PORT TECHNOLOGY
SUMMER EDITION 78 - 2018

# THE JOURNAL OF PORTS AND TERMINALS

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# CONTAINER SUPPLY BLOCKCHAIN

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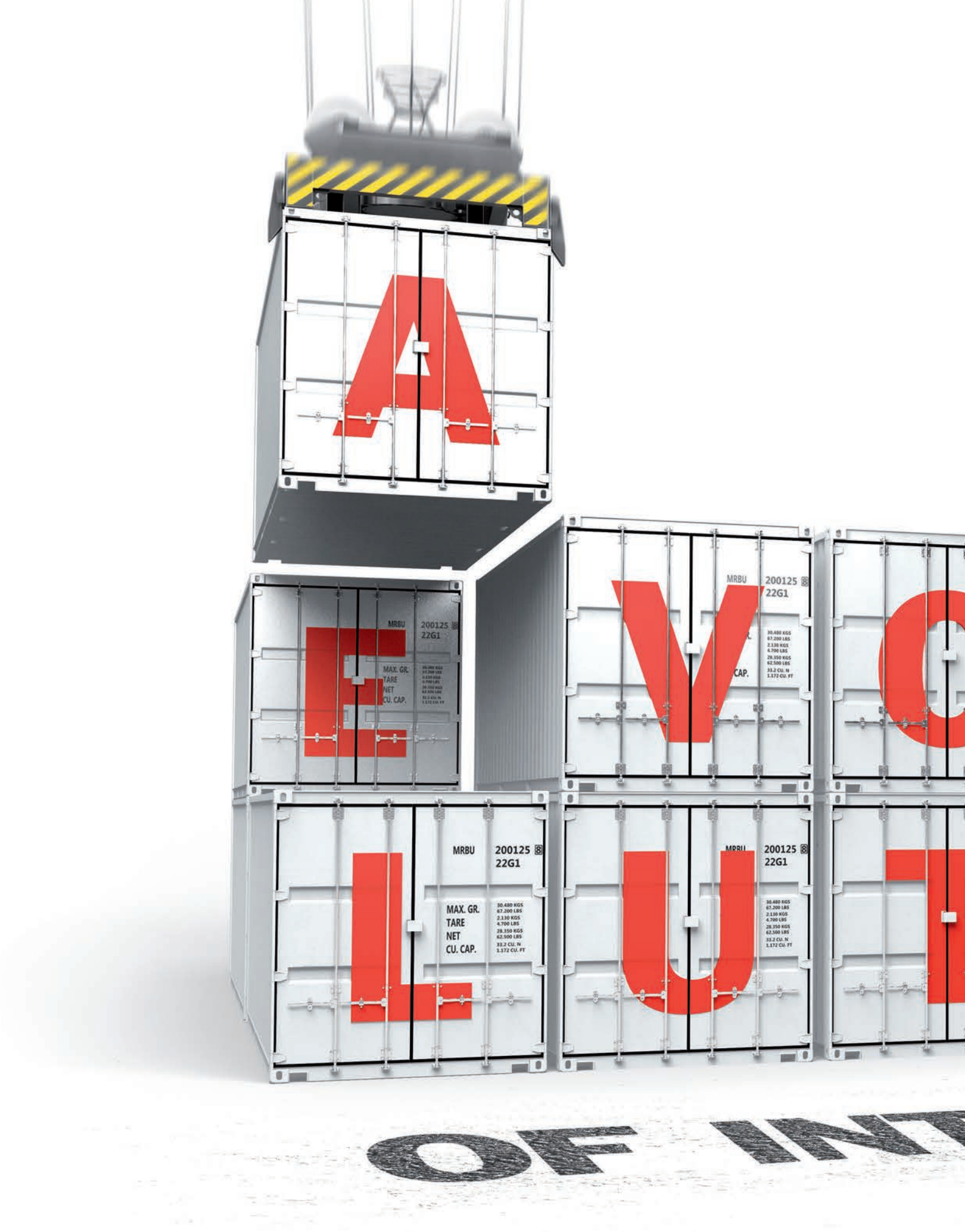


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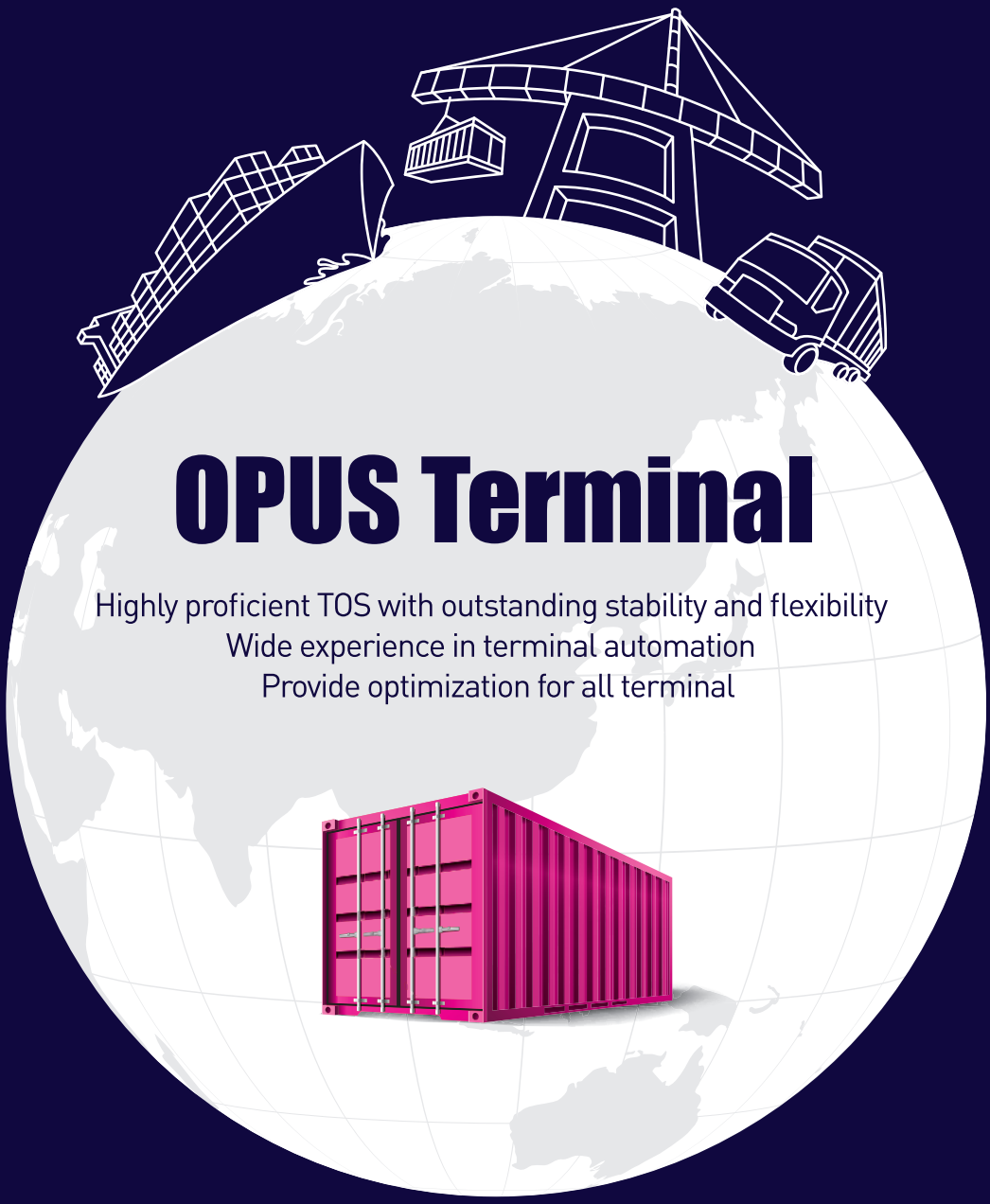


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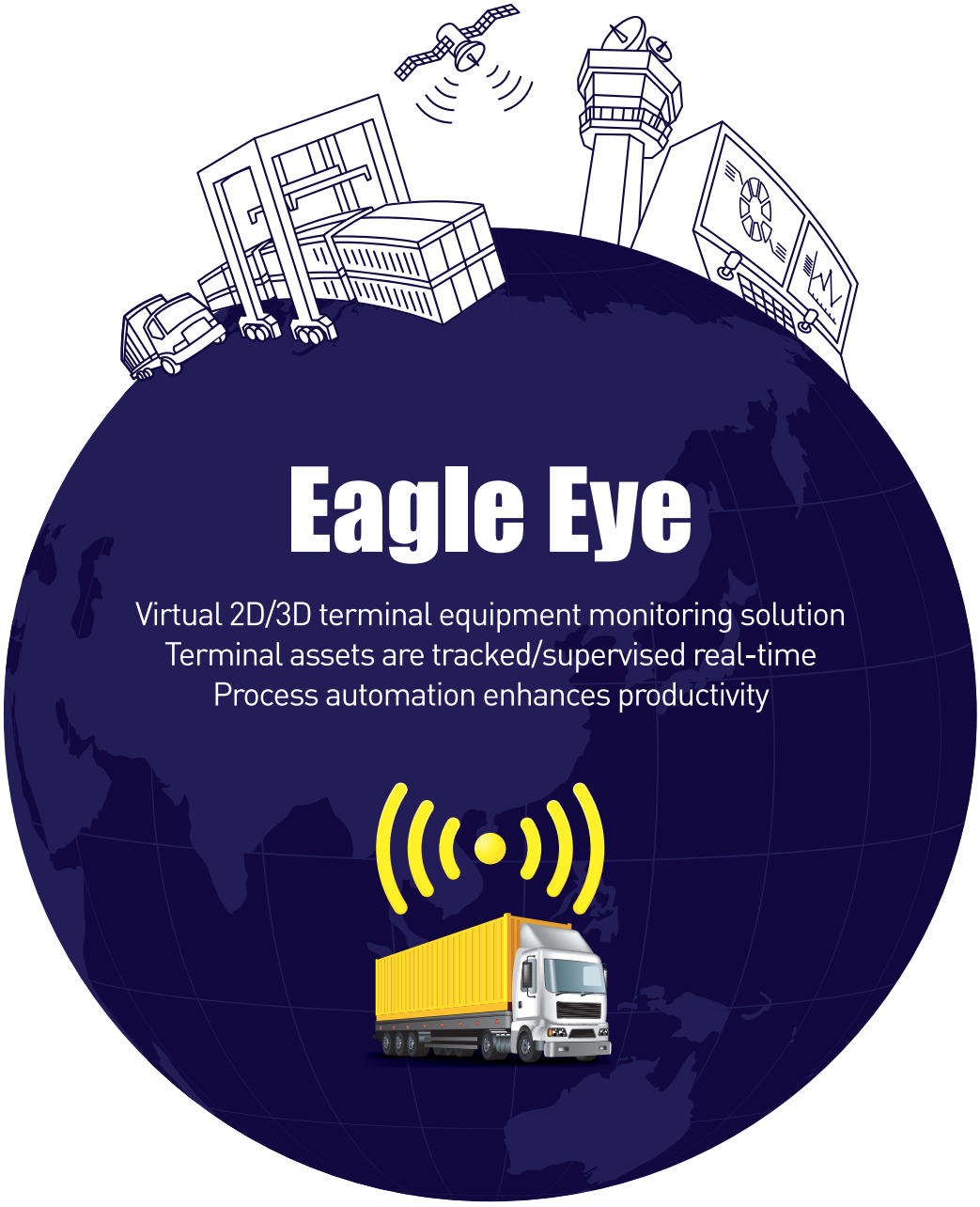


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FROM THE

# MD

A warm welcome to The Journal of Ports and Terminals, Edition 78. What a whirlwind year for us so far! I hope our delegates will agree with me in saying 2018 has seen the best PTI event yet, with our recent Container Terminal Automation Conference (CTAC) 2018 a magnificent foundation from which to build.

As is our style, we had our speakers interacting with our audience after delivering short presentations, and we really seem to have struck gold with this format. I love seeing sessions take on a life of their own and develop in ways that we could not plan. I feel this free and open-minded approach is central to our success. We've heard so much about collaboration, yet it's rare we get everyone together to actually talk. I want Port Technology to provide that platform, and the events are going someway in achieving that aim.

On the back of the success of CTAC, I think it's important we don't settle and we strive to continue the energy we've generated. This is why I'm announcing another event to the Port Technology portfolio: Smart Ports & Supply Chain Technologies.

This new event, to be held in Rotterdam in early October this year, is going to be even bigger and better, as we move beyond the immediacy of the port and look into the technologies that are unifying along the supply chain and evolving the titular 'smart port'.

I've written in these pages before that technology is seriously changing our business models, methodologies and civilization. It is imperative for me that Port Technology is in accordance with such developments, charting the changes and elucidating the evolution as we go.

Since I began my time at PTI, I've always seen that this industry, while ostensibly about ships, cranes and terminal machinery, is the engine of the world economy and therefore a key driver of political, financial and social change. This is becoming ever clearer with recent (and future) advancements in technology, so there's significant opportunity for Port Technology to grow, and I want to grasp that chance along with all of our partners old and new.

On that note, a sincere thank you to all of our partners, we just would not be able to achieve the things that we have if it wasn't for your continued support. We are blessed as a company to have many friends and acquaintances who have such a passion for their work and share the same vision as we do.

Before I sign off, let me just point you in the direction of the paper leading this edition 'Ports for Tomorrow: Smart Links in Intelligent Supply Chains' by Wolfgang Lehmacher at the World Economic Forum. It is a fantastic read that has really helped me and the team build the intellectual groundwork for the Smart Ports & Supply Chain Technologies conference. I really recommend you take some time to read that paper.

