry considerations, particularly to help accelerate progress towards a more sustainable future for shipping.

- Who will govern the oceans?
- Will we recognise the future captains of the sea?
- What will be the nature of our cargo?

We do not have all the immediate answers, but it is important that we begin to answer them. Big changes are on the horizon and the SSI is passionate about helping the shipping industry to work proactively to prepare, adapt and embrace the opportunities that emerge. As we progress on our journey towards a more sustainable future, the words of Antoine de Saint Exupéry have never rung more true: **Your task is not to foresee the future, but to enable it** (The Wisdom of the Sands – 1948).

Franck Violette & Maarten van der Klip
Blue Skies Group, Sustainable Shipping Initiative
March 2015

A truck driver reinvents the shipping industry



Ideal-X, the world's first container carrier, set sail on April 26th 1956 | Image credit: A.P. Moller – Maersk Archives

One of the biggest disruptions of the shipping industry came from an industry outsider - Malcom McLean, an American trucking magnate. Ships used to be loaded and unloaded piece by piece. Ports were dangerous and chaotic; goods were often broken or lost. As global trade increased, this became a real bottleneck. In 1955, McLean, a trucker and industry outsider, considered shipping as part of the wider logistics system and saw that containers needed to be easily and efficiently loaded on to a ship and offloaded onto trucks and railways at each end of the journey.

This was the start of a transformation of the shipping industry that today sees a world where 90% of non-bulk goods are shipped in containers, enabling global production, trade and globalisation as we know it today. Though other factors such as the removal of global trade barriers accelerated the rate of globalisation, a 2013 report focused on 22 industrialised countries between 1962 and 1990 found that containerisation is associated with a 320% increase in bilateral trade in the first 5 years and 790% over the next 20 years. According to the authors, containers played a larger role in boosting globalisation than all trade agreements in the past 50 years put together.¹

A truck driver innovating the way to move goods on the northeast coast of the United States (US) was probably not recognised as an early signal of one of the major disruptions to shipping by those within the industry at the time. In fact, scepticism and active opposition to containerisation within the shipping sector prevented the scaling of the new approach for years. It was only when the US armed forces used standard-sized containers to move huge volumes of goods during the Korean and then the Vietnam wars that the concept was proved at scale. This proved a tipping point, spurring industry leaders to adopt and invest massively in the infrastructure required for containerisation to become mainstream.

¹ Bernhofen, Daniel M. and El-Sahli, Zouheir and Kneller, Richard, Estimating the Effects of the Container Revolution on World Trade (February 28, 2013). Available at SSRN: <http://ssrn.com/abstract=2228625>

Detecting early signs of change

The story of containerisation illustrates one of many ways in which innovations or events from outside a system – in this case, the shipping industry – can be scaled to have a major impact on the future of the system. We live in a world of increasing dynamism and volatility, where global drivers such as climate change, growing demand for limited resources and increasing hyperconnectivity will have significant impacts on the role of business and entire sectors. This makes it crucial to detect early signs of change, or “weak signals” and understand the dynamics among social, political, cultural, technological and environmental change.

The Sustainable Shipping Initiative

The Sustainable Shipping Initiative (SSI) is a coalition of shipping leaders from around the world, with a commitment for moving the shipping industry towards a sustainable vision.

Recognising that the challenges of the future demand significant change, SSI members have developed a shared Vision for 2040, in which sustainability equals success. This entails:

- Changing to a diverse mix of energy sources, using resources more efficiently and responsibly, and dramatically reducing greenhouse gas intensity.
- Providing safe, healthy and secure work environments so that people want to work in shipping, where they can enjoy rewarding careers and achieve their full potential.
- Earning the reputation of being a trusted and responsible partner in the communities where we live, work and operate.
- Developing financial solutions that reward sustainable performance and enable large-scale uptake of innovation, technology, design and operational efficiencies.
- Transparency and accountability drive performance improvements and enable better, sustainable business decision-making.
- Proactively contributing to the responsible governance of the oceans.



Horizon scanning for change

Horizon scanning is the process of looking for weak signals with a potential to impact the future in unexpected ways. For the SSI, the aim of horizon scanning is to identify how we might accelerate the transition to a sustainable future for shipping.

To support this aim, Forum for the Future (Forum) has conducted a scan of events, technologies and industry insights, drawing upon research across a range of industries, including retail, aviation, property development, among others.

Weak signals: a definition

In light of SSI's vision, we are defining a weak signal as follows for the purpose of this report:

“Signs of change that are likely to scale and/ or have an impact on the future of shipping in the long run (10 years or beyond). They may be from within or outside of the shipping industry, and cut across social, technological, environmental, economic or political areas.”

It is worth noting that the “weakness” of a particular signal is context-dependent. For example, from the point of view of automobile companies, Google's driverless cars hitting the roads isn't a weak signal, but a trend rapidly growing momentum and one that will certainly disrupt industry players over the next decade. The potential implications on shipping, however, are less certain and likely to occur over a longer timeframe. We've intentionally focused on early signals that might impact shipping over a longer time frame.

Scanning and sense-making as a social process

Weak signals are inherently uncertain. In some cases we don't recognise a signal until it is too late. In other cases, we might overinflate the potential impact of a new innovation. Quality sense making happens when one is able to tap diverse networks of expertise and people with on the ground knowledge.

Futures Centre topic hub

Via the Futures Centre topic hub, SSI will provide a means for the shipping industry to collectively scan for weak signals. The ultimate aim is to find opportunities for the SSI and the wider industry to accelerate progress towards the SSI Vision 2040.

The topic hub provides the infrastructure for monitoring change in a dynamically changing world. The digital platform will enhance horizon scanning and trend monitoring by gathering and sharing knowledge with individuals and networks interested in the future of sustainable shipping around the world. As the number of engaged people increases, the capacity to gather and share futures intelligence will increase.

In partnership with Forum for the Future, SSI will launch the shipping topic hub on the Futures Centre in April 2015. We invite shipping professionals, practitioners, students and enthusiasts (such as the readers of this report) to engage with members of the SSI via the platform. Share weak signals that you spot – the Futures Centre will carefully curate the information you share, drawing out insights and finding windows of opportunity for change. The shipping topic hub will be available at www.thefuturescentre.org/topic-hubs/shipping

Developed by Forum for the Future, the Futures Centre uses the collaborative potential of the digital world to help make the big shift to a sustainable future.

