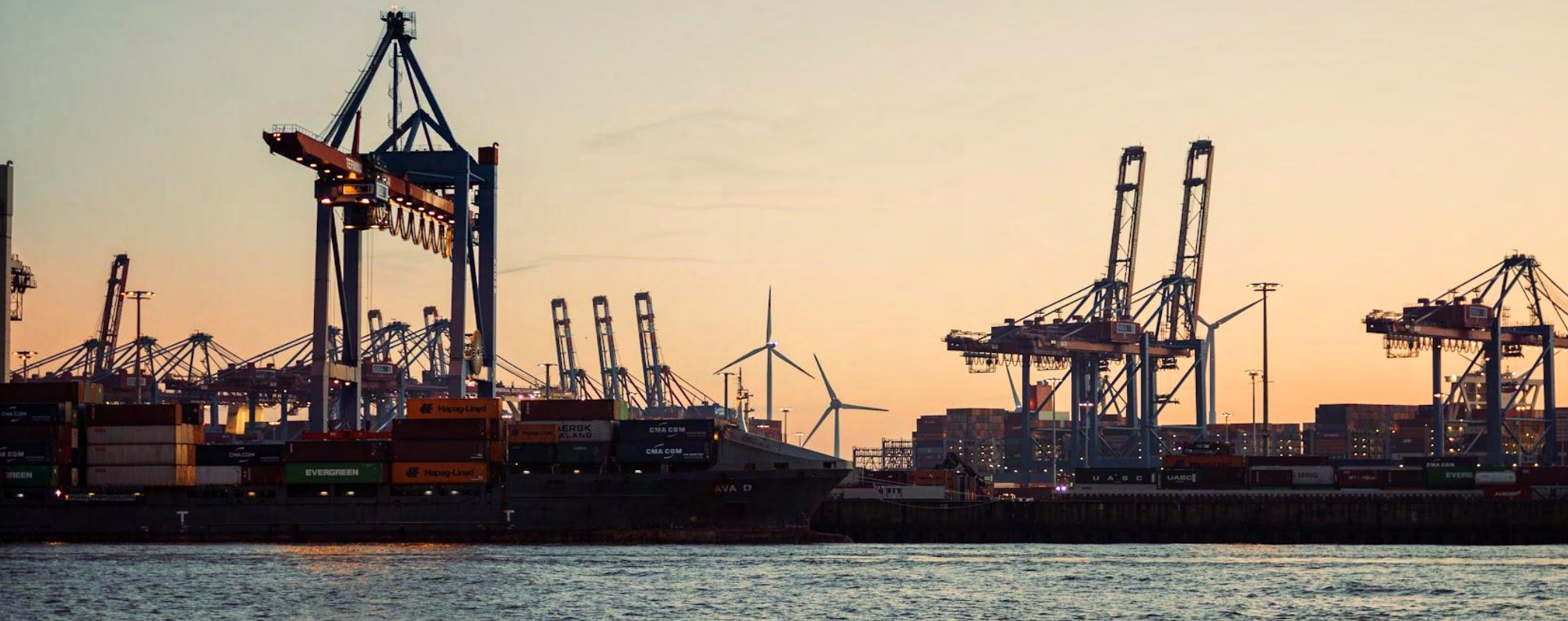
Thetius

BRITISH PORTS ASSOCIATION

TERMINAL **VELOCITY**

Emerging technology and future skills for UK ports



Forward

The British Ports Association has commissioned Thetius to examine how emerging technologies might change skills dynamics across UK ports in the coming years.

In this analysis, Thetius takes a high-level view of the ports of 2050 and unpacks some of the changes that are expected for the sector over the coming decades.

Digital and technological transformation should be high on the agendas of all UK ports and other stakeholders working in or alongside our industry. By working closely with our trade partners, including training providers, careers specialists, and human resource agencies, British ports can begin preparing for a changing world.

To provoke thought, discussion, and action, this extensive and complex subject is distilled into a bitesize vision of the future based upon current trajectories and trend lines. As such, this report provides some useful high level evidence to the UK Government and industry-organised Maritime Skills Commission, which is currently examining skills requirements for the maritime sector. We will also use this report as a key topic in the BPA's own Port Futures programme, looking at emerging and evolving issues affecting UK ports.