James AA Khan, Managing Director

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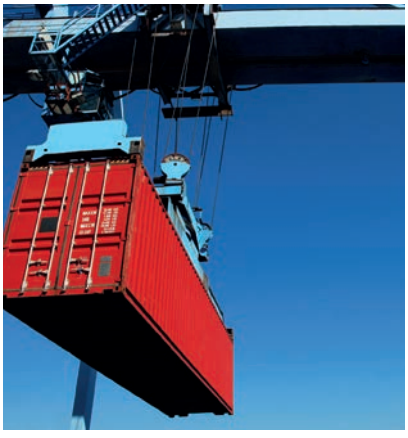

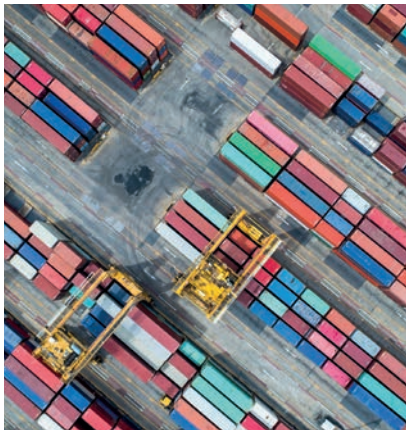

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PORT TECHNOLOGY


# CTAC 2018: A CONFERENCE REVIEW

Richard Joy, Editor, Port Technology

On the 14-15th of April 2018, Port Technology held its third Container Terminal Automation Conference in which we explored how artificial intelligence, automation and digitization will change – and is changing – the container terminal industry.

We discovered some vital lessons during the conference: solution providers must prove the worth of their technology to operators, that blockchain – though potentially revolutionary – is still in its nascent stage (which is the polite way of describing how the ever-enlightening Professor Jean-Paul Rodrigue put it, who also features in this issue) and that while the potential of AI is great, we are still on the cusp of a major wave that we'll do better to ride rather than predict.

Much of the insight we were able to draw from the conference was evidently down to our blossoming short presentation followed by question and answer (with the audience) format. By combining this with speakers representing solution providers, consultancies, academia, and, perhaps most popularly, ports, we fostered a dynamic atmosphere in which no element of the conversation could take precedence. Thereby, each speaker had to temper their aims against the goals of other players in the sector.

Far from being adversarial, this actually created an often intriguing blend. This was no better expressed perhaps than by Chris Mason of Rajant (a mobile network provider) and Miguel Llop of the ValenciaPort foundation who were able to chime with one another on the models of communication networks in terminals. Similarly, Alex Backer of QLess harmonized brilliantly with Marc Laureys of DP World Antwerp, as the two explained how they eradicated endemic truck queues at the Port of Antwerp (Alex further explores this fascinating case in a paper in this edition).

It would also be remiss of me not to mention the fantastic impact Christian Blauert CEO of Yilport had. By laying out his raison d'être for being at the conference and what he wants to see as CEO of a major terminal operator, he brought an urgency to the conference and pinned down the often lofty conversations of AI to everyday terminal operations.

As with the last two conferences, it was a pleasure for me to moderate the introductory session of the event and welcome Neil Davidson (Drewry), Wolfgang Lehmacher (World Economic Forum), Lars Jensen (SeaIntelligence) and

the aforementioned Professor Rodrigue to provide an overview of the present shipping market, automation today and what digitization heralds for the industry. This provided a brilliant foundation, yet it was clear our audience could've benefitted by broadening out this subject matter, and that is something I want to do even more so over the rest of 2018.

The conversations we started here went from macroeconomic to stratospheric as we opened up many doors to the potentialities of the industry, and I believe there's no other way we can talk about the future. The reality is that we don't know the potential of AI, how disruptive it will be, or if it will have a direct impact on container terminal operations, but the fundamental truth is that whatever does happen with the advent of super-intelligence, it will involve the economic, governmental, physical and digital having a much closer relationship, and perhaps even as a fully functioning whole.

It is in this vein that the top companies are already thinking. IBM and the Port of Rotterdam are thinking smart, while Microsoft and Maersk are also combining, stating that while digitization is relatively new and understated in our industry, it is set to fundamentally change, as they preach patience over pontification. Such collaborations led several of our speakers to offer a container terminal biography, charting the development of the modern industry to the present day, exemplifying how drastic change has always been approached with initial trepidation, followed by widespread implementation.

Dr Oscar Pernia of Navis highlighted in his summarizing speech one key takeaway, and that is that we need to maintain our focus on people and technology, not focus our attention on the technology and forget the people. This was also a point well made by Dr Eva Savelsberg of INTTRA (you can read her latest update in this edition). We've been lucky to have her insight in the last few editions of PTI as she's charted a vision for humans and AI to partner each other, while we also broaden our scope to take influence from other sectors. I also feel it's important to mention the point that Lars Jensen made regarding the future winners. In his view this will be those who are prepared for and can handle exceptions.

# NEWS IN BRIEF

### HUTCHISON DEVELOPS REMOTE-CONTROLLED TERMINAL

Hutchison Ports, a global terminal operator, has revealed that it will spend $600 million to open a fully remote-controlled terminal, Terminal D, at Thailand's largest commercial port of Laem Chabang. The new terminal will be the first in the world to control both ship-to-shore (STS) cranes and container yard cranes remotely from a control room, according to Stephen Ashworth, Managing Director of Hutchison Ports' Thailand and Southeast Asia arm, who revealed details about the project at a press conference. Ashworth said the project would be working towards a completion date of 2024.

### MSC TO INVEST $1.1 BILLION IN NEW KHALIFA PORT

MSC Mediterranean Shipping Company (MSC), a Swiss-based logistics company operating the world's second largest containership fleet, has agreed to invest $1.08 billion (AED 4 billion) with Abu Dhabi Ports to establish a new container terminal. MSC will spread its investment over a 30-year concession agreement period to build upon the UAE's position in attracting major international companies at Khalifa Port. The development of the new terminal in addition to another at the port will expand its capacity from 2.5 million TEUs to 8.5 million TEUs in five years.

### SINGAPORE PURSUES $1.1 BILLION PORT DEVELOPMENT

The Maritime and Port Authority of Singapore (MPA) has signed an agreement for a $1.1 billion second phase development of Tuas Terminal — set to boost the total port capacity by 21 million TEUs by 2027. The next phase in the four-stage operation will include the design and construction of 387 hectares of reclaimed land surrounded by 9.1km of caisson walls. When fully developed by 2040, the terminal will have the capacity to handle 65 million TEUs annually — with almost all port functions moved from Singapore's Central Business District moved over to it.

### DP WORLD AND HYPERLOOP ONE CREATE CARGOSPEED

DP World and Virgin Hyperloop One have made a ground-breaking partnership to create DP World Cargospeed, a global company looking to provide freight delivery services through hyperloop technology. DP World and Virgin Hyperloop One unveiled their vision for the hyperloop-enabled freight transportation system at a launch event attended by His Highness Sheikh Mohammed bin Rashid, DP World Group Chairman and CEO, Sultan Ahmed Bin Sulayem and Virgin Group Founder and Virgin Hyperloop One Chairman, Sir Richard Branson. DP World Cargospeed will be designed to transport high-priority, time-sensitive goods including fresh food, medical supplies and electronics, and will be made to connect with existing road, rail and air transport modes to expand freight moving capacity.

### NORWEGIAN FIRMS START FIRST AUTONOMOUS SHIPPING COMPANY

Wilhelmsen and Kongsberg have joined forces to create a new autonomous vessel company called Massterly. The Norwegian companies will take next step in autonomous shipping by offering a complete value chain for autonomous ships, from design and development, to control systems, logistics services and vessel operations. Massterly will use land-based control centres to monitor and operate autonomous ships in Norway and internationally. With a combined 360 years of experience, Massterly will benefit from Kongsberg's technological expertise and solutions, and Wilhelmsen's logistics and ship management operations.

### SAMSUNG PLANNING BLOCKCHAIN SHIPPING STRATEGY

Samsung is planning a blockchain ledger system in order to monitor billions of dollars-worth of trade — it is believed such a system could cut shipping costs by 20%. Song Kwang-woo, who is in charge of blockchain at Samsung SDS, an information technology subsidiary of Samsung, said: "It will have an enormous impact on the supply chains of manufacturing industries. Blockchain is a core platform to fuel our digital transformation." Blockchain has the promise to be a game changer in the global supply chain as it allows disparate entities along the supply chain to collaborate in a secure, private chain. Samsung is another major name to add to the list of companies getting involved in blockchain. The biggest of such names comes in the form of Maersk and IBM who announced a blockchain strategy at the beginning of 2018.

# AUTOMATION & OPTIMIZATION: INTELLIGENT SUPPLY CHAINS

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# PORTS FOR TOMORROW

## SMART LINKS IN INTELLIGENT SUPPLY CHAINS

Wolfgang Lehmacher,
World Economic Forum, Geneva, Switzerland

The port is the smart link in the intelligent supply chain. An 'intelligent' port will connect its non-automated, semi-automated, and fully-automated assets in the yard. A digitally connected operating space leverages data generated from within, received or extracted from external sources to reach decisions that benefit the business and its customers.

The system will monitor information about the position and state of assets and goods that approach and depart from the port, and provide insights into weather, labour disputes and congestion.

Smart ports constantly gather and analyse data to establish full visibility of the flows within a port and steer the assets in the safest and most efficient way. The capability of data management, i.e. the gathering, categorizing, computing and storing of data, sits at the core of the intelligent systems. Data is the oil of the digital economy. Digital businesses and governments capture all types of data that is obtained through the devices of The Internet of Things (IoT) and moves over its data highways to the computing engines.

Data availability, computing power and artificial intelligence (AI) drive visibility and autonomous decision-making along the entire supply chain. Friction in the data flow affects the system, which is why ports need to live up to their role as a smart link in the global world of commerce seriously by collaborating and investing in such technology

### DIGITIZING FOR INTELLIGENCE

AI does not only provide the brain that is needed to compute data for decision making, but also the senses to capture and share data through many tools, such as optical character recognition (OCR), which interfaces with other systems of the digital and biological worlds, including humans. Intelligence along the supply chain starts with digitization, which allows process automation to reduce cost and mistakes by taking paper and human error out of the equation. Digitization also allows the parties to collaborate and transact on the basis of smart contracts. IoT captures and transmits data to inform smart contracts about the position of cargo. The product of digitization is data, which can be used for smart contracts but also analyse and manage the supply chain. Ultimately, smart supply chains use data to steer themselves.

### THE GAIN

Digitizing and smartening the supply chain offers huge tangible benefits. One example is trade and supply chain finance. The Asian Development Bank estimated a global trade finance gap of US$1.5 trillion in 2016. The gap stems largely from hugely underserved small and medium

# Technologies enabling the digitalization of the supply chain

| New technologies | Pre-transaction | | Transaction processing | | | After transaction | |
|---|---|---|---|---|---|---|---|
| | Product selection | Data entry | Workflow management | Document check | Compliance check | Problem resolution | Client mgmt. information system |
| Optical character recognition (OCR) | | **Text recognition** from trade documents to minimize data entry | | **Check for completeness of documents** based on transaction/ product type | **Scrape documents** for AML keyword hit | | |
| Artificial intelligence (AI) | **Intelligent** and **personalized marketing**: Offer new product sales or client promotions based on insights on clients' needs and behaviors | **Populate fields** with text extracted from documents (**integrate OCR with transaction process**) | | **Validate / remed-iate data** with cross-references, machine learning | **Contextual filtering:** Identify suspicious or unusual activity and block suspicious transactions based on predictive indicators | **Intelligentproblem resolution:** Track individual error rates and flag users in need of remediation | |
| Advanced analytics (AA) | | **Enhanced KYC** (e.g., web scrape) | Efficient process and productivity **monitoring, and** predictive analytics to **detect patterns** | | | | Reports enable enhanced **operational and strategic decisions** |
| Robotic process automation (RPA) | | | **Bridge data flow and communication:** Integrate data from different systems into single interface | | | | |
| Internet of things (IoT) | | | **Ease of tracking** goods and documents; **dynamic pricing and financing** triggered by shipment events; **automated payments release** based on "smart contracts" | | | **Track document locations:** Track goods (location, volume, quality) | |
| Distributed ledger technology (DLT) | Create smart letter or credit as **smart contract** on distributed ledger - auto notifications | Replace document-ation, checks, data entry, validation, with **single digital record** | Real time **verification and reconciliation;** workflow executed as per smart contract conditions; replace payment and funds transfer with **cryptocurrency** | | | | |

Source: Bain & Company



sized enterprises (SMEs), caused by the massive volume of paper required for communication among customs brokers, freight forwarders, transportation carriers and myriad government agencies. Paper-based, manual processes, some created centuries ago, lead to complexity and delays, introduce errors and risks and stand in the way of reliable, real-time information gathering and tracking required for credible financing decisions. Consequently, 52% of SME financial request rejections are due to higher risk and lack of collateral.

Paperless border processes are another source of potential improvement through digitization and automation. In 2016, the United Nations Economic and Social Commission for Asia and the Pacific adopted the Framework Agreement on Facilitation of Cross-Border Paperless Trade in Asia and the Pacific to advance regional coherence. Estimates suggest that the agreement could boost Asia Pacific exports by as much as $257 billion annually if it fulfils its aim to encourage the adoption of digital tools to facilitate trade. The United Nations Economic Commission for Europe (UNECE) has also found that export times could fall by 44%.

IBM and Maersk estimate that managing documentation represents a fifth of total shipping costs.