Topic hubs on the Futures Centre are areas where businesses, non-profit organisations, and individuals can collectively monitor the future of a specific area of interest. Participants can gain a better understand of how change is happening and its future implications through discussion, horizon scanning and exploring the convergence of future trends.



Shipping topic hub on the Futures Centre

Combining signals to look at possible futures

This report presents fifteen weak signals. Three common themes emerged across the implications, and we present them here as questions for members of the shipping industry to ponder.

Who will govern the oceans?

We are only starting to understand the far-reaching implications of human activity on marine ecosystems (*How will vessel quieting and underwater noise regulation affect shipping?*, Pg 21; *How might new interest in geoengineering affect shipping?*, Pg 23). What it means to operate responsibly in the oceans is likely to look significantly different 10 years from now. At the same time, growing demand for limited resources has seen a rising number of governments and private sector players eyeing the ocean and its wealth of unexplored resources (*Where will 19 exploration licenses for seabed mining lead?*, Pg 16). As the contest over control of the ocean heats up, (*How might global ocean grabbing affect shipping lanes?*, Pg 10) the question over who governs the oceans will require difficult but open and transparent discussion to arrive at a global consensus.



Image credit: Daniel Ramirez / Flickr

Will we recognise the future captains of the sea?

In a world where transparency is now the rule rather than the exception, what it takes to be a good leader (*How might scrutiny over social media affect shipping companies?*, Pg 12) and leading organisation (*Will changing shareholder expectations have an impact on shipping companies?*, Pg 14) is evolving. As with all sectors, shipping will have to grapple with growing expectations to invest in a sustainable future (*Will the growth of aviation biofuel investments push shipping in the same direction?*, Pg 17). Simultaneously, rapid advances in materials technology and automation (*What could the rise in automated vehicles mean for shipping?*, Pg 11; *How might "Iron Man-like" exoskeletons change shipyards?*, Pg 13; *Could augmented reality change the human resources needs of the shipping sector?*, Pg 20), when scaled, will drastically alter the human resource needs of the shipping industry. Sea captains today have a very different job from their counterparts a decade ago. 10 years down the road, the captain may not even sail physically with his ship!

What will be the nature of our cargo?

Today, affordable shipping enables a globalised economy, and shipping in turn relies on a healthy global economy to prop up operating revenues. How the nature of manufacturing evolves over the next decade and beyond will have a profound impact on shipping. Signs that additive manufacturing will soon become the norm (*How might 3D printing impact on shipping and trade?*, Pg 9) will have an impact on where and how goods are made. At the same time, manufacturers are pushing ahead with efforts to "close the loop" on production (*What opportunities do closed loop and cradle to cradle innovation present for shipping?*, Pg 18). These trends combine to form a complex picture with an unclear impact on shipping volumes, but will certainly require adaptation on the part of shipping players. Further on the horizon, new materials that challenge fundamental assumptions of current manufacturing practices (*What impact might nanomaterials have on ship building and cargo?*, Pg 15; *What might be the impact of '4D printing' self-adaptive materials on shipping?*, Pg 20) are set to keep transportation providers on their toes.

15 weak signals and the impact on sustainable shipping



Image credit: Wikipedia

This report presents fifteen weak signals. The following section introduces each signal, with a brief explanation of the context, and some potential responses to the question “So what?” What are the potential implications on the future from the point of view of the shipping industry?

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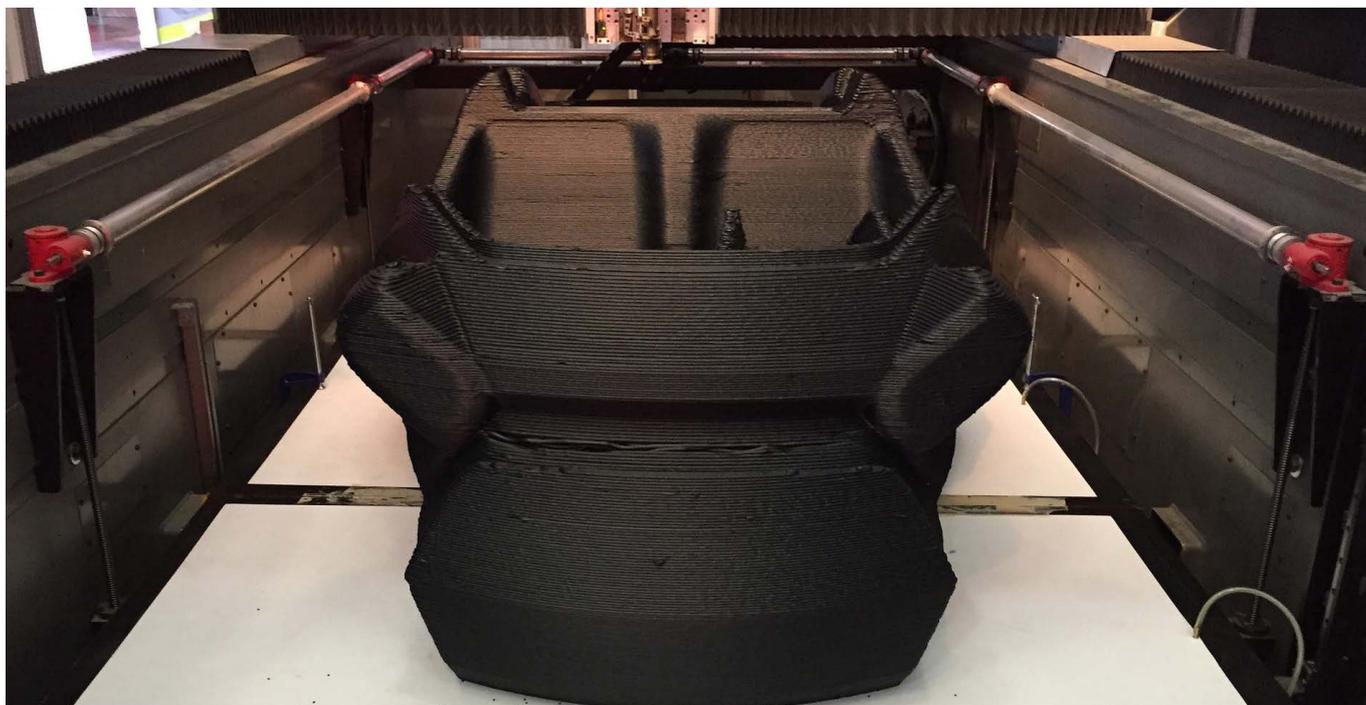


Image credit: John Biehler / Flickr

1. How might 3D printing impact on shipping and trade?

2014 saw Chinese engineering company, WinSun, build 10 one-storey houses in a single day using four giant 3D printers. At the same time, Autodesk collaborated with Local Motors, the leader in open-source hardware innovation, to create the first Spark 3D-printed car. This move marks the first time a major company has entered the 3D printing open-source space.