The British Ports Association is the national trade body for UK ports and harbours, representing over 400 ports, terminals and marine facilities, collectively handling just under 90% of the UK's maritime trade. We also represent all of the main maritime passenger, energy, fishing, and marine leisure hubs in Britain and work closely with Port Skills and Safety— the industry's lead body on skills and training.

Thetius enables innovation across the maritime industry by delivering a suite of research, consultancy, and talent services to the ports and shipping sector, as well as technology developers, innovators, and OEMs. Their global team of technology analysts and researchers all have extensive maritime sector experience, giving their research output a level of contextual understanding that is unparalleled in maritime innovation consultancy.

The British Ports Association, together with our partners Thetius, are delighted to present *Terminal Velocity - Emerging technology and future skills for UK ports*. We hope you find the following pages informative, entertaining, and insightful.

Richard Ballantyne
Chief Executive
British Ports Association

Introduction

When considering which technologies are most likely to influence future generations of UK ports, we need to begin with two simple questions:

- *What technology will be available?*
- *Which technologies will each port actually use?*

Particularly as an island nation, ports are an essential link in the UK supply chain; however, they're also a high-risk environment for workers. Add the fact that the maritime industry is notoriously conservative, and it becomes clear that any significant changes to the status quo will require that the benefits are proven, the risk profile is minimised, and a return on investment is established. Why change an imperfect system for an unproven one, without first ensuring the odds are stacked towards success?

It's highly plausible that new technology will completely disrupt the ports industry, and the ships of 2050 may no longer berth, load, discharge, and use port services in the traditional manner. However, while this may happen by 2050, it's unlikely. Most ships' working lives are between 20-30 years, so the cutting-edge ships ordered today for delivery in a couple of years from now will probably still be working in 2050.

In most ports, a diverse labour force is engaged in delivering marine operations, including pilotage, towage, dredging, surveying, and buoy maintenance. By 2050, technological changes will affect these tasks, and changes in legislative requirements for maritime qualifications will cover the skills required for these roles. In this mini-report, we take a closer look at which technologies are most likely to influence the next generation of UK ports and ask: what skills should the industry be looking for now, to prepare for the ports of tomorrow?

The big picture

A 2020 Techvalidate survey[1] found high costs, labour unions, and lack of skills were the biggest barriers to automation in sea ports. While these results are limited,

[1] TechValidate. (2020). *Challenges to Implement Automation.* https://www.techvalidate.com/product-research/navis-n4-platform/charts/41E-A0E-426

previous research in other industries has found similar results.[2] [3] [4] [5] [6]

In a 2017 survey, 76% of container terminal operators identified optimising operations as their primary concern, closely followed by reducing operational costs (67%).[7] Ports are an interface between land and sea transport so, as shown during COVID-19, they can become a chokepoint for multimodal transportation. Port call optimisation is key to ensuring the free-flow of goods. In the push for environmentally sustainable operations, sea transport will continue to increase and take further market share from air transport in the coming years, making the optimisation of future traffic demand ever more important.

Just as the once futuristic technologies of the internet and the smartphone have become an integral part of our daily lives, today's cutting-edge technologies will reach a tipping point well before 2050, paving the way for wider workplace adoption.

Barriers to technological progress will always exist; however, a combination of regulatory and competitive pressure and changes in adjacent industries such as shipping will force change over time. Similar pressures will dictate the pace and nature of developments in port technology.

It's highly plausible that new technology will completely disrupt the ports industry

2 Larsson, J., & Wollin, J. (2020). *Industry 4.0 and Lean – Possibilities, Challenges and Risk for Continuous Improvement.* Blekinge Institute of Technology. https://www.diva-portal.org/smash/get/diva2:1458094/FULLTEXT02

3 Sharpe, B. (2017). *Barriers to the adoption of fuel-saving technologies in the trucking sector. International Council on Clean Transportation.* https://theicct.org/sites/default/files/publications/HDV-fuel-saving-tech-barriers_ICCT-briefing_07072017_vF_0.pdf

4 Kantar Public. (2019). *Business Basics: Attitudes to Adoption (BEIS Research Report Number 2019/018).* Department for Business, Energy and Industrial Strategy. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/838473/attitudes-to-adoption.pdf