## THE BRAIN

AI allows computers and machines to function in an intelligent manner, and it is computing engines that are pivotal to the intelligent supply chain ecosystem. Two important functions connect AI and computing engines. The first is machine learning, which designs and deploys models into applications, processes and other machines. The other is streaming, which controls system data flows. The brain needs to perform the processes of sensing, reasoning and acting. Sensing is needed to capture what is happening in the supply chain. Reasoning is the process that helps to assess the importance of what has been sensed, and acting means taking necessary steps in a reliable way.

## OPERATIONAL AND BIG DATA

Millions of sensors, tags and badges allow the collection of continuously small operational data about the status and changes in each and every part of the system. Real-time locating systems (RTLS) identify and track the location of assets, individuals and objects, such as trucks, rubber-tyred gantry (RTG) cranes and reefer containers.

Small and big data combined with immense computing power allows the intelligent supply chain to constantly perform predictive analytics and uses machine and deep learning models to:

- Track the developments within and around the supply chain
- Identify trends and anticipate risks and opportunities to avoid disruption
- Create additional value for government, businesses, consumers and citizens

Powerful data mining tools can extract data from hundreds of thousands of websites. The software tools connect the operating system with the digital world through application program interfaces (API) and allow slicing and dicing social media and website data according to specific needs. Cognitive operating systems crawl internal enterprise resource planning (ERP) systems to find and filter out information as the basis to make longer term but also short term decisions to ensure the highest fluidity of goods, data and finances along the supply chain and avoid disruption.

## DIGITAL EYES, EARS AND VOICE

There are many ways data is captured and shared. Intelligent cameras help to raise security at the gate. Facial recognition ensures that only authorized personnel can enter the port. Cameras feed cognitive operating systems with information taken off number plates and help to monitor and follow the movements in the port, including people moving in office buildings

and warehouses. Optical character recognition (OCR) in combination with AI can help to populate fields with text extracted from documents. OCR does not only minimize data entry efforts but also assists AI tools in checking the progress of documents that validate and remediate data with cross-references. OCR reduces risks by scraping documents for anti-money laundry keywords.

AI powered tools like Alexa help humans to interact easier with the digital world. Chatbots are now ubiquitous in customer service and Google has just announced a device dubbed 'AlterEgo' that can, in their words, read our minds by picking up neuromuscular signals triggered by internal verbalizations. In order to speak, the brain needs to send impulses to our muscles which the systems can analyse and decode. Facebook and Neuralink are aiming at building brain-computer interfaces (BCI) that turn thoughts into text by intercepting brain-signals instead of nerve signals.

## AGILITY AND SCALABILITY

Constantly rising amounts of data require systems to scale. A system that reaches capacity is no longer fully reliable and limited in response. Companies have two options: scale up or scale out.

- Scale up: Extend the specialized hardware with its numerous central processing units (CPU), the brains of the computer where most calculations take place. Scaling up by extending hardware requires procuring, installing and testing.
- Scale out: Use cloud-based systems with distributed architecture that stings together – behind one interface for the customer – numerous computers to scale larger data sets with powerful parallel computing. If something fails, other computers take on the extra load.

## PIONEERS

The Port of Rotterdam has installed the port community system Portbase, which offers intelligent services for optimizing calls at the terminals, and efficiently exchanges information between companies and with authorities for planning. This includes analysis to understand how to bundle containers to and from terminals to reduce costs and emissions.

An application combining several technologies was used by the Australian cotton trader Brighann Cotton Marketing for a shipment of 88 bales of cotton from Texas (USA) to the Chinese Port of Qingdao. The Commonwealth Bank of Australia and Wells Fargo have used a combination of distributed ledger, smart contracts and IoT to facilitate a trade transaction. Sensors allowed the banks to monitor the shipment's route, triggering the smart contract to release payment for the cotton once it crossed a predefined location.

Maersk has introduced a remote container management (RCM) system that permits monitoring the moves of cargo. This is particularly relevant for sensitive, higher value refrigerated container freight, where elements such as rough weather

can knock off a container. However, the installation of IoT devices to track roughly 300,000 reefer containers took Maersk close to three years.

Maersk has also recently announced the formation of a joint venture with IBM to apply digitalization of supply chains and blockchain to trade. This initiative is engaging an ecosystem of corporations, customs agencies, and logistics companies. The goal is to take the paper out of the chain and make all processes transparent.

## SMART GOVERNMENTS

The de facto central banks of Hong Kong and Singapore recently announced plans to connect the Global Trade Connectivity Network (GTCN), the trade finance platforms they are developing, which will use distributed ledger technology. Their objective is to make the multi-trillion-dollar funding of international trade more efficient and reduce the risk of fraud in letters of credit (LOC) and other transactions. Linking the two digital platforms is part of a broader plan between the Hong Kong Monetary Authority and the Monetary Authority of Singapore to join forces on distributed ledger and other financial technology.

Another example is the single window. The one simple point of entry that can ease submission of import and export documents and other supporting evidence offers extraordinary gains. According to 'Paperless Trading: How Does It Impact the Trade System?' by the World Economic Forum and UNECE, in Senegal the electronic single window reduced border preclearance and clearance processing time by 90%, from an average of two weeks to just one day. The cost of border processes has decreased by 60%.

Governments need to find ways to ensure full IoT coverage. This is particularly true for those that are responsible for large countries. Humans need large bandwidth – IoT does not. There is a difference between watching videos and tracking a container. IoT needs strong antennas to provide national and global coverage.

## BEYOND THE TECHNOLOGY

Technology is an enabler. It is a means to an end and not an end in itself. Enablers are components of a digital strategy that improves, adjusts or reinvents business models. The business model is what drives real value for customers and businesses. Thus, digital transformation is business model transformation.

Here are some basics for future organizations:

- Upgrade legacy IT systems and shift to a modular, more adaptable architecture that uses middleware and application programming interfaces (API)
- Define an advanced technology roadmap, and prioritize use cases for proof of concept, specific business models and cost-benefit cases
- Invest selectively in new technologies, such as AI and robotic process automation, to harness near-term benefits and prepare for developing longer term solutions
- Explore strategic partnerships with other ecosystem participants
- Design a next-stage operating model, including new governance and ways of working

Moving towards a new way of working is critical in making the supply chain and ports smarter. Orchestrating the change towards a digital organization requires strong leadership. Transformation roadmaps and digitization programmes are needed to back up the push. Most digital programmes start with experimentation. The successful ones are selected to be taken to scale them throughout the enterprise, with all the challenges and obstacles, including securing funding and changing the thinking and behaviour of people.

## THE DARK SIDE

Security and other risks associated with automating processes, transactions and decision-making along the supply chain will arise. This should not hold us back, we just need a new quality of risk management. In the Fourth Industrial Revolution, cybersecurity is the responsibility of leaders. The good news is that cyber-risk can be managed with traditional risk management tools. However, the magnitude of the potential damages requires a more holistic analysis and attention from the top. Further, the exchanging of successful practices across systems will help to increase resilience.

Some operating systems will be private or semi-private, within a specific supply chain, operated in a closed group of trusted parties. Other platforms might need to be neutral to attract and not scare off participants. Despite the advantages of fully integrated systems, we might need to think about some level of fraction for security reasons. Companies, governments and banks will be forced to develop robust API gateway infrastructures to be able to connect safely with all types of platforms. The cyber war is the battle of bots. AI powered agents wait at the gateways but also patrol the systems to detect malicious activities at the earliest stage.

## LOOKING AHEAD

Smartening the supply chain requires coordinated change across the ecosystem of buyers, sellers, brokers, carriers, banks and governments. In theory, it requires the simultaneous adoption of required technologies along the entire chain. However, technologies will develop irregularly, with certain supply chains or businesses achieving early benefits, and certain countries moving faster than others. Harmonization of standards allows for scaling across different platforms. Common regulation and interoperability between platforms are prerequisites for the full exchange of data across the global connected network of supply chains with ports as important links.

Building intelligent ports and systems requires investment, collaboration and the mitigation of risks. Realizing a largely automated supply chain that makes and executes its own decisions requires moving from manual to digital, from connected to intelligent. We have embarked on the journey. Let's make it an enjoyable and enriching experience for all.


## ABOUT THE AUTHOR

Wolfgang Lehmacher is an author, global executive, advisor, entrepreneur, and expert in the field of supply chains, transport and logistics. Lehmacher has been involved in various major change initiatives in the supply chain. He has been President and CEO of GeoPost Intercontinental and a Member of the Executive Board, as well as Director: Supply Chain and Transport Industries at the World Economic Forum.


## ABOUT THE ORGANIZATION

The World Economic Forum (WEF) engages with political and business leaders within the world society to shape global, regional and industry agendas. It was established in 1971 as a not-for-profit foundation and is headquartered in Geneva, Switzerland. It is independent, impartial and not tied to any special interests. The Forum strives in all its efforts to demonstrate entrepreneurship in the global public interest while upholding the highest standards of governance. Moral and intellectual integrity is at the heart of everything it does.

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# NEXT-GEN EFFICIENCY IN REEFER OPERATIONS

## NEW TECHNOLOGY AND SMARTER WAYS OF WORKING

Søren Leth Johannsen, Chief Commercial Officer,
Maersk Container Industry, Denmark

A reefer typically circles the world four times under extreme handling and weather conditions. Every year. Over a typical working life of 15 years, maintenance and running costs rapidly add up. There is evidently huge potential in reducing inefficiencies and costs in reefer operations.

The good news is that a combination of new technology and smarter ways of working is paving the way for modern reefers. Transparency in performance and consumption, better interfaces and connecting to smart systems across the supply chain will be the elements that power this transformation.

To achieve these goals, there needs to be a strong focus on making life easier and more efficient for shipping carriers and service providers from the moment the reefer is in operation. Truly transforming the industry is going to need everyone to work together, right along the transport value chain, to implement new technology. There is a pressing need for us to look at opportunities to standardize, using tried and tested processes. This is not going to be straightforward in an industry that has traditionally been resistant to this kind of thinking.

### CUTTING ENERGY COSTS

Energy costs have always been a pain point for shipping lines and are therefore a crucial development focus for reefer manufacturers. Increasing the energy efficiency of reefers has a direct and measurable cost benefit. For example, Chiquita recently put some numbers on the impact of its recent fleet renewal with 2,500 Star Cool containers. The savings will be substantial.

For every new container, Chiquita has stated that it achieves energy savings of up to 35% compared to their older units. This impressive figure looks even better when you add in the energy saved by Star Cool's embedded energy-saving software. This automatically shuts down the container compressor when it is not actively needed, saving up to 58% of energy consumption when compared to older units. As a result of these improvements, Chiquita is making electricity savings of 34 million kilowatt hours per year, which translates into an annual reduction of 17,000 tons of CO2 emissions.

### PROTECTING AND OPTIMIZING CARGO QUALITY

While saving energy is one factor in reefer operations that can be achieved using existing technologies, the challenge is to not compromize cargo quality in the process. This is why MCI's energy-saving software was originally built around produce quality. In effect, the energy savings are a by-product of increased cargo quality, making it a genuine win-win.

The software avoids undershooting the

set point. While the fruit is still warm, the cooling system is run at full capacity to rapidly reach the desired temperature. Once the cargo is at set point, the fan and compressor speeds are optimized to provide precisely the cooling required to keep the fruit in perfect condition. By avoiding over-cooling, the fruit arrives at its destination in optimum condition and far less energy is used in the process. This unique principle enables Star Cool reefers to demonstrate a 50-75% reduction in energy use compared to conventional reefers.

Container lines and fruit multinationals are using the software to optimise their reefer operations while improving cargo care. At the same time, the energy savings will definitely benefit the terminals too.



## THE VALUE OF TOTAL TRANSPARENCY

Transparency in terms of performance and energy consumption holds huge potential for eliminating costs and enables operators to take strategic decisions. For example, all Star Cool reefers come with a built-in energy meter that provides container lines with a super-efficient and precise surveillance tool to measure kilowatt hours consumed in real time. This can be done either manually or via modem, throughout the transportation window including at the terminal. The energy meter also allows for a more individual cost assessment of equipment coming into the terminals, which will benefit planning for terminal operators.

## GAINING STRATEGIC INSIGHTS

The container lines are telling us that they will use the energy meter to examine the cost of operating a certain shipping lane compared to the freight rates they are charging. This will provide them with full cost transparency, right down to the individual reefer. At the same time, they will be able to supply factual carbon footprint data to their customers, which is an important value proposition when selling against airfreight.

We were the first to introduce this technology and at least one vendor has already followed suit. Eventually, I believe energy meters will become a standard feature that will be beneficial for the entire supply chain.

## REPLACING DOWNTIME WITH UPTIME

The reefer industry has a system called PTI (Pre-Trip-Inspection), which checks that the machine is functioning correctly. This is carried out by the depot before loading the reefer with cargo and is a straightforward operational process. However, no one is earning anything with the reefer while this is being carried out. On top of that, the PTI itself costs money. To correct this inefficiency, we reshaped the process and called it ITI (Intelligent Trip Inspection), which has made PTI obsolete. Instead, the reefer carries out a self-diagnostic check while it is in operation, thus replacing downtime with uptime.

A standard feature on all Star Cool reefers, ITI provides an enhanced digital inspection system that confirms whether the container is ready for the next trip and alerts operators in the event that any steps in the ITI process need investigation. This is a further example of how the smart use of technology can give shipping lines increased transparency that can be transformed into measurable cost savings.

## MOBILITY AND EASE OF OPERATIONS

The maintenance and running costs incurred throughout the typical 15-year working life of a reefer are unavoidable. However, this is an area that can be significantly optimized if handled more efficiently.