Credit Suisse recalculated its 3D printing projection in 2014, predicting that the manufacturing tech's market will increase to \$800 million by 2016. The revised projection is a startling 357% increase from Credit Suisse's \$175 million market estimate in late 2013. Driving that claim is the bank's opinion that prosumers (a new class of producer-consumers who simultaneously function as consumers, editors and producers of new ideas and products) have embraced the technology and that we are already seeing widespread acquisition and adoption of 3D printing technology.

So what?

- Fundamental shifts in patterns of trade, with major consumer goods designed and retailed virtually before being manufactured in a local and distributed network, could see a fall or stagnation in shipping volumes.
- The advent of 3D printing onboard ships could create an opportunity to integrate shipping into the manufacturing chain. In one possible scenario, ships could print and manufacture goods en-route to their destination, ensuring client customisation and speeding up delivery times.
- Shipping companies could also save on maintenance costs and time by printing any spare parts and equipment needed at sea on an ad-hoc basis. This could the lower capital investment required.



Image credit: U.S. Navy photo by Mass Communication Specialist 3rd Class Raul Moreno Jr./Released

2. How might global ocean grabbing affect shipping lanes?

A September 2014 report by the Transnational Institute, Masifundise and Afrika Kontakt, entitled 'The Global Ocean Grab: A Primer', claims to unveil a new wave of 'ocean grabbing'. Ocean grabbing refers to large-scale exploitative practices that 'grab' the natural resources, particularly fish, in a certain area. The practice is usually carried out by large Western or Asian nations and threatens the livelihoods of many small-scale fisher people in developing countries. According to UN experts, ocean grabbing is as threatening as land grabbing.

The report cites examples of luxury beach-resorts in Sri Lanka where fishermen can no longer gain access to the coast, the destruction of mangrove areas in Ecuador to promote export-oriented shrimp aquaculture, and the dramatic rise of Rights Based Fishery (RBF) policies that have handed over large tracts of ocean to industrial fishing companies in Europe, Canada and elsewhere.

Additionally, disputes over access and exploitation in many parts of the ocean continue. Sovereignty over the South China Sea is being contested by China, Japan and some ASEAN countries. Disputes continue over the Arctic as well. Increased resource scarcity, as well as improved technology that allows for easier exploitation of ocean resources, will only make countries more eager to extract goods from the oceans.

So what?

- Potential disruption to shipping lanes if territorial disputes escalate, and if international or trade organisations call for protected fishing areas that limit sea traffic.
- Rising awareness of 'ocean grabbing' as a phenomenon and disputes over access and exploitation may create a more widespread shift towards ocean privatisation.
- Shipping companies that take a proactive stance on ocean governance issues and invest in local community development stand to benefit.



Photo: Self-driving car

3. What could the rise in automated vehicles mean for shipping?

Google has unveiled its first “fully functional” prototype of its self-driving car and plans to test it on the public roads of San Francisco Bay Area in 2015. Google is one of seven companies, including Nissan, BMW and Mercedes-Benz, which have won approval to test driverless cars on public roads. Already, innovations are emerging around the technology. CUVE, a membership-based shared transit system, combines notions of the sharing economy with driverless automobile technology. Customers use an app to request a car to take them to a destination, much like a taxi. The app will optimise the number of people who can share the same route or part of a route, picking up and dropping off multiple people at once.

Lessons learned from the impact of driverless cars on the automotive industry can shed some light on how unmanned ships will be received. From a liability perspective, autonomous vehicles have a much lower accident rate than human-controlled ones. Regulatory problems may occur when established stakeholders – in the case of cars – traditional manufacturers, car services, and taxis, try to prevent the adoption of the new technology. With the shipping industry these actors could be labour unions or established marine legislative bodies.

The first autonomous cargo vessels are expected to enter service in the next 10 years. The EU has put €3.8m into this area through the Maritime Unmanned Navigation through Intelligence in Networks (MUNIN) project, which looks into a range of relevant areas including autonomous route finding, collision avoidance, predictive maintenance concepts and shore-side control. Rolls-Royce announced in 2014 that it has set up a virtual-reality prototype of unmanned cargo ships, while DNV GL released details of the “ReVolt”, a concept prototype that is fully electric and autonomous. While full autonomy may be a long way off, precursor innovations such as improved route planning, reduced crew requirements and data management requirements are all on the horizon and make good business sense.

So what?

- If autonomous or semi-autonomous shipping vessels were to scale, the human resource needs of the shipping industry would change significantly. A much smaller technical staff would be required on board. Instead, a strong engineering team would be needed for ship design and maintenance.



Image credit: Robert Scobel / Flickr

4. How might scrutiny over social media affect shipping companies?

In an era where transparency has become the rule rather than the exception, boards of directors are starting to evaluate the social media competency of CEO candidates. A December 2014 Harvard Business Review piece shared: “Five years ago... social media competency wasn’t even on the radar. Now, according to the board members and CEOs we interviewed ... a strong social presence is often high on the list of factors they consider when vetting CEO candidates.”

In a recent example, AirAsia’s handling of the disappearance of Flight 8501 gained favourable response in contrast to the diffuse and sometimes contradictory messages that initially followed the disappearance in March of Malaysia Airlines Flight 370. Within hours after the flight’s disappearance, AirAsia founder Tony Fernandes flew to Surabaya, where the flight 8501 departed. He briefed relatives waiting for news and took to Twitter to post a stream of messages linking to the latest statements from AirAsia or offering thanks for messages of support sent to the airline. Crisis management experts have credited Fernandes’ response as a “textbook example” and believe it will prove to be crucial to the airline’s long-term credibility.