5 Baldwin, J., & Lin, Z. (2001). *Impediments to Advanced Technology Adoption for Canadian Manufacturers.* Statistics Canada. https://www150.statcan.gc.ca/n1/pub/11f0019m/11f0019m2001173-eng.pdf

6 Estrin, L., Foreman, J., & Garcia, S. (2003). *Overcoming Barriers to Technology Adoption in Small Manufacturing Enterprises (SMEs).* Carnegie Mellon University. https://apps.dtic.mil/sti/pdfs/ADA443496.pdf

7 TechValidate. (2017, August). *What are your terminal's biggest operational challenges?* from https://www.techvalidate.com/product-research/navis-n4-platform/charts/E5E-CEF-8CC

Transformative technologies

Like portable and handheld computing devices, transformative technologies are those which, if adopted, will fundamentally change the way port operations are conducted. We can divide new technologies based on the impact they'll have and the probability of adoption.

High-probability technologies

Big data,[8] alternative fuels,[9] and automation[10] will transform port operations by 2050. In most cases, this change will be direct; however, big data's greatest impact will be indirect, incentivising data collection, sharing, and collaboration. These, in turn, will facilitate and encourage regional and international port communities to optimise and balance port calls and traffic flows for the benefit of all.

Big Data

Computing "big data" involves the analysis of extremely large data sets, too big for conventional analysis techniques. Big data analytics is an enabler of most transformative technologies, including automation, artificial intelligence (AI),[11] machine learning (ML), and digital twins.[12] As connectivity improves, the use of connected sensors will proliferate rapidly. Cloud computing technology that has the ability to handle big data will be the column that supports all environmental sensing, condition monitoring, and the 'internet of things'.

For ports, big data (via AI/ML) drives berth and yard planning, anomaly detection, predictive maintenance, and mooring systems. When combined with effective communication systems and external data sources, such as those from single-window systems, AIS, or other ship-tracking technology, big data will facilitate just-in-time (JIT) arrivals, a concept which will remain central to port operations, even if recent events have encouraged a more 'just-in-case' methodology by manufacturers and retailers. By simplifying planning and administration, big data processing may also enable port authority and government awareness and assessment of secondary risks to ports and the supply chain.[13]

8 Chubb, N. (2020). *Brief guide to big data in shipping.* Thetius. https://thetius.com/brief-guide-to-big-data-in-shipping/

9 Gardner, N. (2021). *Understanding alternative marine fuels.* Thetius. https://thetius.com/understanding-alternative-marine-fuels/

10 Gardner, N. (2021a). *A brief guide to container terminal automation*. Thetius. https://thetius.com/a-brief-guide-to-container-terminal-automation/

11 Gardner, N. (2021b). *Current and future uses of artificial intelligence in the maritime industry.* Thetius. https://thetius.com/current-and-future-uses-of-artificial-intelligence-in-the-maritime-industry/

12 Brunton, L. (2021). *The current state of maritime digital twin solutions.* Thetius. https://thetius.com/research-the-current-state-of-maritime-digital-twin-solutions/

13 Shaw DR, Grainger A and Achuthan K (2017) *Multi-level port resilience planning in the UK: How can information sharing be made easier?*

Automation

Automation, while reliant on big data, has a discrete impact. Not everything can be automated, but many port activities, both physical and administrative, are predictable and repetitive. These activities are prime targets for automation.

From cranes to unmanned straddle carriers, automation is already in use in many major container terminals. Expanding the use of automation into other types of port terminal will become technically viable within the next thirty years. Whether non-container ports and terminals adopt automation depends very much on the port's strategy and competitor landscape.

Alternative fuels

Today, a range of alternative ship fuels and propulsion systems are vying for supremacy in a post-fossil fuel supply chain. By 2050, one or more of these will succeed in surpassing fossil fuel oils, but it isn't yet clear which. This paradigm shift is likely to affect ports in three ways:

1. petroleum ports and terminals will adapt or close;
2. provision of bunker/refuelling/recharging facilities for vehicles and vessels; and
3. changing risk profiles and emergency response.

As the proportion of vessels reliant on crude oil derivatives contracts, some ports have capitalised by creating new business in areas like wind farm construction and support,[14] [15] while others have been forced to lay off staff.[16] [17]

The risks and processes around today's fuels are well-known and well-understood. Liquid Natural Gas (LNG), hydrogen, ammonia, methanol and even lithium-ion batteries pose variable risks, and need appropriate facilities and safety plans.