Technicians are the frontline caretakers of the reefers. Giving them the tools they need to work smarter can go a long way to maximizing reefer uptime and supporting the proper planning of service activity to reduce downtime. Up to now, work processes have often been cumbersome and time-consuming for technicians. Our most recent tool is an app that makes it easier for technicians to carry out onsite service and maintenance work. The app provides quick and easy access to the information and technical support they need, right where they need it – at the reefer.

The app enables technicians to look up alarm codes and access the latest trouble-shooting techniques. If the reefer needs servicing or repair, additional tools like guides, manuals and service videos can be instantly called up on the app. Warranty checks can be carried out onsite by simply scanning the container number: the app

displays all warranty information for specific parts. This also saves time for admin staff by automating the sharing of updates and guides via the app. We are looking forward to further developing the app's features in collaboration with technicians.

### TWO MACHINES ON ONE PLUG

Another example of using smart technology to improve efficiency is Star Cool's unique electrical circuits. Whereas a standard reefer outlet is rated and protected to 32 amps, Star Cool's main circuit protection is just 16 amps. This enables the operator to run two Star Cool reefers on each power outlet – 100 per cent safely and in all cooling situations. The benefits include ensuring smooth operations during peak season, either on shore or onboard the vessels. It is even possible for ports to slightly over-book, because they now have a smart solution that can effectively double capacity without needing to modify the electrical grid. This is good for business and good for customer satisfaction too.

### CONNECTING WITH SMART SYSTEMS

To achieve further transparency in cold chain operations, certain shipping carriers have introduced Remote Container Management (RCM). One of MCI's customers, Maersk Line, pioneered the development of this technology. This innovative system takes the reefers online and brings real-time transparency into cold chain operations. It has the potential to provide significant operational cost savings as well as adding value from within the supply chain. The carrier's customers will get unprecedented visibility into their cargo during transportation, enabling better operational planning and increased customer satisfaction.

Connecting reefers to smart systems and making use of the abundance of data generated is a major focus for MCI and an area where we will see real transformation in the near future. Besides smart features such as the automated replacement of PTIs and the energy meter function, we expect to contribute a lot more value-adding innovation in the future.

### TRANSFORMATION IS THE KEY

No one in our industry is under any illusion that things are going to get easier in the intermodal business any time soon. If anything, increasing digitization, Industry 4.0 and constantly increasing competitive pressure will squeeze margins even tighter.

Truly transforming the industry is going to need everyone to work together, right along the transport value chain, to implement new technology and finds ways to standardize processes. But I have no doubt that the smart use of technology has the power to keep us all in the game – as long as we keep focusing on sustainable cost reduction, energy savings and increased levels of customer service. The players who are strong in the future will be those who have embraced change – taking efficiency and energy reduction onto a new level. That will be good for the industry, for the end-consumer and ultimately for our planet too.

### ABOUT THE AUTHOR

Chief Commercial Officer of Maersk Container Industry (MCI) since 2005 and has held various positions during the past 21 years within Maersk. Based at MCI's R&D and test centre in Southern Denmark, he spends much of his time on the road visiting customers and partners around the world.

### ABOUT THE ORGANIZATION

Maersk Container Industry (MCI) develops and manufactures refrigerated containers, dry containers and the Star Cool™ refrigeration machine for the intermodal industry. With around 5,000 employees, MCI has R&D and test facilities in Denmark, two production facilities in China, one in Chile and a global network of over 400 service providers.

### ENQUIRIES

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# END-TO-END PLANNING PROCESSES

Dr. Oscar Pernia Fernandez, Vice President, Applied Innovation,
Navis and XVELA, Rotterdam, the Netherlands

I imagine a future where a terminal will be able to adjust its operations dynamically to meet the required service level agreement (SLA) for each vessel in the supply chain. This terminal of the future will perform in an ecosystem that helps a vessel get in and out of port efficiently while providing visibility and predictability to the whole ocean supply chain. There is a long way to go, but we are clearly moving toward such a future, and automation and digitization are central drivers in turning this dream into reality.

Before we can reach this future, we have to address fundamental constraints in the way the current container shipping industry works. While we may talk about collaboration and data sharing, at present planning processes across the container flow take place in silos, with little standardization or real-time information exchange and few opportunities for collaboration. As a result, all stakeholders lack the critical visibility and connectivity required to reach the next level of efficiency and productivity.

This paper elaborates on the meaning of end-to-end planning processes and emphasizes some standardization principles around processes and solution-based technical integration. I will also elucidate our approach at Navis to reshape the container shipping industry by getting back to our planning solution roots and by empowering our company's collective knowledge, commitment and innovation DNA.

## THE NAVIS STORY

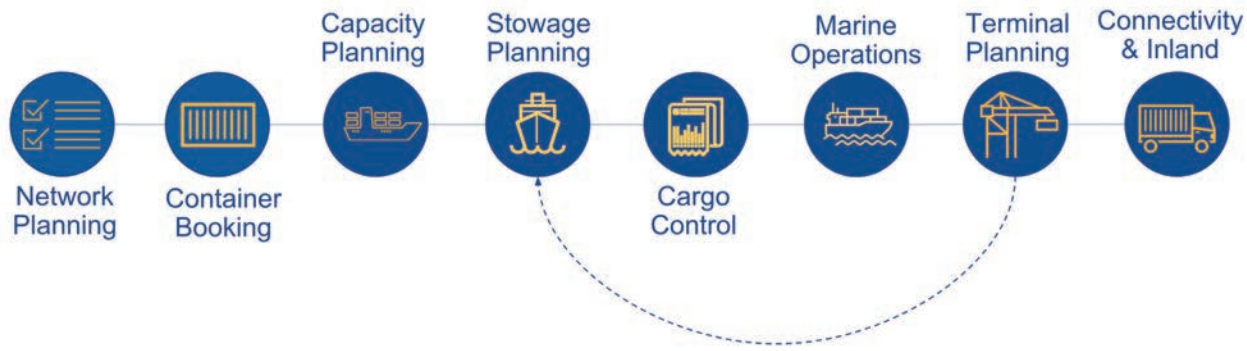
I was amazed to discover that in 1985 terminal planners were performing their jobs with paper and stickers. Not that long ago, planners had to manually monitor and manage the discharge and load operations of containers. In 1986, Navis founder Dr Jon Shields completed his PhD entitled: A Computer-Aided Containership Stowage Planning System. This was the root of Navis's influence on container planning.

Dr Shields and his team used their knowledge and passion to create a new solution for stowage planning. Introducing ground-breaking innovation within the vessel planning process, they developed a software product that integrated the rising processing power of computers with a user-friendly graphical user interface – a far cry from paper and stickers.

Today, the world is different. Computer science and engineering have progressed substantially and the problems we must solve today are more complex. While the original Navis product did grow from stowage to all related terminal planning processes, such as vessel planning, berth planning, yard planning, intermodal, and so forth, the current focus at Navis – and XVELA in particular – is on leveraging connected technologies to integrate planning processes.

## END-TO-END PLANNING VALUE PROPOSITION

The problems carriers and terminals are trying to tackle with digital initiatives and end-to-end (E2E) planning processes are as follows:




End-to-End Planning Processes

- Planning lead time: Planning processes across the container flow are not well integrated and this results in a myopic view of overall process performance, as well as a continuous back-and-forth/ manual intervention, causing long lead times
- Network flexibility to changes: The container flow is driven by dynamic variables and the carrier network needs to be flexible to accommodate the inherently changing conditions across the container transportation
- Exceptions/contingency recovery: Unexpected disruptions incur significant costs and long recovery processes in ocean supply chains, as networks are not ready to deal with exceptions and contingencies in a standard form
- Operational efficiency: Process automation and analytics capabilities, particularly those leveraging new technologies, will necessitate evolving human roles and reduced OPS 'crews' for managing the different planning processes

The value brought about by solving or mitigating these problems and the potential enablement of new, related opportunities includes:

- Standardization & simplification: Standardize what is possible to standardize and render IT solutions to support this standardization and simplification, including more integration between processes such as stowage, berthing, vessel and yard planning
- Integrated joint planning: Clear guidelines and evaluation criteria both on process-specific performance and its SLA with other processes which influence that process, for example, stowage quality enabling terminal performance (BMPH)
- Continuous improvement: Analytical capabilities to capture the execution outcome in order to retrofit the planning process, identify improvement opportunities, and make the planning process more prescriptive and adaptive.
- Ecosystem synergies: As the IT landscape becomes more diverse and software platforms more sophisticated, it is important that the technology in this ecosystem establish natural connectivity and data capabilities for holistic value generation

## STANDARDIZATION

There are fundamental changes needed in today's planning processes. If our industry is able to standardize processes end-to-end, the digitalization and automation of those processes will become the easier challenge. Our industry is a 'Plan B' industry; the user experience is exception-based and so far we have not augmented humans, machines, or software to manage the uncertainty of exception scenarios in an integrated and proactive manner.

The overall ocean supply chain and the individual actors are demanding advanced connectivity and integration. We must foster paradigms that will move the industry toward further decentralization of the management of specific processes, thereby allowing greater transparency and traceability control along the supply chain, connecting vessels, ports, terminals, inland, and all related assets.

The focus on integration is not trivial and we see many actors progressing on acquiring, partnering, and developing software solutions to empower digitalization across the enterprise. The key focus is on data integration – making data consistent, agnostic, and connectable, with real-time connectivity to make applications seamlessly interact to support specific processes.

Key to this data integration is standardization and the consolidation of practices already established in other industries with regard to process engineering and middleware systems. These are fundamental to making complex and embedded systems both 'carrier grade' – reliable, tested, and proven, and 'mission critical' – vital to support key business operations.

Several port operators and technology suppliers are executing huge digital transformation plans with the goal of improving operations management and subsequent service to the ocean supply chain. A clear direction on standardization of processes and technology integration will benefit all, with lower implementation risks and higher impact.

It's time and it has been done already; when looking at how other industries have leveraged standardized processes and integration of technology in operations, our industry is clearly behind.

## CONCLUSION

Ocean supply chain demand is no longer just about time and cost. The new logistics models, such as those of Amazon or Alibaba, require an integrated network from product manufacturing to product delivery, and from customer experience to market analysis, hence exigent requirements on reliability, transparency, and predictability across the cargo flow.

Terminals, in particular, are subject to planning changes/exceptions, suffering serious data quality constraints from the supporting information, as most of the processes are not standardized. So the perception that terminals are the only bottleneck is not completely fair. The end-to-end connection of planning processes is a fundamental requisite to transform terminals into intelligent network nodes.

Technology solutions will not magically solve our problems. The emerging technologies cannot enable change if we don't unlock the potential of connecting processes, leveraging data, and fostering


End-to-End Planning Value Proposition

value-creation mind-sets for operational and environmental efficiency and sustainability.

At Navis, while building, launching, and piloting the XVELA platform as a ground-breaking collaboration concept for the container shipping industry, we have gained insight into some of the related opportunities that are available in our industry:

- How connected technologies from XVELA and Navis ensure the availability of critical planning information exactly when it is needed, enabling more informed decision-making and better service
- How early visibility and collaborative planning can help ocean carriers and terminal operators identify and capitalize on new opportunities to increase efficiency
- How machine learning enables semi-automated stowage to simplify and speed up vessel stowage planning while improving utilization
- How ship owners and managers can gain real-time vessel performance data to monitor, analyse and optimize fleet performance and improve energy efficiency

All in all, digitization and automation, along with the use of emerging technologies, will help us realize the vision to enable faster and more open collaboration across the container flow. However, we must also achieve the standardization and integration principles outlined in this article if our progress is to be lasting and consistent.

## ABOUT THE AUTHOR

Dr. Oscar Pernia (Telecommunications Engineer and Industrial Engineering PhD) is responsible for Applied Innovation at Navis and XVELA, leading ATOM Labs in Rotterdam and focusing on the discovery and experimentation for Navis software solutions while tackling ocean supply chain related problems. During his career, Oscar has supported different organizations in two main areas: building new capabilities and creating highly motivated and talented teams, and driving IT solutions and operational processes together to produce tangible business results in those companies. For more than 15 years, the baseline of his work has been centered on the implementation and optimization of processes and solutions for ports and terminals, with the last 10 years focused on automated terminals, participating in more than 30 terminal projects globally.

## ABOUT THE ORGANIZATION

Navis

Navis, a part of Cargotec Corporation, is a provider of operational technologies and services that unlock greater performance and efficiency for the world's leading organizations across the shipping supply chain. Navis combines industry best practices with innovative technology and world-class services to enable our container terminals and carriers alike to streamline their ocean supply chains and better collaborate together, transforming how goods are efficiently delivered. Whether tracking cargo through a port, automating equipment operations, or managing multiple terminals through an integrated, centralized solution, Navis provides a comprehensive set of solutions to optimize terminal performance, vessel performance and cloud-based collaboration that drives transparency, efficiency and profitability to a network of ocean carriers and terminal operators.

XVELA

XVELA provides a transformative, cloud-based collaboration platform and maritime business network that drives transparency, efficiency and profitability to ocean carriers and terminal operators. Through real-time collaboration, shared data and actionable visibility across the vessel rotation, XVELA enables terminals, carriers and their operational partners to work together to simplify, coordinate and synchronize their operations, starting with stowage planning and quickly expanding to berth management and port call optimization. The result is a win-win solution that allows both terminals and carriers to forge new efficiencies, improve customer service and reliability, and capture substantial untapped savings across the ocean supply chain. www.xvela.com

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# DP WORLD

## LINKING THE SUPPLY CHAIN

Rashid Abdullah, CEO: Europe & Russia,
DP World, Dubai, UAE

Technological disruption has altered every aspect of our lives. The changes caused by disruption have been so dramatic and irreversible that none of us could have foreseen them. In fact, our current world, with all of its high-tech distractions and ever-increasing connectivity, is incomprehensible to our very own parents.