For shipping, the growing use of social media aboard ships (recent research shows >80% of marine crews are active on social media) has lifted the veil on an otherwise “invisible” industry. High profile incidents at sea and the images and videos now appear within minutes on Twitter and YouTube, putting pressure on shipping companies to respond quickly and publicly to prevent the spread of misinformation. Increased visibility of incidents at sea can result in global reaction and opinion, accurate or not, influencing how governments, investors and individuals react. Public expectations of immediate action can result in erroneous responses.

So what?

- Social media competency is no longer something only consumer-facing companies have to worry about. All organisations are increasingly subject to public scrutiny for their social and environmental impacts, and individuals will be held to account.
- Leaders in all fields, including shipping, will be assessed on different sets of skills, including social media.
- Within the organisation, the availability and accuracy of information, and the capacity to communicate appropriate details in a sensitive and timely manner, will become increasingly important.



Image credit: Ekso Bionics / Flickr

5. How might “Iron Man-like” exoskeletons change shipyards?

In 2014, the US Navy acquired two high-tech exoskeletons for potential use in naval shipyards. Designed to reduce ergonomic accidents, such as overexertion and repetitive motion injuries, exoskeletons will potentially allow operators to work longer and more efficiently with reduced muscle fatigue.

At around the same time, Daewoo Shipbuilding and Marine Engineering started testing wearable robotics, outfitting staff with robot exoskeletons that allow users to walk at a normal pace and, in its prototype form, lift objects with a mass of up to 30 kilograms without strain. Leading shipyards are already renowned for automating jobs such as cutting and grinding steel, polishing and welding, and see the use of exoskeletons as a natural next step.

So what?

- There are some immediate health and safety benefits: workers lifting heavy weights would be less susceptible to strain injuries through the use of exoskeletons, resulting in better efficiency and workflow.
- Successful large-scale deployment of exoskeletons would greatly improve the productivity and efficiency of shipbuilding, improving turnaround times and reducing overall manpower needs.
- However, as with most forms of automation, this may also mean a loss of jobs for existing shipyard workers. The changing working conditions demand a rethinking of labour regulations and rights.

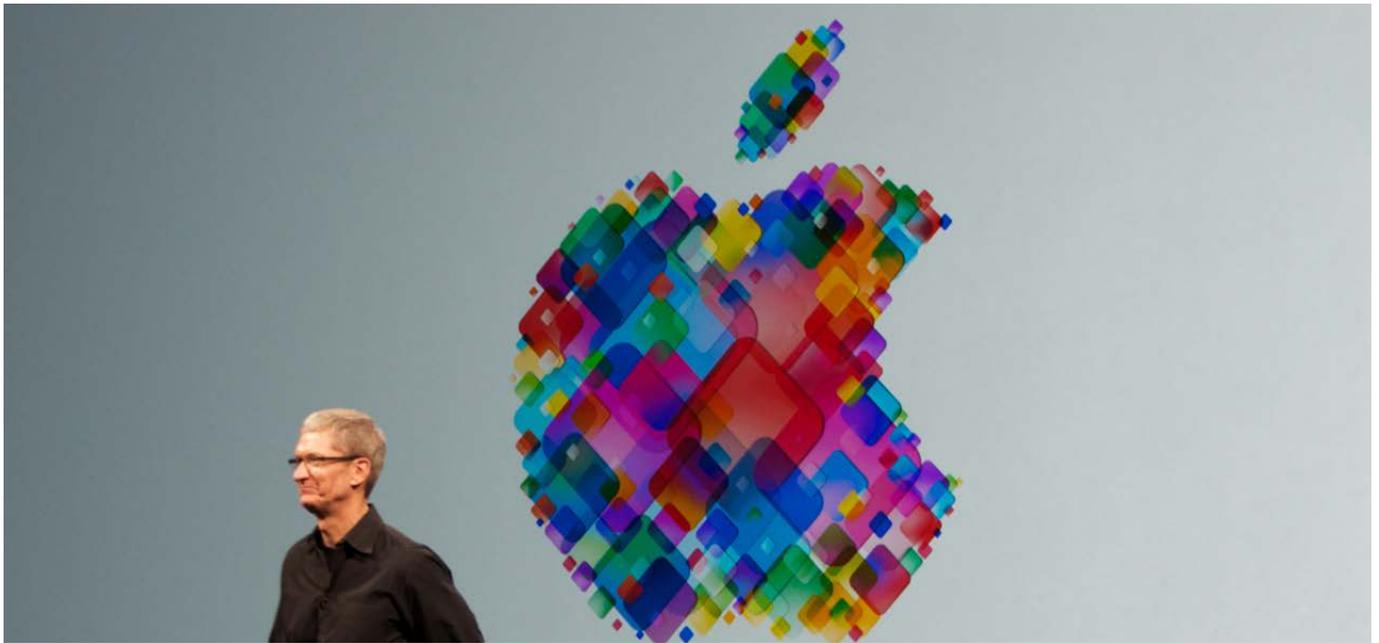


Image credit: Mike Deerkoski / Flickr

6. Will changing shareholder expectations have an impact on shipping companies?

2014 has seen some heroic CEOs swimming against the tide on shareholder value. “If you want me to do things only for ROI reasons, you should get out of this stock”, Tim Cook, the CEO of Apple, famously responded, when asked whether climate change investments were undermining shareholder value. Greater momentum is with new legal forms that try to avoid being trapped that way: B-Corporations, co-operatives, impact investors, social entrepreneurs, and others.

Shareholders themselves may soon be looking for companies to live up to different performance measures. Divestment campaigns have gained momentum in the past year, encouraging individual and institutional shareholders to divest fossil fuel stocks from their portfolios. Campaigners argue that in a carbon-constrained future, fossil fuel companies will have a large stock of stranded assets, in the form of coal mines, oil wells, coal-fired power stations and the like. They may also, at some point, face damage claims on the basis that they knew their emissions were causing climate change, as it happened with tobacco companies that tried to bury warnings on cancer.

So what?

- At the moment, the shipping industry remains heavily reliant on fossil fuels, with alternative energy sources struggling to gain mainstream adoption. If companies are required to set a value on fossil fuel-related assets, and report them as ‘material risks’, this could prove a large cost to shipping companies, resulting in stranded assets.