Technological Forecasting and Social Change. Special issue on Disaster Resilience.

[14] Associated British Ports (ABP). (2021). *ABP unveils ambitious vision for Port of Lowestoft in support of SNS energy sector.* https://www.abports.co.uk/news-and-media/latest-news/2021/abp-unveils-ambitious-vision-for-port-of-lowestoft-in-support-of-sns-energy-sector/

[15] Port of Inverness. (n.d.). *Renewable Energy.* https://portofinverness.co.uk/activities/renewable-energy

[16] BBC News. (2016). *Redundancy threat for workers at Humber Estuary ports.* https://www.bbc.co.uk/news/uk-england-humber-35504022

[17] Hugill, S. (2015). Workers face redundancy at Port of Tyne. The Northern Echo. https://www.thenorthernecho.co.uk/business/13847354.workers-face-redundancy-port-tyne/

Insight

Docking an Autonomous Vessel

An autonomous container ship steers for the port approaches and enters the final phase of a trans-oceanic voyage. Passing the fairway buoy with no crew onboard, the vessel's navigational AI neural networks connect automatically to the port's environmental application programming interface (API) and start receiving real time environmental data. Now in ultra-high precision mode, the ship is maintaining a cross track error below 50cm.

The vessel securely connects to a remote pilot: a qualified human, located at a state of the art navigational command centre on shore. The pilot will monitor the approach and will be equipped to intervene if required.

Once within range, precision guidance systems at the berth will communicate with the vessel's navcom and the ship will initiate a final approach. Multi-channel optical and spectral sensors, processing several terabytes of data per second, help the ship's AI neural network to build a highly accurate digital twin of the vessel and the berth, modelling multiple control surface input commands in real-time to ensure the vessel docks with unparalleled precision.

Once in range, vacuum mooring armatures deploy to tether the vessel to the berth and bring it to rest alongside. Once in position, a team of port technicians will board and conduct visual inspections of the vessel and cargo before coordinating the arrival of automated cargo handling equipment.

Low-probability technologies

Certain technologies in development have a low probability of being in widespread use in supply chains by 2050. However, if these technologies gain traction in the coming decades, they will profoundly revolutionise the ports industry.

Elon Musk's Hyperloop[18] or Maglev trains[19] are examples. If adoption rates increase and they become commonplace in high-volume freight transport by 2050, they will incentivise the development of new technologies to speed up cargo operations in ports to avoid bottlenecks. If ships could discharge directly into the hyperloop tunnel at sea,[20] or if ports are sufficiently connected by hyperloop tunnels or maglev tracks, cargo operations could look very different. Indeed, a global network of ultra-green, ultra-high speed links could outmode ships altogether. The likelihood of this happening by 2050 is low however, as either option relies on extremely large investments in infrastructure over a

[18] Hyperloop Transportation Technologies, HyperloopTT. (2020). *Hyperloop Transportation Technologies*. HyperloopTT. https://www.hyperlooptt.com/

[19] US Department of Energy. (2016). *How Maglev Works*. Energy.Gov. https://www.energy.gov/articles/how-maglev-works

[20] Peters, A. (2016). *Imagine A Hyperloop That Uses Underwater Tunnels To Replace Cargo Ships*. Fast Company. https://www.fastcompany.com/3062709/imagine-a-hyperloop-that-uses-underwater-tunnels-to-replace-cargo-ships

very long period—assuming the remaining technical challenges can be overcome.
Similarly, while widespread adoption of personal jet packs,[21] flying shipping containers,[22] semi-submersible container ships,[23] and airships[24] would undeniably impact ports, but again, the probability of these technologies having a disruptive effect on the industry within the next two decades remains remote.

Ports of 2050

If we were to teleport an average port operative from 1991 to a port of 2021, how long would it take them to familiarise themselves with the operation? Afterall, most ports haven't changed that much, if at all, in the last 30 years.

Based on the rate of technological progress in recent years, an average port operative of 2021 who found themselves in 2050, would take much longer to adjust. Regardless of the port, workers in 2050 will inevitably face more automation, and need a higher level of technical knowledge as a result.