From voice-activated homes, to algorithms finding our new favourite bands, the incessant march of disruption has left no stone unturned. Maritime logistics is no different, with technological changes challenging traditional notions of supply chains, logistics networks and terminal operations. While many operators may be perturbed by the rate of change, sticking your head in the sand and hoping for the best is not a viable business model in such a competitive and dynamic sector.

### BIGGER, BETTER SHIPS

The capacity of the biggest containerships afloat has risen sharply in the last five years and more than doubled since 2000. The basic economics explain this shift; larger sizes have led to a more cost-efficient offering – something that is worth celebrating in our sector. The ships on the seas could get even bigger, within reason.

Yet, larger ships require a different approach to loading, sorting and discharging cargo; an approach that many terminal operators have been slow to pick up. Port terminals require wider loading berths to accommodate these bigger ships and cranes with a greater reach and capacity. The cost-efficient offering of larger ships is tarnished if it takes the terminal operator twice as long to get the cargo off the ship and onto the next stage in the supply chain.

Terminal operators need to wise up to the reality of larger ships, harnessing the latest technologies to help them accommodate these behemoths of the sea. For example, in the UK and Belgium – at DP World Southampton and DP World Antwerp Gateway – we have invested in state-of-the-art super post-panamax cranes that can handle the largest of ships. A greater reach with larger lifting capacities allows the decanting of large cargo ships at impressive speeds, making sure that we squeeze out any of the potential delays out of the supply chain. For us, as a primarily origin and destination operator, it's extremely important to have fast, efficient craning capacity, as we are the first touch point for cargo leaving the shores, and the last when it comes ashore.

In addition to the increased craning capacity we have at our terminals, we have also introduced autonomous cranes. Automating cranes and other terminal operations is nothing new, but developments and advances in autonomous technology and machine learning have meant we can better integrate autonomous cranes into our yard handling, as well as programming more sophisticated and complex loading and discharging procedures of containers.

### FORECASTING, TRACKING AND TRANSPARENCY

Technological innovations that are also changing the way we manage, operate


and maintain our terminals are those technologies that allow for better forecasting and tracking, as well as providing greater stock transparency. Technologies within this subcategory are by no means ubiquitous and some require extensive investment, while others are relatively cheap to integrate into existing operations.

As stated before, the maritime logistics industry is ripe for disruption and those who seek to dare to challenge the status quo will reap significant benefits in the future. Within the paradigm of modern trade and booming e-commerce, forecasting product cycles and changes in consumer demand, as well as providing transparency to merchants using your network, is crucial for creating successful and lasting partnerships.

While consumers may purport to be more discerning than they actually are, merchants and suppliers are having to tighten up their supply chains in light of the numerous scandals that have taken place in a variety of sectors, such as garment manufacturing. Providing transparency and comprehensive logs of cargo information and port throughput to these merchants, which can easily be integrated into their systems, is going to become essential for terminal operators.

The DP World global network has invested heavily in our terminal ecosystems to improve our ability to forecast, track and provide reliable information at the drop of a hat. By using smarter technologies, we have helped drive efficiency savings and improved the service we offer our partners. Our 'Where's My Container' service, for example, has been rolled out at our terminals in the UK and we are looking at rolling it out across our other European terminals in a phased manner. This gives our customers real-time insight as to where their cargo is by using their individual identification code, putting them at ease and helping them manage their customers' expectations.

We also displayed our sustainability efforts through DP World's Solar Power and Global Education Programmes, and have also launched an innovation incubator 'InnoGate' to encourage employees to think out of the box and develop ideas that improve what we do and how we do it. To date there have been 1,972 staff generated ideas that have led to 139 success stories.

## CONSUMER TRENDS DRIVING TECHNOLOGICAL DISRUPTION

Disruption often feels like it appears from nowhere, but there is always a driving force, whether it is conscious or not. In our game, the customer is king. The changing rate of consumer demand, the form that demand takes, and the expectations customers have of the supply chain's ability to deliver, are all driving substantial technological shifts.

One of the major trends driving technological disruption within port ecosystems is the need for speed, fuelled by the ever-growing offering of next day deliveries. As merchants continue to offer faster and cheaper delivery times on goods, the logistics supply chain is having to streamline itself, squeezing out inefficiencies and investing in technology that helps them live up to lofty customer expectations.

When speed is the name of the game, and ships are getting bigger, integration is the route to success. Getting containers off of the bigger ships and onto the next stage in the chain in a timely manner is key for any terminal operator. For many of these operators, a lack of clarity and organization in this stage of the supply chain is a major cause of delays, incurring costs and frustrating merchants at the same time. Intermodal port offerings that integrate sea, road, rail and even barge, with automated loading systems and stock oversight are becoming more of a prominent model within maritime logistics, as providers are seeking to cut out cost by gaining back those minutes, hours and days that would be lost by using more traditional operations.

We have seen first-hand the difference an intermodal model can make. At DP

World Constanta in Romania, our operation allows cargo to be removed from incoming ships and onto rail heading across the country and with the potential to reach the hinterlands of west Europe at a lightning fast rate. This level of integration is made possible by the technology we use to forecast and streamline our operations.

As such, we are aiming to encourage a port-centric model throughout our terminals. For example, London Gateway's logistics park offers importers an exciting opportunity to tighten up their supply chain solutions, cutting costs, time and carbon emissions by locating their landed cargos closer to major population centres. The development of a Common User Facility (CUF) means that logistics services and activities can be offered on a 'pay-as-you-go' basis, ranging from basic devanning to cross-docking, storage and value-added activities such as pick-and-pack, labelling, pre-retail and distribution.

As well as reducing costs, port-centric logistics can also streamline operations and improve customer service because containers are unloaded, checked, stored, picked and distributed from a single port-based location. As a result, customers benefit from lower costs, shorter lead times, a more efficient supply chain, a reduced carbon footprint, and cost-effective logistics and distribution. We want to help our customers perfect the port-to-shelf element of their supply chain.

## CLEANER SOLUTIONS

With the International Maritime Organization meeting recently in an attempt to thrash out a pathway for shippers to aid in the global effort to decarbonize, DP World has already been recognized for its leadership position by the Carbon Disclosure Programme (CDP). Technological advances are allowing us, as terminal operators, to offer cleaner and better solutions to our partners, something that we have an economic and social imperative to do.

Larger ships still need fuel. In order to harness the efficiency savings of emerging technology and decarbonize our operations, we have put cleaner, renewable energy at the heart of our network's future. At our facility in Antwerp, we have built an onsite bio-gas plant and installed wind turbines to decarbonize our terminal operations. Our Antwerp Gateway terminal is the greenest terminal in the Port of Antwerp. In some terminals, we have taken this further by installing electrified cranes to help load and unload ships and aid yard work, as well as integrating electrified barges. As renewable energy becomes ever more cost-effective due to advances in technology, we are planning to continue our journey to creating a zero-carbon logistics network.

Remote control cranes in our terminals at DP World Yarimca and Rotterdam World Gateway are energy saving through more accurate positioning on the ship with smoother and efficient movements, giving consistent productivity that's unaffected by external factors. At DP World London Gateway, our grid connected cranes regenerate energy back into the electricity grid for reuse.

Our latest straddle carriers are using hybrid technology that harnesses regenerative energy and stores it into the battery for future use. We continue to investigate other concepts and technologies for existing RTGs and Straddle Carriers to further reduce the carbon footprint of our operations.

## CONCLUSION

Technological advances, and the subsequent disruption they cause, can make our ports greener, bigger and better. But this will not happen overnight. Changes of this magnitude require terminal operators to think differently about their operations, how they can be improved and where technology will bring the greatest gain, whether it's to their internal processes and systems or to the service they are offering their customers. Changes are never easy to undertake, but when the alternative is being left behind, the entire sector has to move forward.

## ABOUT THE AUTHOR

Rashid Abdulla has been recently appointed as CEO & Managing Director of DP World's Europe and Russia Region. Rashid has extensive industry experience and moved on from his most recent role as CEO & Managing Director of DP World's Asia Pacific Region; where he contributed significantly to the success and growth of multiple business units in the region.

## ABOUT THE ORGANIZATION

DP World is a leading enabler of global trade and an integral part of the supply chain. It operates multiple yet related businesses – from marine and inland terminals, maritime services, logistics and ancillary services to technology-driven trade solutions. It has a portfolio of 78 operating marine and inland terminals supported by over 50 related businesses in over 40 countries across six continents with a significant presence in both high-growth and mature markets.

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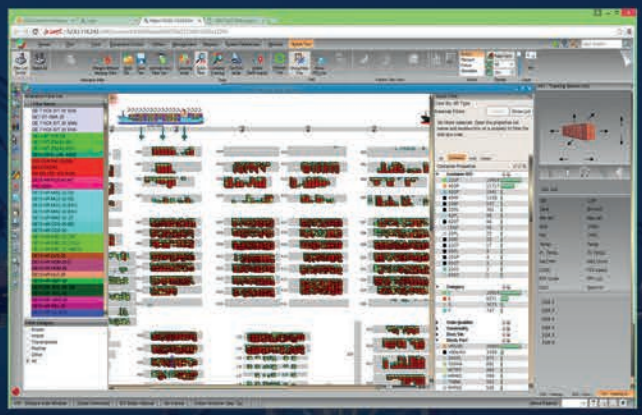

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# INTEGRATING SMART PORTS AND SMART SUPPLY CHAINS

## THROUGH THE PRISM OF SINGAPORE

Dr Wei Yim Yap, Senior Lecturer, Singapore University of Social Sciences, Singapore
Dr Jasmine Siu Lee Lam, Associate Professor, Nanyang Technological University, Singapore

The notion of 'smart' in the technological sense and when applicable to the port and supply chain community encompasses the dimensions of analytics, predictive capabilities and intelligent systems that can learn and adapt automatically. Advancements in analytics capabilities and the proliferation of technologies that are deployed to facilitate information capture and process execution present ports and supply chains with the opportunity for much closer interaction. The aim of such modern technology is, or should be, to enhance efficiency, safety and security.

In the case of Singapore, the container port interacts with thousands of supply chains on a daily basis – and millions on an annual basis – that cover almost every habitable region on the planet. All of this is being accomplished without a single container being lost. Transhipment activities are also inherently complex with the port being the world's largest transhipment facility handling about 28 million TEU of transhipment containers annually.

As well as this, there is a sizeable import/export of container traffic of almost 6 million TEU. In addition to handling such a high volume of traffic, the container port has to accommodate supply chain demands not only from the perspective of transhipment and local container operations, but also the demands of associated stakeholders, including regulatory authorities, enforcement agencies and suppliers of port services. The challenge is compounded by significant variations in peak and non-peak traffic where the port has to contend with fluctuations on a daily basis.

### CONTAINERS AND BEYOND

Notwithstanding the challenges presented by container operations, the port hosts several other activities which compete for use of the same fairways and anchorages. For example, containers form slightly more than half of the 628 million tonnes of cargo handled at the Port of Singapore in 2017. The port also handles a significant amount of oil, and conventional and non-oil bulk cargo. Quite astonishingly, containerships only account for a 12% of total arrivals of vessels in a year. Altogether, the port handles almost 150,000 vessel calls on an annual basis that includes tankers, bulk carriers, passenger ferries and freighters with a ship arriving at or departing the port every two minutes.

As well as cargo operations, vessels perform a variety of tasks that include

| | CITOS | PORTNET | TradeNet, TradeXchange | Marinet | VTIS | NTP |
|---|---|---|---|---|---|---|
| Emphasis | Container terminal operations | Container shipping lines and port users | International trade, global focus | Shipping community | Navigational safety | Innovation and trade, Singapore focus |
| Administrator | PSA | PSA | Crimson Logic/ PSA | MPA | MPA | Singapore Customs |
| Owner | PSA | PSA | IE Singapore 55%; PSA 45% | MPA | MPA | Singapore Customs |
| Port operator community | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Shipping line community | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Shipper community | – | ✓ | ✓ | – | – | ✓ |
| Supply chain community | – | ✓ | ✓ | – | – | ✓ |
| Port service provider community | – | ✓ | – | ✓ | ✓ | – |
| Trade facilitation community | – | ✓ | ✓ | – | – | ✓ |
| Government agencies | – | ✓ | ✓ | ✓ | ✓ | ✓ |

Source: Authors, based on information from the various information systems.

Table 1: Information systems developed to bring about a 'smart' port community in Singapore

bunkering, re-supply, minor repair, change of crew and inspection among other activities. The plethora of associated intra-port vessel movements and supply chain activities inevitably poses immense challenges for managing the efficient and safe use of the port's fairways and anchorages. Together, these developments and constraints pose immense stresses in resource mobilisation, deployment and usage, especially between traffic peaks and troughs from the perspective of the port and supply chain operators. Hence, smart solutions involving closer integration with supply chains are seen as a critical enabler to address these challenges.

## SMART INTERACTION

Several initiatives have been developed by various government agencies and the container terminal operator PSA with the intention of bringing about the benefits of smart port-supply chain interaction. For example, systems developed include the Vessel Traffic Information System (VTIS), Computer Integrated Terminal Operations System (CITOS), PORTNET, Marinet, TradeNet and TradeXchange. These systems have different functions, serve different aims and are meant to address different aspects of the port and supply chain.