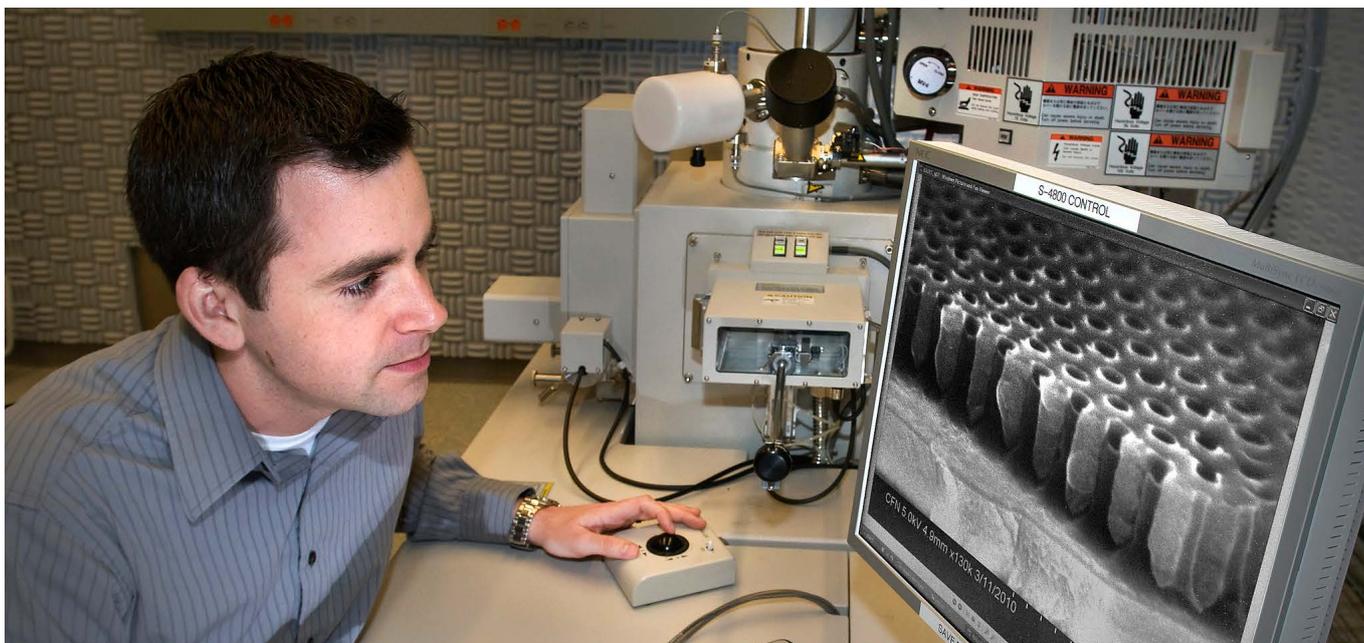


Image credit: Brookhaven National Laboratory

7. What impact might nanomaterials have on ship building and cargo?

Nanomaterials – a term describing those materials, organic or synthetic, in which a single unit is usually sized between 1 and 100 nanometers (nm) – are typically lighter and stronger, perform better at extreme temperatures, and provide better insulation than their counterparts. For example, Buckypaper, a thin sheet made of carbon nanotubes, is one tenth the weight of steel but potentially 500 times as strong. Already, nanomaterials are used in a variety of ways in the aviation industry, mostly as fillers and coatings, where the weight to strength ratio of materials is particularly important.

As the commercial and sustainability benefits of nanomaterials gain traction, there have been calls for greater material standardisation, transparent pricing and security of supply to enable more widespread use of these materials in mainstream manufacturing. Players from across the electronics, medical, construction and marine industries are experimenting with the use of nanomaterials. As an early example, Zyvex Marine has manufactured a prototype craft using composite non-enhanced carbon fibre. Zyvex reported a 75% reduction in fuel consumption costs, translating to increased range and lower operating cost.

So what?

Economies of scale resulting in more widespread supply and application of nanomaterials could impact shipping directly and indirectly.

- New materials may have a profound impact on the way that ships are built, operated and ultimately recycled at the end of their lives. Ship builders need to understand how new lightweight and recyclable materials, combined with other innovations such as self-healing coatings and on-board component production, will affect their design choices.
- Investment in 'nano-enhanced' ships could give companies a competitive edge as forthcoming emissions regulation is implemented. Nanotechnology has the potential to transition manufacturing into a new era, with the rise of nanofactories producing materials with superior capabilities while reducing their environmental impact. Such a transition is certain to have an impact on the shipping industry - from the ships themselves to the contents and weight of their cargo.



Image credit: Peter Thoeny

8. Where will 19 exploration licenses for seabed mining lead?

Seabed mining, a closely watched, if relatively unexplored territory, is set to emerge soon as a significant new use of the world's oceans. The International Seabed Authority (ISA) has granted 19 exploration licences, and Nautilus Minerals' Solwara 1 project in Papua New Guinea is expected to be the first commercial deep-sea mining project to start operations within the next five years.

As commercial plans to exploit mineral resources on deep-ocean beds gather pace, marine researchers are increasingly concerned about the damage such projects might cause to the sensitive and little-understood ecosystems that thrive there. While some studies show that seabed mining offers an alternative that could be less environmentally destructive than land-based mining, scientists remain cautious about the potential environmental impacts. There are also concerns around the socio-economic impact that these mining activities will have on communities located in the proximity of mining spots, where onshore processing and transport infrastructure are likely to spring up.

Scientists are taking to the sea as part of a three-year, €12 million programme: Managing Impacts of Deep Sea Resource Exploitation (MIDAS), designed to address environmental and social concerns and to develop a set of guidelines for industry.

So what?

- The emergence of seabed mining will affect the shipping industry by creating demand for a new generation of vessel designs to support, process and transport minerals extracted from the ocean bed.
- Shipping players that venture into seabed mining will face increased scrutiny from NGOs and local communities concerned about environmental and social impacts.
- The accelerated implementation of new ocean governance policies may also affect shipping companies, whether or not they are directly involved in the mining.



Image credit: The Open University

9. Will the growth of aviation biofuel investments push shipping in the same direction?

A slew of biofuel partnerships and investments in the aviation industry in 2014 indicate biofuels may be ready to scale, moving beyond a 'chicken and egg' scenario in which industry investment awaits international legislation, and vice versa.