A significant proportion of impacts on port operations will come from technological advancements in their service user's and supply chain partner's operations. For example, increasing numbers of marine autonomous surface ships (MASS) may make it financially viable for shipowners to operate large numbers of small feeder ships. This would lead to widespread changes in cargo shipping, such as pivoting from the "hub and spoke" model to a "point-to-point" model,[25] routing cargo directly to its final destination, thereby spreading the load and reducing bottlenecks at high-throughput ports. This, combined with freeport areas and the push for efficiency, may encourage manufacturing to move closer to ports. While not a technological change in port operations, it would transform port operations, and provide new jobs in the port community area.

Regardless of cargo throughput, the UK ports of 2050 will have several things in common:

21 Debusmann, B. B., Jr. (2021). *Is the use of jetpacks finally about to take off?* BBC News. https://www.bbc.co.uk/news/business-57652297

22 Kenn, K. (2020). *Ghana to start using drones in carrying shipping containers.* AfriTechPost. https://www.afritechpost.com/ghana-to-start-using-drones-in-carrying-shipping-containers/

23 Oney, J. (2017). *Seahorse Shipping [Video].* YouTube. https://www.youtube.com/watch?v=D2OK0NPv5jQ

24 Hunt, J. D., Byers, E., Balogun, A. L., Leal Filho, W., Colling, A. V., Nascimento, A., & Wada, Y. (2019). *Using the jet stream for sustainable airship and balloon transportation of cargo and hydrogen.* Energy Conversion and Management: X, 3, 100016. https://doi.org/10.1016/j.ecmx.2019.100016

25 Rodrigue, J. (2021). *Point-to-Point versus Hub-and-Spoke Networks.* The Geography of Transport Systems. https://transportgeography.org/contents/chapter2/geography-of-transportation-networks/point-to-point-versus-hub-and-spoke-network/

- increased physical automation, particularly of port vehicles and cranes;
- individual mechanical aids, such as powered exoskeletons, to help with any remaining manual operations;
- increased process and system automation including single-window systems, coordinated data-sharing, and automated tools for berth and yard tracking and planning;
- increased tracking and sensors to drive data-based decisions, including predictive maintenance, and personnel and asset tracking within the port;
- facilities for handling alternative fuels and charging electric vehicles and vessels, and responding to related emergencies;
- remote pilotage; and
- resilience to extreme weather and climate events.

Next we explore the possibilities and present a picture of the high, medium and low throughput ports of 2050.

High Cargo Throughput Ports (>10 million tonnes per annum)

As it is today, high cargo throughput ports and those engaged in substantial commercial activities will have the greatest access to funding to support upgrading their facilities to the cutting edge of port technology. As ships increase in size and capacity, some of these ports will handle fewer ships, but the already-critical yard planning could become a major bottleneck in a high-flow cargo environment. These ports will have the opportunity to rely on AI tools and digital twin technologies to handle yard planning. Any changes in transportation technology ashore, such as maglev or hyperloop, will impact these ports the most.

As the MASS transition progresses, these ports will develop dedicated MASS terminals. These berths will integrate with the common MASS systems, providing jobs for those overseeing and maintaining the equipment.

On site, automated electric vehicles and cranes will carry out most port operations, overseen and maintained by specialised port operatives. Predictive maintenance systems will monitor the equipment's condition and schedule maintenance to minimise down-time.

On-site energy generation from tidal, solar, energy recovered from the lowering of crane loads, or other power sources, will work within a green grid to provide charging capacity for electric ships and port vehicles.

These ports will have new bunkering, storage, and emergency-response facilities for the various alternative fuels used by future ships, and as these ships become increasingly designed for specific cargoes, high-throughput ports will differentiate themselves from their competitors by providing specialised cargo services, such as on-site bagging, wood curing, fruit and vegetable ripening, or other specialised services that may develop over time.

A high level of automation will mean port operatives spend most of their time in monitoring or remote control stations, leaving hazardous areas without operatives on the ground. As operatives move around the site, wearable sensors will track them and ensure their safety. At the current rate of progress, 8G will be due to be rolled out soon after 2050, so by 2050 these ports may be debating whether to upgrade the port's local network.