For example, the VTIS addresses the issues of efficiency, safety and security in port waters. CITOS on the other hand is an Enterprise Resource Planning system meant to optimize internal resource deployment and usage within the container terminals. Among these systems, PORTNET offers the most comprehensive coverage from the supply chain perspective except that the system is proprietary to PSA and focuses on the container shipping community.

Many of the systems are also targeted at certain aspects of the supply chain and thus have visibility only for parts of the product, information, asset and financial flow (see table 1). In terms of supply chain security, the Secure Trade Partnership programme which is administered by Singapore Customs is more of a voluntary certification process emphasizing risk management by participating businesses. Hence, there is opportunity for better resource utilization through improved visibility by integration of these systems to enhance transparency and simultaneously lower transaction costs between the various parties involved.

The capabilities of these systems can be enhanced to encompass data mining, diagnostics, analytical and predictive abilities brought about by technologies that can be deployed to facilitate information capture and process execution in the port environment. Using the example of VTIS, the next generation system should be able to conduct predictive analytics and identify traffic hotspots by making use of real time data.

These developments present the Port of Singapore and associated supply chains with the opportunity to achieve closer interaction with the aim of enhancing productivity and efficiency of resource utilization, as well as safety and security.

Going beyond data analytics to achieving smart solutions will also mean leveraging on the embedded information and knowledge within various port and supply chain-related processes across time and space to bring about enhanced service quality, commercial viability and improved environmental sustainability not only for the port and supply chain community but for the wider public. Together, these developments will also have significant benefits, not only from the perspectives of port and supply chain efficiency, safety and security, but also on resource utilization for the new Tuas Port in land scarce Singapore.

## ENHANCING THE REACH OF THE SUPPLY CHAIN

In 2017, the Singaporean government announced the development of the National Trade Platform (NTP) which when completed potentially allows Singapore's firms to enjoy annual man-hour savings worth US$453 million. The NTP is aimed to better serve trade-related needs of businesses through services such as document digitization, process automation and e-application for trade finance.

In 2018, PSA increased its stake from 15% to 45% in CrimsonLogic – the administrator of TradeNet and TradeXchange. The move

is seen as a strategic move to bolster PSA's reach to the shipper community through CrimsonLogic's subsidiary Global eTrade Services which is connected to 23 customs nodes worldwide. The move will also provide PSA with the capability of co-creating next generation B2B2G platform solutions aimed at integrating processes and improving efficiencies for shippers, government agencies and other stakeholders in the supply chain.

## LOOKING FORWARD

Going forward, integration and streamlining of operating and data systems pertinent to the port, shipping and supply chain community in Singapore by leveraging on technological possibilities offered by blockchain will allow transactions to be verified not only electronically but autonomously. Imagine the tremendous savings that could be achieved between various parties involved in terms of paperwork, time and money. Instead of having to migrate to one single platform, blockchain technology offers the possibility of working through different platforms by different operators that are in consensus, and simultaneously kept up-to-date with changes with no party required to be an intermediary for trust.

That said, there may still be a need to work out a common protocol among the stakeholders as the process will involve dozens of different shippers, shipping agents, port service providers, banks, logistics companies and regulatory authorities. Multiply this across supply chains to other port systems and we will witness international trade and logistics being revolutionized in no way the world has ever seen before.

## ABOUT THE AUTHOR

Dr. Wei Yim Yap
Wei Yim Yap is Senior Lecturer at the Singapore University of Social Sciences. In the course of his 20-year career that straddled both academia and industry, Dr Yap has worked closely with the international maritime and port community dealing with different aspects of the port business including port development and marketing, process improvement and performance benchmarking, competition analyses, commercial feasibility and investment appraisals, economic impact analyses, environment scans and maritime cluster development. Dr Yap's research interests and publications cover the fields of business and economics relating to port, shipping and logistics matters.

Dr. Jasmine Siu Lee Lam
Jasmine Siu Lee Lam is Associate Professor and Centre Director, Maritime Energy and Sustainable Development (MESD) Centre of Excellence at Nanyang Technological University, Singapore. She has been invited by various organizations, port authorities and banks as a key speaker at international conferences and seminars. Leading a research team and working closely with the industry and government agencies, Dr Lam has completed 40 R&D projects and has over 200 publications, including 100 refereed international journal papers. She is the Editor/Associate Editor of three international journals, including Maritime Policy & Management.

## ABOUT THE ORGANIZATION

Singapore University of Social Sciences (SUSS) is one of Singapore's six national universities. Its mission is to provide lifelong education that equips learners to serve society. SUSS provides an applied education that targets both fresh school leavers and adult learners with a focus on the social sciences. There are 15,000 students enrolled in 70 programmes offered by the university.

Nanyang Technological University, Singapore (NTU) is a research-intensive public university with 33,000 undergraduate and postgraduate students. NTU was placed the world's best young university (under 50 years old) by QS for the fourth consecutive year in 2017 and 11th in the world and the best in Asia in the QS World University Rankings.

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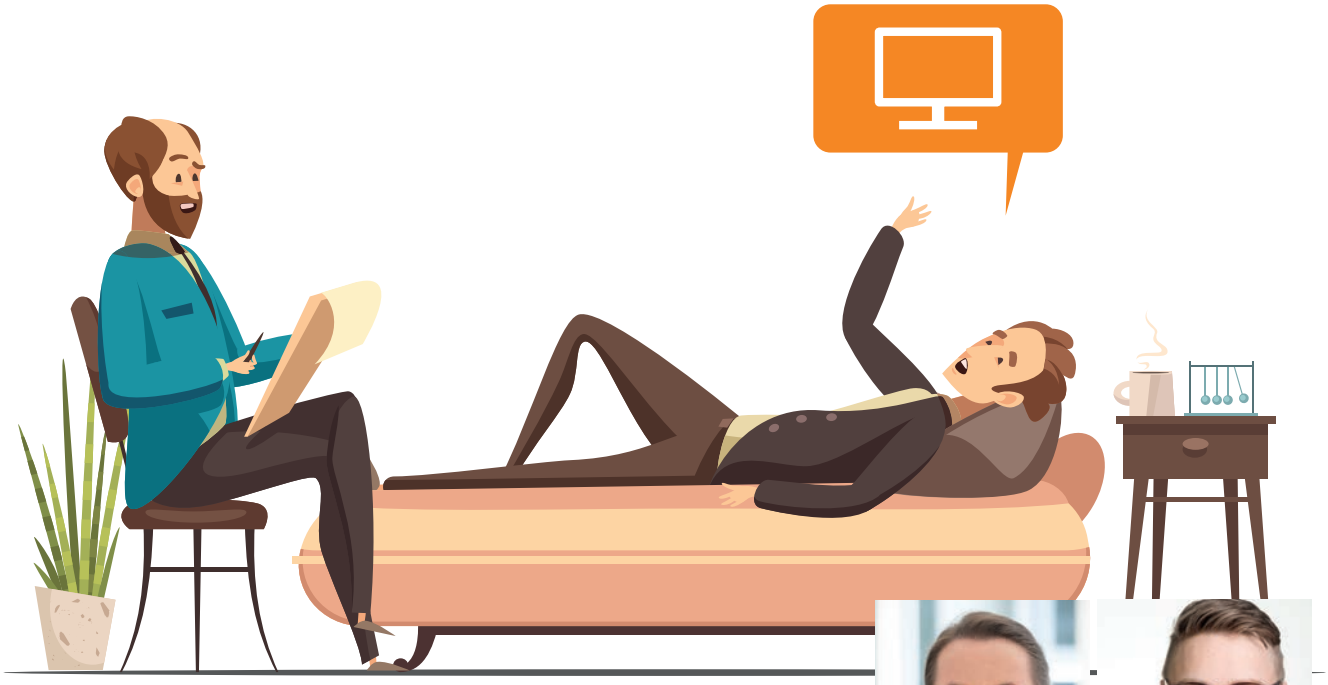
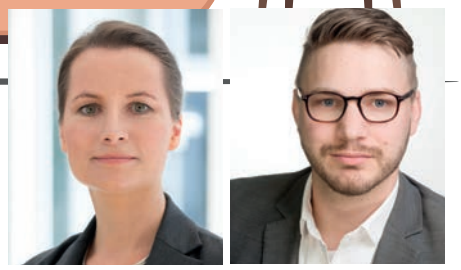




# HUMANS AND TECHNOLOGY

## UNDERSTANDING THE SCEPTICAL USER

Dr Eva Savelsberg, SVP: Logistics Division,
INFORM, Aachen, Germany

The world is moving forward quickly. What was once science fiction (the internet, robots, artificial intelligence, etc), is increasing commonplace. Underlying these innovations are challenges around both technology itself and how humans interact with new technology. Understanding both is crucial to addressing why users are resistant to technological innovations. Equally, it is paramount in fostering a path forward so that new technology solutions can drive value instead of floundering in the hands of skeptical users.

### TECHNOLOGY IS HERE TO STAY

"Come here. I want to see you." These were the first words communicated over the telephone by Alexander Graham Bell to his assistant in 1876. After that first call, Bell penned a letter to his father in which he noted, "... the day is coming when [telephone cables] will be laid on to houses just like water or gas - and friends converse with each other without leaving home." Despite its revolutionary ability to connect people anywhere, anytime, it took approximately 75 years for the telephone to reach 50 million users. A lack of infrastructure and technological constraints are generally the two factors noted when discussing the very slow adoption of the technology.

Fast forward to the 1950's and the TV was introduced; it took TV about 13 years to reach 50 million users. Fast forward again to the late 1980's and the first commercially available internet hit the market - that took approximately 4 years to reach 50 million users. In 2016, Pokemon Go was launched and the app reached 50 million users in only nineteen days. The pace of technological adoption is quickening, and drastically. The challenges that hindered the adoption of the telephone are all but non-existent today.

Today, the internet serves as a common backbone for almost all technological innovation. While not perfect, its common use architecture allows anyone, anywhere to develop and distribute a new technology with ease. Further, since the mid 1900's, Moore's law has seen the steady doubling of technological capability every two years or so. Today, most of us carry a mini-supercomputer in our pocket. Ironically, these supercomputers take us back to the beginning of the story; our smartphones are designed to supersede the, now, outdated telephone system.

Today, consumer facing technology companies are able to innovate on time-frames measured in months and users can adopt those innovations in mere days. While the pace of innovation and adoption is slower in the enterprise IT world - it too has dramatically increased over the past two decades.

Over the past 25 years, improvements in computer hardware have resulted in an increase in computing power by a factor of 2,000. This seems impressive until one compares it to the advances in optimization algorithms over the same period. For instance, linear programming algorithms, considered the most important class of


optimization techniques by many experts, have improved by a factor of 1.4 million times. When combined, the effects of both advances generate a tremendous 2.8 billion times improvement in processing capability. To better understand this, a planning model, using linear programming, that takes us a second to solve today, would have taken almost 100 years to solve in the 1990's.

When you combine the technological innovations we are capable of today with an entire generation of digital natives – the Millennials – we are headed directly into an era where technology will not support terminal operations, but rather define them. We're seeing the start of this in automated terminals where processes have been redefined to suite robotic equipment. The addition of technologies like AI and Machine Learning (ML) will see more significant changes to come.

## WE'RE CREATURES OF HABIT

After 25 years of implementing systems, we've learned a lot about what users like and dislike about systems that offer decision support. Predominantly, most users are sceptics, at least to begin with. But why? What are their concerns underpinning the use of advanced technology? And, how do you implement change that does not cause disruption?

In psychology, the measure that best aligns with a willingness (or lack thereof) to try new things is called 'openness' – it is one of the 'Big Five' personality traits and is well researched and well documented. In most cases, openness follows a normal distribution, meaning that some people are very open to new experiences, some are really closed to new experiences, and the rest lie somewhere in the middle. Those in the middle are likely to have areas of their life where they are more open, and areas where they are more closed.

Interestingly, those who are more open to new experiences are more likely to progress up the corporate ladder into leadership roles. These are also the individuals who are often responsible for specifying and selecting new systems. On the flipside, their colleagues are generally more set to routines – a trait that is strongly associated with moderate to low openness. Experiences that challenge those routines are almost always interpreted in a negative context. The saying 'we're creatures of habit' isn't a saying because it sounds good, but rather, because it is true.

The largest concern users have when first working with decision support systems is that the system will replace them. Job loss, or even the fear of job loss, is an extremely powerful fear. Some psychologists argue that the emotions surrounding job loss are on par with those surrounding any kind of major emotional loss. This fear can be exaggerated depending on how the project is introduced to the users. When users are not actively involved in defining the criteria and in the selection process of the system they are often taken off-guard when the system is ready to be implemented.

It takes time for users to trust that an advanced decision support system isn't going to take their jobs, however, this is only their first challenge to overcome. New, complex systems come with the challenge of learning a new system. Senior staff, who often already feel challenged by technology are often stressed by the idea of learning how to use a new system. This fear is exacerbated when younger employees are able to learn the new system more quickly – in these cases, senior staff can often revert to fears of job loss.

There are also feelings of distrust, and many users are confused as to why new systems are implemented. They believe that they've managed to run the terminal successfully without a technology system and feel as though their experience and skills are underrated by the its introduction – especially with decision support systems that are capable of making the majority of the decisions they would normally make. These feelings of distrust often leads to features within systems being disabled or ignored.

When implementing a new system, terminal operators need to understand that the project is more than a technology project that will deliver

specific management KPIs by improving operational parameters A, B, and C leading to an ROI of X over N years. Implementing a new system is as much a project about cultural change as it is about operational change and to implement cultural change, change management processes can be of great benefit.

It is estimated that only 54% of major change projects are successful. Those that fail are plagued by higher than expected costs and lowered employee morale. Studies also show that when employees see major projects fail, or fail to deliver major elements, cynicism sets in, which in turn, further undermines adoption, utilization, and worse – company culture.