Cathay Pacific negotiated a long-term supply agreement with biofuel producer Fulcrum over ten years; British Airways announced a partnership with Solena Fuels, which has committed to building the world's first facility to convert landfill waste into jet fuel. Within Europe, a consortium consisting of KLM, Amsterdam Schiphol, sustainable jet fuel producer SkyNRG, and the Dutch government, is working on a central biofuel blend for the common fuel supply system at Schiphol Airport, due to roll out in 2015.

Industry experts expect to see an international mechanism to put a tax on aviation emissions within the next two years. This would significantly alter the economics of low-carbon alternatives, and may be part of the motivation for this recent rise in investment.

So what?

- Significant progress in biofuel investment and uptake on the part of the aviation industry will place growing pressure on the shipping industry to do the same, or find alternative means to cut emissions.
- Shipping, which accounts for similar, if not higher levels of global emissions as the aviation industry, faces similar pressures to reduce the sector's greenhouse gas emissions. For shipping companies, switching to biofuels has the added advantage of eliminating air pollutants (SO_x and NO_x), which are already being enforced via environmental regulations set out in the MARPOL Convention.
- The shipping sector is still in a very early stage of orientation towards biofuels. There are a growing number of research and pilot projects, but no significant consumption at the moment.



Image credit: Walmart

10. What opportunities do closed loop and cradle to cradle innovation present for shipping?

Some of the world's largest multinational businesses have recognised the advantages of 'closing the loop' on their supply chains. From energy and water conservation to product take-back programmes, materials reuse and recycling, we are seeing major food and beverage, consumer products and electronics manufacturers move towards becoming 'zero-waste' and 'zero emissions' businesses.

The ultimate goal is 'cradle-to-cradle' product lifecycles in which all materials used to produce, package and distribute products to consumers are recaptured, reused or recycled. This has seen the emergence of 'reverse supply chain management' as a new industry. Aiming to close the loop on the supply chain, these companies offer an integrated one-stop shop for re-manufacturing, as well as reusing and recycling products, their constituent parts and raw materials.

We will witness an evolution in logistics and distribution systems as more sophisticated reverse supply chains emerge, in order for base materials to be sorted and sent to the respective materials processing plants. This would have both environmental and economic implications. A simplistic scenario of a 100% successful product take-back would mean twice the distance travelled, freight cost, CO2 emissions and packaging for every product.

So what?

- As a crucial part of the global logistics and supply chain system, shipping could play an important role in shaping sustainable closed-loop supply chains. Some possible areas include:
 - Developing new vessels designed to carry bulk recycled cargo;
 - Designing dedicated separation, recycling or processing facilities on board vessels;
- Transparent monitoring of shipping emissions to allow for effective accounting of the reverse supply chain.
- More immediately reverse supply chains will result in new trading routes as parts re-processing, recycling and manufacturing will likely take place in different locations.

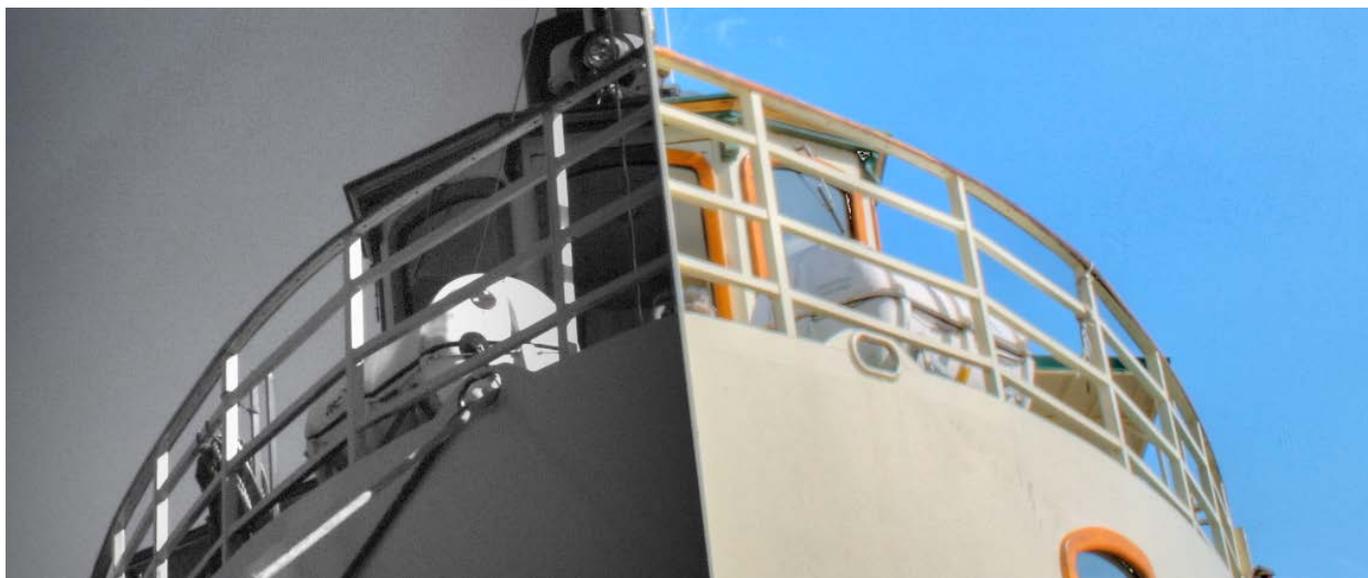


Image credit: Misguided_photo / Flickr

11. Could augmented reality change the human resources needs of the shipping sector?

In early 2014, Rolls Royce, together with VTT Technical Research Centre of Finland, released a concept video visualising what might be possible in a future where virtual reality bridges replace traditional seafaring controls.

The technology even has the potential to improve upon the “real life” experience, increasing a captain’s situational awareness through visual augmentation that allows them to “see through objects on the deck for an unobscured view at the surrounds”.

DHL released a report “Augmented Reality in Logistics” later in the year, which predicted that the Augmented Reality (AR) market will grow to \$5.2 billion by 2017, up from a mere \$181 million in 2011. Already the company is thinking of implementing wearable headsets that could optimise the picking process in warehouses. As the first generations of augmented reality are installed and tested, experts believe that sophisticated versions will appear within the next 15 years.

So what?

Augmented reality (AR) could be used to optimise operating systems and decision-making, introducing efficiencies in both human resources and energy use.

- In the short-term, AR technology can be used to train ship captains and operators. In the long-run, it will change the human resource needs in the industry, reducing physical ship crew numbers while increasing the need for engineers and maintenance capabilities to set up and maintain the systems.
- The development of AR technology will sit closely alongside the design of autonomous vessels, and face a similar set of socio-ethical concerns.