Today's cutting-edge technologies will reach a tipping point well before 2050

Insight

Coordinating Autonomous Dry Bulk Cranes

A cargo operations supervisor scans a bank of screens. The cranes, busily navigating AI-optimised routes around the terminal, drop precisely calculated bulk material loads into hoppers. The sensor-generated topography of the cargo surface is overlaid on the cranes' camera and LIDAR feeds, while the dynamic stability feed confirms the ship's automatic ballast system has slowed to match the rate of discharge.

The predictive maintenance system for crane A3 beeps to consult the supervisor. Nothing serious—a fractional increase in the probability of bearing wear in the gravity generator. The supervisor confirms the computer action and swipes the screen to send the information to the technical team for attention. The central cargo operations algorithm reduces the demand load for crane A3 by 2.5% to compensate.

Another screen beeps an alert: hold 2 will need a bobcat shortly. Glancing at the overview, the supervisor confirms that one autonomous bobcat is online, charged, and waiting outside the working area. The system brings the bobcat into position, ready to lift into the hold. The comm buzzes—it's the GPO, asking permission to enter the work zone. The supervisor initiates the A-berth automation shutoff, double-checks the personnel-tracking system, and takes remote control of A2 before giving the GPO permission to enter the work zone and connect the electromagnetic lifting wires.

As a freeport with an innovation hub, these ports will be able to provide targeted training to their port workers and the surrounding community, increasing the pool of skilled workers. They'll likely become part of an international connected ports partnership, allowing data-sharing through shared technology to monitor shipping and environmental data. This shared data will help to facilitate just-in-time (JIT) arrivals, which by then will be the default for a maturing, technologically enabled, global supply chain.

Medium Cargo Throughput Ports (>1 million tonnes per annum)

Overall, these ports will have high levels of automation, but will be less automated and more flexible than the high-throughput ports. They may also be freeports, but will have proportionately more staff, fewer specialised berths, and be better able to handle ships with less recent technology than higher-throughput ports.

Although these ports will have bunkering facilities for the most common alternative fuels used in the area, ships which need other fuels may need to be supplied by road tankers or bunker barges. As with all ports, charging will be available for electric ships and vehicles, and the port will be as close to carbon-neutral as possible.

Local port associations for medium and low-throughput ports will work together to achieve economies of scale when it comes to technology acquisition. By handling a wider range of cargoes than low-throughput ports, medium-throughput ports will be more resilient to the shift away from less-sustainable products such as petroleum products and logs.

Low Cargo Throughput Ports (<1 million tonnes per annum)

By 2050, as now, we will see the greatest variability in low-throughput ports, although some non-cargo activities could involve substantial commercial opportunities. Today's specialised petroleum or log-handling ports may have adapted to a shifting marketplace and pivoted to serving environmentally friendly sectors such as wind-farm support or alternative fuels. While these ports will have some automation, such as automated weigh-bridges, they have a more limited scope and budget for major changes. Remote control cranes, forklifts, and similar vehicles may be in use as new technologies become more attainable as they mature. Some ports will specialise by automating their operations to suit particular cargoes, while others will provide general services with less automation.

As high- and medium-throughput ports focus on handling newer, larger ships, low-throughput ports will be a refuge

for older ships, including coasters and feeder ships, fishing boats, short-sea shipping, and small cruise ships that want “the human touch”.

These ports will have the advantage in agility and flexibility, which will allow them to test, refine and implement automated monitoring and management tools that rely on minimal infrastructure investment, such as yard tracking and planning, mooring and flooding risk assessment/warning tools etc.

Improved transport links for self-driving cars, trains, and public transport will make these local ports industrial and training hubs. As with the medium-throughput ports, regional port associations will be key to ensuring tech accessibility.

Non-cargo Handling Ports

For ports that don’t handle cargo, such as energy facilities, offshore supply hubs, fish landing infrastructure, marinas, repair yards, and passenger terminals, the outlook is subject to broader interpretation.

There have been many advances in yacht and pleasure craft technology that are designed to make handling and navigation easier and safer for non-professional crews.

Assisted docking systems are already available that utilise dynamic positioning technology in conjunction with onboard motion, positioning, and environmental sensing systems to automate vessel control in response to joystick inputs from the operator. This concept will develop into smart docking systems that enable fully-automated berthing. This could be as simple as providing highly accurate digital twin models of the marina berth, overlaid with live wind, tide, and traffic data. This is most likely in marinas that accommodate large yachts.