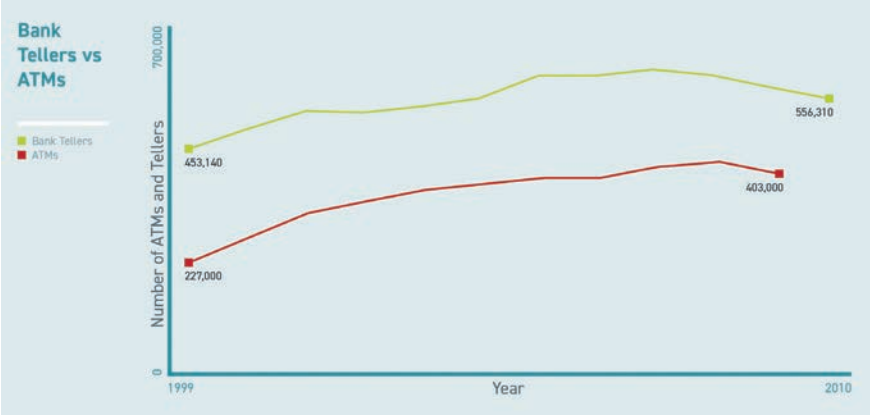
- Change management is a well-researched branch of social and business science with many models and techniques that can be implemented. Of the many available, there are some common elements such as:
- Involve every layer of your organization throughout the entire process
- Work from within your culture to implement change
- Continuously assess and adapt your project to suit the combined technological and cultural needs of your organization

## GETTING TECHNOLOGY IMPLEMENTATION RIGHT

With the onslaught of technological innovation, one could be left wondering whether technology should just replace humans so as to avoid the challenges a human element adds to a technology project. It is an easy conclusion to draw when you consider that today, decision support systems are capable of running a terminal's daily operations automatically with little, to no human intervention. Add to this equation the advancements in AI and ML that are only enhancing an intelligent system's learning and decision-making capabilities and one can easily envisage a future where the human operators of ports will be obsolete in due course.

History can lend a hand here. A technology we all consider commonplace today revolutionized its industry and the world after it was introduced in 1967 in Enfield, London. When it was conceived, the same questions that face the port industry today were present – but how the story unfolded isn't as straight-forward as you might think. The technology, of course, is the Automated Teller Machine, or ATM as it became commonly known to the world.

When you move past the marketing spin behind the development of the ATM (offering customers convenience), banks pursued the technology for two primary reasons: addressing workforce limitations




(banking unions in the UK wanted banks to close on Saturday) and reducing costs (operational labor costs to be more precise).

Well we all know that the story of the ATM was a success for the technology, but how about the humans? ATMs achieved their goals of allowing banks to reduce their operational hours and reduce the total number of tellers required per branch (less humans). The twist is, that because banks could allow for greater cost controls per branch, the number of branches increased dramatically which in turn led to an increase in bank teller positions in the market (more humans). Further, their roles evolved from completing the mundane, simple task of dispensing and collecting money, to ones which added increased value to banks, such as selling services or improving customer service outcomes.

There is one more plot twist with the ATM story. ATMs led to the creation of an entirely new service industry. Never before had a technology needed to be so exposed to the elements – the mean time between failures was high and humans were the intervention to resolve the issues that arose. The rise of the ATM also led to the creation of the ATM service technician and the growth of an industry.

We see the same story play out across other industries too. The introduction of automated weaver technology in the 19th century led to an increase in the number of weavers. The introduction of electronic discovery (e-discovery) software in legal offices in the 1990's led to an increase in paralegals. The moral of these stories – technology enables humans to achieve. When humans are relieved of mundane tasks, they are enabled to focus on higher level problems that technology isn't yet capable of automating.

The future of humans in terminal operations isn't bleak. In fact, it is likely to be better than ever before. As operators begin to allow intelligent systems to assume the day-to-day decision-making in terminal operations, they will be free to focus their skills and experience at solving larger operational challenges, managing by exception, and improving customer service outcomes.

## THE OPERATOR OF THE FUTURE

Terminal operators who excel in the future will be the ones who develop partnerships with their technology partners. As the pace of innovation continues to quicken, traditional specification, development, and delivery business models will not suite the terminal industry. New business models, based on mutual trust, shared risk, and joint reward will be the defining characteristics of successful terminal operators of the future. These new contracts will allow for flexibility in project delivery that does not exist today, while allowing for improved outcomes for end users of the systems and better cultural outcomes for the organization.


## ABOUT THE AUTHOR

Dr Eva Savelsberg is Senior Vice President of INFORM's Logistics Division. She specializes in Agile Optimization Software that renders a wide range of terminal processes more productive, agile, and reliable. Eva is also lecturer at the University of Aachen (RWTH), where she received her PhD in mechanical Engineering in 2002. Eva has published 5 books and over 35 papers on innovation in freight transportation.


## ABOUT THE ORGANIZATION

INFORM specializes in Agile Optimization Software to improve operational decision making. Based in Aachen, Germany, the company has been in the optimization business for nearly 50 years and serves a wide span of logistics industries including maritime and intermodal terminals.

## ENQUIRIES

Web: www.inform-software.com/sceptics

# THE SEA-FREIGHT AUTOMATION FRAMEWORK (SAF)

Alex Goussiatiner, PEng, Senior Port Consultant

Current supply chain operations sit in an information technology paradigm that can be characterized as follows: human controlled supply chain processes and manual user tasks, large monolithic platforms, process 'silos', incommensurable user interfaces, and no industry wide APIs and communication protocols. The combined result of all these factors is a low automation level and high software initial, as well as extensive maintenance costs.

The sea-freight automation framework (SAF) is an open source initiative created to introduce an automation structure (a set of APIs for supply chain operations and communications) to the industry. Its objective is to unify and further automate business processes as per the table below:

## CONCEPT OF ENGAGEMENT

The SAF engagement concept is derived from the smart contracts model used in blockchain. 'Engagement' simply means a set of promises by actors within shipping processes to handle a particular asset (i.e. a shipping container, a conventional consignment, export declaration, a marine

| Current Paradigm | SAF |
|---|---|
| Human control supply chain processes and manual user tasks | Machine controlled supply chain with process flow automation spanning over all supply chain participants with less dependency on human availability and efficiency |
| Large monolithic platforms | Individual well defined granular services integrated with traditional operating systems when required |
| Process 'silos' | Full integration between processes |
| Incommensurable user interfaces for online services | Unified user interfaces for all online services |
| No industry wide standard APIs | Standard engagement APIs: Message data structures and service definitions written using interface description language (IDL). |
| No industry wide standard protocol | gRPC Protocol: Modern, cross-platform, open source remote procedure call protocol (initially developed by Google ) |

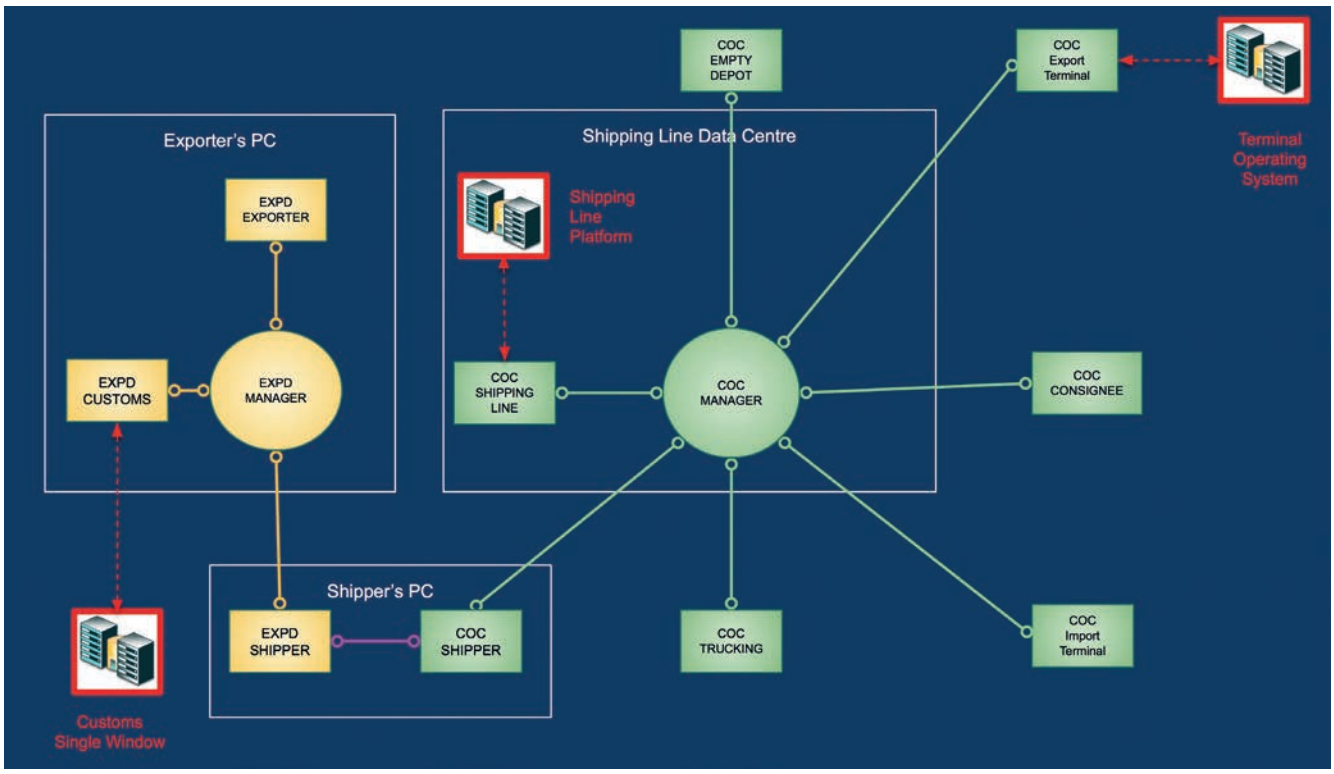



Figure 1: Export Declaration (EXPD) and Contract Of Carriage (COC) chains

vessel). Realization of the promises leads to achieving a certain target milestone event, such as "export declaration is accepted", "container arrived" or "vessel departed".

SAF presumes that all physical shipping tasks such as container stuffing, road transportation, and vessel discharge, as well as all non-physical tasks such as preparation of the contracts and documents, data input, data exchange, and payment processing, are performed to fulfill a certain promise pledged by an actor. SAF also identifies the types of repetitive sea-freight engagements requiring communication between actors.

## CONTRACT OF CARRIAGE ENGAGEMENT (FCL SHIPPING)

Full container load (FCL) shipping is a door-to-door sea-freight concept. Containers are sealed at the origin and opened at the destination. Therefore, the target milestone for this engagement is a full container arrived at the destination. The main actors in the engagement are the shipper, shipping line, the trucking company, rail company (if applicable) and consignee. Their promises are stated in the terms of conditions of the 'contract of carriage' governed by the bill of lading (BOL).

For this BOL type, shippers are bound to:

- Transport empty containers from empty depots to exporter premises
- Load cargo inside containers
- Provide verified gross container weights to shipping lines
- Transport containers to export marine terminal
- Send shipping instruction to shipping lines

## ENGAGEMENT CHAIN PATTERN

The SAF network consists of two types of service:

1. Manager Service: Fully automated application (no user tasks) which tracks and controls execution of the engagement processes
2. Actor Service: Semi-automated application (some user tasks). The application supports human-machine interfacing and automates the execution of an engagement process on behalf of an actor

An engagement chain is a temporary group of services participating in an engagement process. It consists of a manager and multiple actor services. A chain is established dynamically every time a new engagement process is created. The chain gets depreciated whenever the engagement process terminates.

## MANAGER/ACTOR SERVICE RESPONSIBILITIES

An SAF network of independent services should be in constant evolution. Services will startup and shutdown, and the service network location (IP address and port) will be changing due to upgrades. However, SAF services will able to find each other and form engagement chains. To accomplish this, SAF needs a centralized service registry (SAF SR) – a database containing the network location of active service.

The engagement manager and actor services perform automatic tasks on behalf of the participating actors. It replaces 'user' tasks, performed by human users. The Manager Service records the creation of the engagement process and assigns a unique process identifier. This ID is used in all further communications between actors and manager services. The process gets created when parties agree to cooperate to execute the engagement.

The execution of engagement processes are governed by the terms and conditions of the contracts between participating actors. The Manager Service maintains data objects containing parameters of the contracts and the type of messages exchanged during the execution.

Upon receiving certain milestones in the engagement process, The Manager Service automatically generates and sends an invoice to the 'payer' Actor Service. It follows a predefined control process if notification of payment has not been received after the due time.

Actor services perform as a facade for traditional operating systems such as the customs single window, shipping line platform, or terminal operating system (TOS). Engagement chains exchange data amongst themselves. This is done by communication between services representing the same actor.