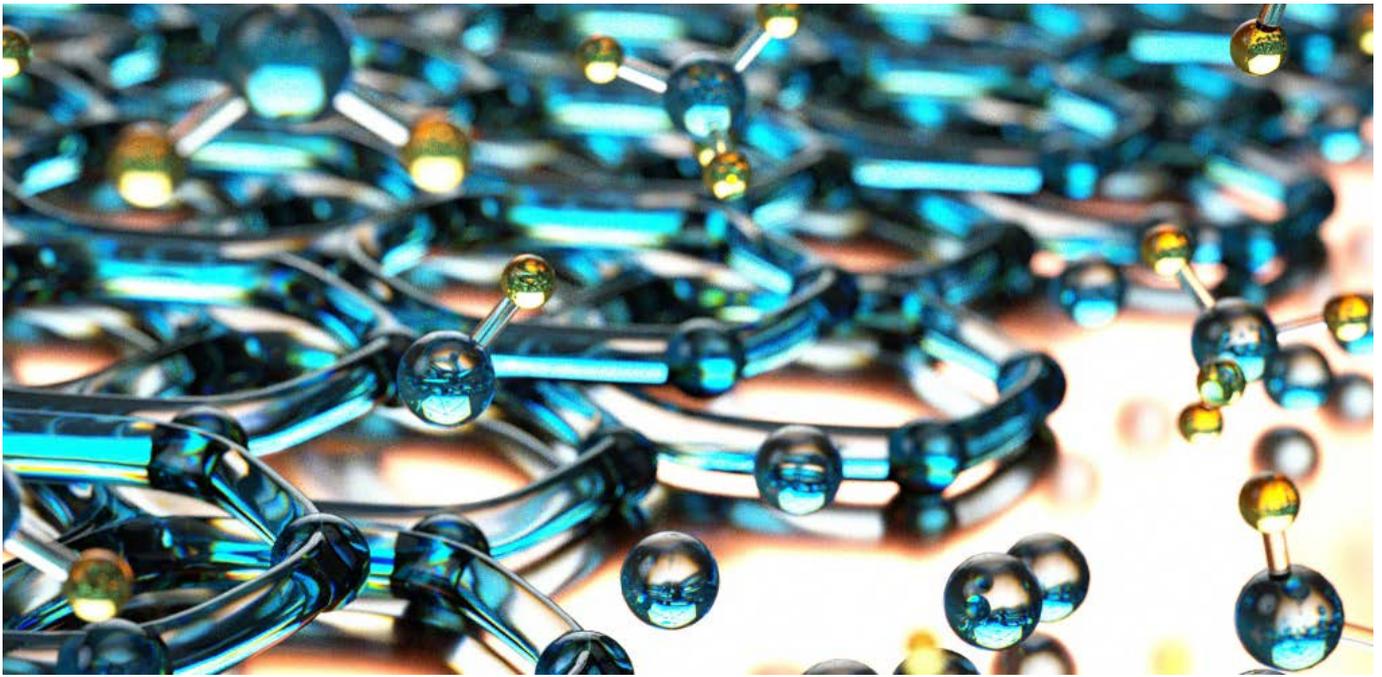


Image credit: Hinkle Group

12. What might be the impact of '4D printing' self-adaptive materials on shipping?

MIT's Self-Assembly Lab has developed materials that can be programmed to transform their shape autonomously.

The materials range from flexible carbon fibre and hybrid plastics to wood grains and textiles. As Skylar Tibbits, Director of the Lab, explains, "The way we build our structures has become increasingly sophisticated, but the materials we build them from are static, waiting for us to fit them to the required shape."

Coined '4D printing', where 3D-printed material changes shape over time, the technology opens up a world of possibilities, potentially allowing buildings, infrastructure and equipment to continuously adapt to our use, and to the environment around them. These 'smart' materials would respond to daily wear and tear as does skin, healing itself, and so minimising the need for repair. They could also be programmed to learn new material behaviours, befitting different purposes.

So what?

The potential impacts of this technology at full maturity are vast, and could impact shipping both directly and indirectly.

- On ships, programmable material may make it possible to replace the need for existing robotic monitoring mechanisms that involve batteries, sensors and electronics that can be failure-prone.
- For shipping customers, self-adaptive material could work its way into packaging and transportation of goods. The potential in materials that respond to different temperatures, altitudes, or even blunt impacts could make for smarter packaging and prevent damage during shipping.