Services such as hull cleaning and sewage pump out are likely to be delivered with the aid of automated robotic systems. Robotic craft are in development that remove hull fouling while a vessel sits alongside. Barge tenders and water taxis operating around the port may also commonly be remotely operated, or fully autonomous.

Refuelling docks will remain, but are likely to stock little or no diesel fuel, offering green alternatives such as electric recharge points and liquid hydrogen. The port area will likely generate more of the energy consumed at the port locally, using wind and solar harvesting plants and even small-scale tidal generators.

Environmental management will be an important factor for many non-cargo ports, and greater monitoring may be

achieved by using autonomous craft patrolling port limits, or by installing smart buoys that collect and transmit live data to the cloud.

Roles and skills in 2050

According to the UK National Careers Service, a port operative needs mechanical aptitude, the ability to use electronic devices for basic tasks, physical abilities like lifting and bending, and generic soft skills such as communication, attention to detail, and the ability to work with others.[26] The only requisite qualifications listed for a port operative are a medical check, and (possibly) a drivers' license. As a result of the low barriers to entry, there is a risk of instilling the idea that many port operatives are low-skilled manual labourers who will be easily replaced by automation in the ports of 2050.

With the rise of automation, a sizable port workforce will still be needed to fill skill gaps where the cost of automation is considered prohibitive against the value derived (e.g. securing mooring lines etc.), as well as monitoring and maintaining equipment, requiring a high level of understanding and technical skill. Humans may also be required to operate equipment and systems, but may be doing so remotely, from safe, clean operations control rooms. Skilled staff will also be needed to solve the "edge cases", or problems that the equipment is not designed to handle, or which might confuse artificial logic under certain conditions..

While the port operatives of 2050 will certainly need to use consumer computing devices, interpersonal skills and problem-solving will remain critical at all levels. Flexibility, innovation, communication, and creativity will be essential, but these will rely on a solid foundation of digital literacy, including understanding of electronics, AI, and data integrity.

Plugging the gap

While some of the port technology of 2050 may resemble science fiction and the skills required appear to be some leap from those of today's port operatives, it is useful to reflect on how far the industry has come since 1991.

In November 1995, the United Nations Conference on Trade and Development (UNCTAD) described the internet as, "...a computerized network that spans the world…".

[26] UK National Careers Service. (n.d.). *Port operative*. https://nationalcareers.service.gov.uk/job-profiles/port-operative

Insight

Optimising Port Calls in 2050

The port scheduling network is connected to every international port across the world. Globally-agreed standardisation means that all status messages, terminology, nomenclature, cybersecurity, and communications protocols are universally understood across the entire supply chain.

Nine weeks from now, the port is expecting the arrival of a 16,000 TEU container vessel to discharge import cargo. The vessel has two port calls on two continents to complete before arrival, but the port's AI scheduling system is already expecting the vessel to be 8 hours ahead of her scheduled arrival time. By analysing real time vessel performance data, global meteorological route models, and live gantry performance metrics, the destination port will monitor the ETA in real time. Infact, the port duty controller is able to model the state of the port at any given time in the future. Fuel supplies, service demand, wharf occupancy, crane demand, truck, rail, and hyperloop traffic, and the status of the air and water quality of the port environment, are all modelled for risk assessment and planning.

The controller is alerted to a cargo handling conflict for a new arrival that has been scheduled by a booking agent to arrive in 6 days. Two cranes will be inactive for a few hours of planned maintenance which is highly likely to impact on discharge operations for the vessel. The operator alters the scheduled arrival time to coincide with the completion of the maintenance window, sending a message to the vessel operator to expect the new arrival time and adjust the voyage speed accordingly.

They go on to list just 13 ports worldwide that had websites, and addressed a need to explain how ports can access this new technology with, "...a computer linked to a server which in turn is linked to the Internet."[27]

The youth of 2021 are "digital natives"—they've never known a world without the internet. Accessing it and using it in daily life is knowledge acquired by osmosis—as familiar as catching a bus, or visiting the supermarket. In progressive schools, children learn the concepts of coding and data analysis before they turn 10. They'll grow up using AI tools and machine learning models in the same way that previous generations used typewriters, personal computers, and smartphones.

When today's students enter the workforce in 10 or 15 years, cutting-edge port technology will be just another application of familiar concepts.

[27] UNCTAD. (1995). *Ports Newsletter No. 14.* https://unctad.org/system/files/official-document/sddportmisc4_en.pdf

Training today's port workers

The challenge before port operators is upskilling their workforces today. The new entrants of 2021 will be the managers and team leaders of 2050. However, a natural reluctance to upgrade equipment that's still working creates a lag in adoption of state-of-the-art technologies until:

- the price comes down;
- the original equipment becomes uneconomical, uncompetitive, illegal, or impossible to maintain;

  or

- there is a way to retrofit the existing equipment for extra functionality.

As a result, unless human and economic drivers change, port equipment will be upgraded piecemeal over the next 30 years. This means ports will have an opportunity to train today's workers gradually as they progress through the ranks. Training that goes beyond "which buttons to push" and includes explanations of the underlying concepts will give staff a chance to develop their knowledge and understanding and develop alongside the port itself.

Rather than sending staff away on courses, modern educational technology,[28] such as extended reality (XR)[29] and targeted bite-size training modules will make on-site training viable. If ports provide a clear route for continuous career progression linked with ongoing training, and make training available to everyone rather than just those who interact with the equipment, they will increase staff engagement and reduce the threat posed by change.

Since ports upgrade equipment at different rates, in a few years "exchange programs" could give workers experience with new equipment before it's installed in their port, and give decision-makers the chance to assess whether the equipment would be a good fit.

Offering alternatives

Wherever it is introduced, new technology changes the skills dynamics of the workforce and creates new jobs. Port technology has been, and will be, no different. Ports with high levels of automation will end up needing fewer manual labourers, and more technically-proficient staff. In a fast-changing industry, this could lead to

[28] Gardner, N. (2021c). *How will advanced simulation impact maritime training?* Thetius. https://thetius.com/how-will-advanced-simulation-impact-maritime-training/

[29] Gardner, N. (2021d). *Brief guide to extended reality in the maritime industry*. Thetius. https://thetius.com/brief-guide-to-extended-reality-in-the-maritime-industry/

redundancies; however, the slow rate of change anticipated in most ports, presents a comfortable time frame for change that allows the ports industry to properly support the transition to a differently-skilled workforce. They can plan ahead, change their hiring practices, promote from within, and allow natural attrition and retirement to reduce staff over a long period.

By creating an attractive hub for local manufacturing and innovation, freeports will increase job opportunities for workers whose skills don't easily match emerging requirements.

Final thoughts

As a 2018 Barclay's report noted, "even the most path-breaking technologies end up automating specific tasks within a job, not the job itself."[30] Change is inevitable, and the coming decades will see accelerating technological changes throughout society, so we need to prepare. Another report observed that "[technological change] reduces employment opportunities in low-skilled and routine occupations,"[31] while jobs involving perception, manipulation, and creative and social intelligence are less susceptible to automation.[32]

Just as we couldn't have foreseen the range of jobs created by the internet, we can't foresee with absolute certainty the range of jobs that will be created by upcoming technological innovations in UK ports.

We can, however, be sure that workers will need different skills. By planning ahead and taking proactive steps to understand the degree of technological change that is approaching, port and terminal operators, their supply chain partners, and government and local authorities can ensure that a measured, deliberate, and controlled adaptation process takes place.

What is also clear is that emerging technologies will be a disruptive influence regardless of a stakeholder's readiness to take advantage. Preparing for a new paradigm is important at all levels of the UK ports industry.

30 Barclays. (2018). *Robots at the gate: Humans and technology at work.* https://www.investmentbank.barclays.com/content/dam/barclaysmicrosites/ibpublic/documents/our-insights/Robots-at-the-gate/Barclays-Impact-Series-3-Robots_at_the_Gate-3MB.pdf

31 Dachs, B. (2018). *The impact of new technologies on the labour market and the social economy.* European Parliamentary Research Service. https://www.europarl.europa.eu/RegData/etudes/STUD/2018/614539/EPRS_STU(2018)614539_EN.pdf

32 Frey, C. B., & Osborne, M. A. (2017). *The future of employment: How susceptible are jobs to computerisation?* Technological Forecasting and Social Change, 114, 254–280. https://doi.org/10.1016/j.techfore.2016.08.019

Thetius

BRITISH PORTS
ASSOCIATION

For more information visit
www.britishports.org.uk/port-futures