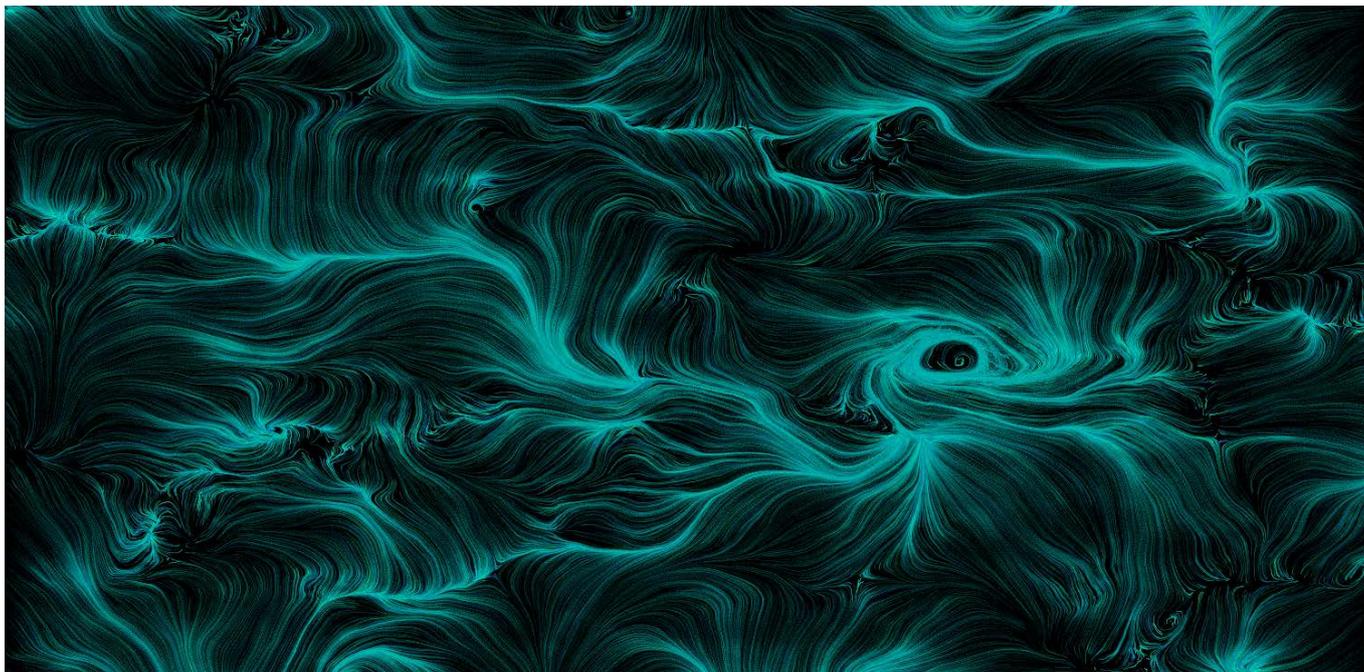


Image credit: Martin / Flickr

13. How will vessel quieting and underwater noise regulation affect shipping?

There is mounting concern that noise proliferation poses a significant threat to marine ecosystems and the survival of marine mammals, fish and other ocean wildlife. Ships produce noise that generally falls in the low frequency band, which coincides with the frequencies used, in particular, by baleen whales, fish, seals, sea lions and dolphins for communication and other biologically important activities.

Scientists, environmental groups, government agencies, and forward-thinking sectors of the shipping industry are starting to enter partnerships aimed at reducing noise from large ships and the associated negative effects on ocean life. One example is the collaborative European research project AQUO, which is exploring solutions to mitigate underwater noise related to maritime transport.

Regulatory approaches are also continually evolving – from simple sound-level thresholds to accommodate other factors than just “loudness”, such as frequency, time and location. In late 2013, the International Maritime Organization (IMO) adopted guidelines to reduce underwater noise from commercial ships.

So what?

- With stricter vessel quieting and underwater noise regulations round the corner, the shipping industry will be expected to dedicate resources to research, assess, plan and mitigate the effects of underwater noise on marine life.
- In the near-term, changes will be expected in the design of engine room machinery and propelling mechanisms to reduce noise.



Image credit: Pieter von Marion / Flickr

14. How might high profile aviation incidents, which expose the risk of flight, impact shipping?

A series of high profile aviation tragedies dominated global headlines in 2014. While experts have stated that the events were unique and do not point to a systemic problem in the aviation industry, the cluster of incidents has served as a public reminder of aviation's susceptibility to extreme weather events, terrorism acts and communicable disease.

Statistically, the world is enjoying the safest-ever overall period in aviation history, with aviation deaths and major plane crashes continuing to fall over recent decades. Recent events highlight that these statistics do not curb business and reputational losses for those airlines involved in the incidents. Most significantly, the loss of Malaysian Airlines' flights MH370 and MH17 have directly resulted in falling ticket sales, forcing the embattled airline to restructure: one-third of staff (6,000 employees) lost their jobs as part of a \$1.9 billion overhaul.

So what?

- Aviation has weathered worse crises in the past and it is unlikely that these incidents will alter the overall trajectory of growth in demand for commercial flights. However, if the frequency of terrorism and weather-related aviation incidents continues to rise, businesses may be spurred to re-evaluate transportation options. It is possible that shipping will increasingly be viewed as a relatively low-risk freight option and gain popularity.



Image credit: Doblonaut / Flickr

15. How might new interest in geoengineering affect shipping?

Geoengineering is attracting new interest, as the impacts of ocean acidification and global warming gain international recognition. In September 2014, the World Meteorological Organization reported that “the current rate of ocean acidification appears unprecedented at least over the last 300 million years”.

The US-based National Academy of Sciences has been studying various geoengineering solutions to climate change and is scheduled to release a report this year, based on a technical evaluation of a limited number of proposed geoengineering techniques, including examples of both solar radiation management (SRM) and carbon dioxide removal (CDR) techniques. The report will comment generally on the potential impacts of deploying these technologies, including the potential risks and consequences (both intended and unintended) for ocean acidification, and possible environmental, economic and national security concerns.

One such geoengineering solution would utilise olivine minerals, a group of abundant green-tinted silicates that are formed from the cooling of magma after volcanic eruptions, to remove carbon dioxide from the atmosphere. Dutch geo-chemist Olaf Schilling advocates sprinkling the mineral over the world’s ocean to have the additional benefit of mitigating ocean acidification.

So what?

- Studies have held shipping emissions responsible for contributing to high levels of local ocean acidification.¹ If geoengineering starts to gain mainstream acceptance, there may be the opportunity, or even expectation, for shipping industry players to invest in studies and innovative implementation of these solutions.
- However, there are concerns that new interest and debate around these mitigating solutions may distract from efforts to reduce the emissions, which is the root cause of the problems.

¹ IMO (2000) Study of Greenhouse Gas Emissions from Ships; Final Report to the International Maritime Organization

About the Sustainable Shipping Initiative

The Sustainable Shipping Initiative (SSI) is an ambitious coalition of shipping leaders from around the world, which is taking practical steps to tackle some of the sector's greatest opportunities and challenges and achieve a vision of a shipping industry that is both profitable and sustainable by 2040.

SSI members are leading companies from around the world and NGOs Forum for the Future and WWF. The cross-industry group represents ship owners and charterers, shipbuilders, engineers and service providers, banking, insurance, and classification societies.

www.ssi2040.org

About Forum for the Future

Forum for the Future is an independent non-profit working globally with business, government and other organisations to solve complex sustainability challenges. Our Futures Centre uses the collaborative potential of the digital world to help make the big shift to a sustainable future. By tracking trends, sharing resources, and stimulating dialogue, we can explore how change is unfolding and make considered choices about what we do today for better outcomes tomorrow.

The Futures Centre features topic hubs, areas where businesses, non-profit organisations, and individuals can collectively monitor the future of a specific area of interest. Participants can gain a better understand of how change is happening and its future implications through discussion, horizon scanning and exploring the convergence of future trends. Our first topic hub explores the future of shipping.

www.forumforthefuture.org
www.thefuturescentre.org

If you want to get involved
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