## SAF APIS

APIs are an agreement between the services and the clients. It defines the requests the service will receive and the expected responses. SAF defines one API for each service. Thus, SAF services play

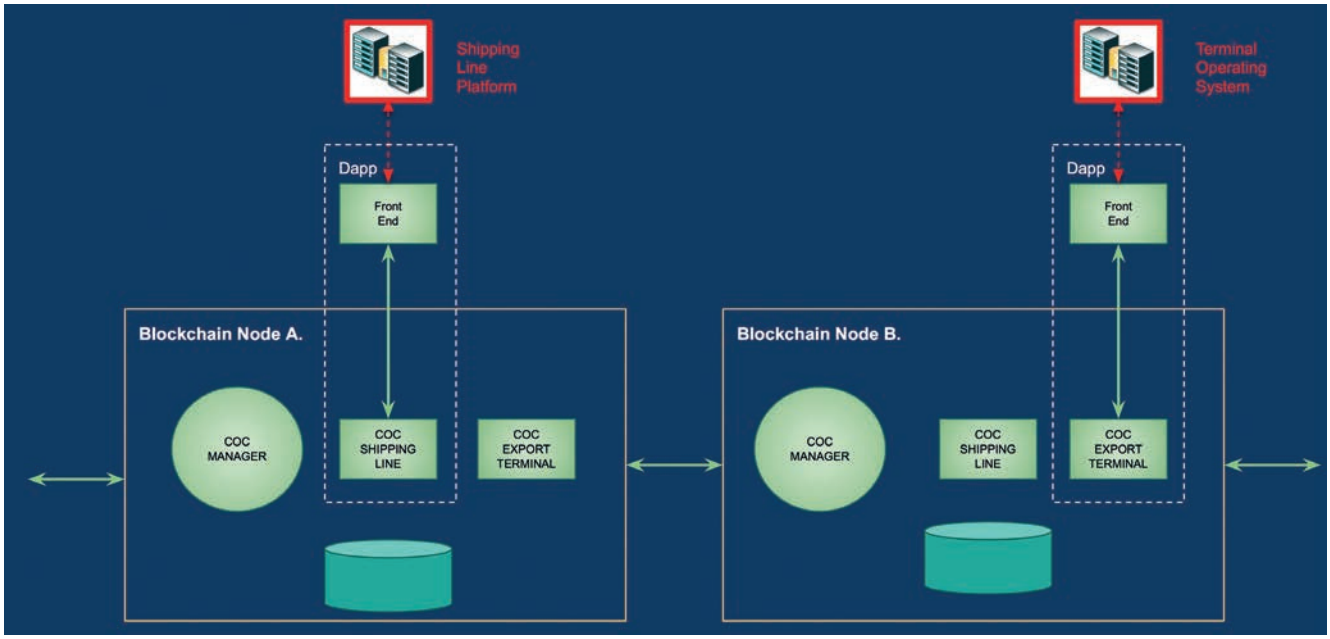



Figure 2: SAF Services Implemented as Blockchain Dapp

both the client and server role.

SAF APIs use Protocol Buffers (Google's open source data interchange format) version 3 (Proto 3) as their interface definition language (IDL) to define the API interface and the structure of the payload messages. The APIs precisely define methods that clients can call, as well as parameter and return messages for the methods.

Proto 3 is also used to describe complex multilayer and extendable data structures of messages. In the message definition, each field has a name, type, and unique numbered tag. The tag should not be changed during the use of the message, however, new fields can be added if required.

SAF uses gRPC, an open source remote procedure called (RPC) protocol. The protocol and software library were initially developed at Google, which connect SAF services in and across data centers and connect devices, mobile applications and browsers to SAF services. The gRPC protocol can also be used to communicate with blockchain network nodes including Ethereum Project and Hyperledger Fabric.

Most importantly, gRPC generates idiomatic client and server stubs for services using Proto 3 API as a source. Thus, SAF API will be automatically converted to fully functional programmes simplifying the network programming and eliminating the need for parsing the messages defined in SAF API.

## IMPLEMENTATION

SAF doesn't prescribe how engagement services are implemented. The SAF framework can accommodate services created by various technologies. Any 'cloud-based' or 'on- premises' application which supports SAF API is a legitimate SAF service. The following scenarios describe typical implementation of SAF Services:

### SCENARIO 1: MICROSERVICES

Both Actor and Manager Services can be implemented as a 'microservice'. Microservices are an approach to distributed systems that promote the use of finely grained services with their own life cycles which collaborate together. Microservices with their own communication layer, business logic and databases match the requirements of SAF very well.

There are many models for the deployment of SAF microservices: On premises, public cloud, private cloud, and software as a service. Figure 1 presents a model where all SAF services are deployed on premise.

### SCENARIO 2: BLOCKCHAINS

Both Actor and Manager Services can be implemented as a Blockchain Decentralized Application (Dapp) which consists of 'smart contracts'. Smart contracts are special programmes which run on top of a blockchain database and frontend, which is a channel that connects blockchain with the outside world.

If services are implemented in the same blockchain, their 'smart contracts' will communicate directly by calling each other. For example, COC Manager smart contract will calls methods on COC Shipping Line smart contracts and vice versa. Semantics of the messages exchanged between the smart contracts shall adhere to SAF API.

Actor Services will perform as a facade for the operating systems using Dapp frontend as a communication channel. For example, COC Export Terminal service will perform as facade for a TOS. The service will use the front end as a channel for communication with the TOS.

### SCENARIO 3: MICROSERVICE/BLOCKCHAIN HYBRID

The SAF API framework can be used to integrate multiple blockchain networks and microservices utilizing the advantages of both technologies. For example, SAF microservices can utilize a centralized service registry and payment processing blockchain applications.

## CONCLUSION

SAF is an initiative to create an automation framework and shift from current human control to machine control operation. If adopted by industry it should drastically increase the level of automation and reduce IT costs.

## ABOUT THE AUTHOR

Alex Goussiatiner, PEng, is a Senior Port Consultant specializing in port management, engineering, port automation and industrial AI. During his carrier, Alex has worked with several scientific research institutions, leading engineering companies (Ausenco and AECOM) and with marine terminal operators including Global Ports PLC as COO of the group.

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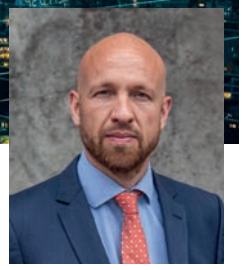


# DIGITAL TRANSFORMATION

## ARE START-UPS THE NEW LEADERS?

Mare Straetmans, Managing Director,
PortXL, Rotterdam, Netherlands

The maritime and logistics sectors are changing rapidly. Digital technologies enabling online booking, real time insight and unbelievable analytics have changed the game and many newcomers are challenging even the developments of last year. Whether it is start-ups like Flexport or Xeneta or large corporates such as Amazon, everyone, from logistics service providers, to shipping companies, to ports and freight forwarders, all are stepping-up their digital game. The market is in flux.

So what is the Holy Grail? If you are a maritime or logistics company many people will probably urge you to start implementing smart analytics, or perhaps they'd recommend you realize real time information sharing, or even better, to implement blockchain. The future is uncertain, but perhaps these are solutions that will make all the difference as we move into the digital future. However, in the Netherlands we have a saying: "The best pilots are ashore!" this means as much as when you look at a problem from a distance with a holistic view, a solution seems pretty obvious, but when you are at the wheel and deeply entrenched in the action, it is much harder to see what is going on outside of your immediate frame of reference. So, with regard to the digital revolution, maintaining a broad, open perspective will be imperative in keeping pace with the market.

The key takeaway from all this is that as individual companies looking to prosper, we cannot do this alone. We need to work with different players in and out of our sectors to deliver value, stay abreast of developments and ensure we are in the best position to spot new trends, collaborate and innovate.

### IF YOU DO WHAT YOU'VE ALWAYS DONE...

So what is the problem with focusing on all these great new technologies such as smart analytics, real time information and blockchain? Well, the problem is that it is not about implementing one amazing new technology, but it is about 'implementing' a set of organizational capabilities that ensures that your organization is adopting new technologies all the time, in a reactive, multifaceted manner, today and tomorrow.

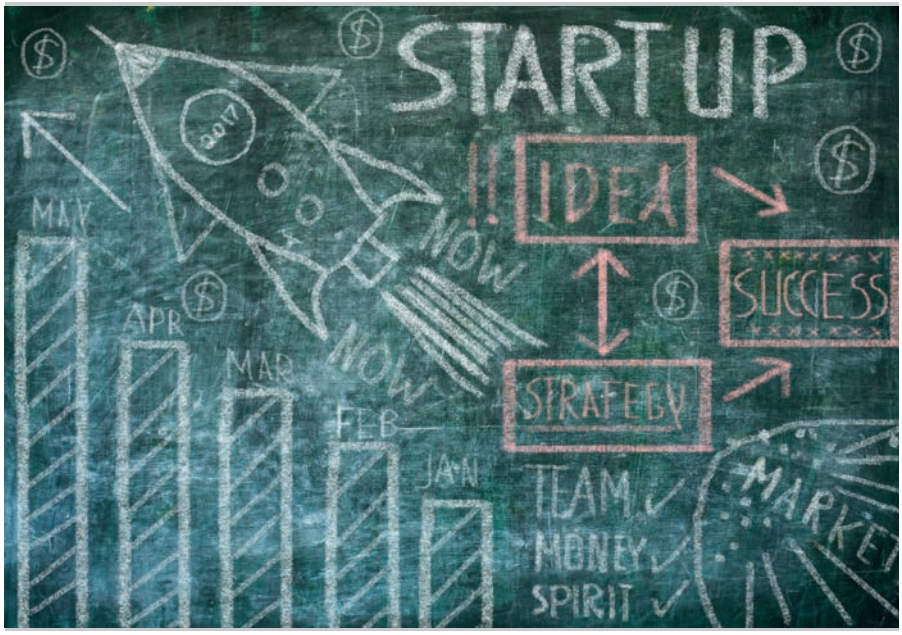
The big question therefore is "How will the current players maintain their supremacy in the new marketplace?" Innovation clearly is the pillar that more and more companies are relying on, yet we all know innovation has many meanings: You can do it in-house. You can work with other players in your sector or the wider supply chain. And, of course, you can start by adopting start-up technologies. This has become a very popular option. But why are companies doing this?

### START-UPS

There are three good reasons to start scouting start-ups. First of all, start-ups generally bring really new and exciting technology into and industry where you can still find existing players working on old operating systems, or even worse, working with old methodologies. Secondly, start-ups are generally a lot quicker (and cheaper) to work with. They can start tomorrow, find workarounds for everything, and deliver you a new version of the work instructions for the tool in real time. Finally, they inspire. Start-ups have an ambition to change the world, or at least the sector, they hear and

know about all the latest developments and inspire your people to get informed.

Does this mean that there are only advantages to start-ups? No – in a word. The main issue is that working with start-ups is actually very difficult because they don't know your working situation as well as you do, and the products they deliver often require some additional adjustments and modifications, and furthermore, often they do not have the financial foundation to wait 60 days (or your company's waiting period) before your finance departments decides to pay the bill. This doesn't mean start-ups should be out of the question, it is just that by realizing these limitations it will help you in actually getting value out of the technologies.




## SCOUTING, TESTING AND SCALING TECHNOLOGIES

So how can you make working with start-ups work? Firstly, to make the required impact with start-up technologies it is best to plan for a two or three year learning curve for your organization. This time is required to master the capabilities needed in finding new technologies to bring real value for your organization. Value means bringing cost reductions, new business, increases in safety and/or sustainability and productivity. There are three phases involved in realizing this value:

### PHASE 1: SCOUT

Scouting means searching, finding and assessing start-up technologies. That may sound easy, but what does a good start-up look like? Which proposition can add the most value for your company? And which proposition can actually be implemented fairly easily (the proverbial 'low hanging fruit')? Unfortunately, there is not a simple answer to these questions. There is an element of gambling and just doing it necessary here, as engaging on this journey is the only way to go. The funny thing is that this could be the biggest learning curve for the employees in the organization – not debating and planning every single step, but going into action and learning on the job.

### PHASE 2: TESTING

Okay, you found the new technology you require, but does it really work well? And does it work in your digital landscape? When testing the technology, you generally need to involve all the relevant business units in your company. On top of that you need to design a relevant, potential and successful pilot.

### PHASE 3: SCALE UP

If the prior two phases have all worked out, at this point your organization has already made incredible steps, but no business value has been created yet. Of course, there have been many lessons learnt, which are also of great value to the company, but you are looking for real value that you can see in the business results. So if the new technology is tested and the results were successful, the next step is to scale up the solution. Depending on the exact dynamics of a given organization, this means even more business units need to be involved, as well as locations. Worse still, your suppliers, partners and clients also need to change their ways of working.

## CONCLUSION

The realization is kicking in that developing new technology and working with start-ups is a true learning curve. Are there shortcuts? At present, I don't think so. We all share the risk factor. For each technology that you implement, you need different people from inside and outside the organization to make it work. We see today that more and more companies are starting their learning curve, and companies that do this focus on dedicating time to learning lessons. They have people from the organization involved, from top management to the people doing the actual work recording progress and maintaining the imperative holistic perspective. Are such companies afraid of failing? Perhaps. Yet they realize that it is more crucial to actually stop projects that failed and learn from them than to mitigate all the risks involved in starting projects, or not embracing the change at all.

## ABOUT THE AUTHOR

Mare Straetmans is the Managing Director of PortXL, the first and only maritime, logistics and energy related accelerator in the world. Straetmans has experience in fostering innovation in the port sector. He had a key role in impacting the maritime and logistics sector particularly as Strategy & Innovation Lead within a large maritime corporation. Furthermore, as a consultant he has developed experience with organizational and strategic challenges.

## ABOUT THE ORGANIZATION

Ports, maritime and logistics sectors are dealing with an increasing level of challenges such as hyper-competition, an increase of digitalization and an increase in sustainability responsibilities. But they also deal with the rapid rise of new technologies, like blockchain, IoT, digital logistics, drones, virtual and augmented reality. PortXL is a company scouting, matching and accelerating startups, in close connection with large corporates like Shell, Van Oord, Vopak, Thales and more. Being the first and only entrepreneurship hub in maritime in the world, PortXL has established a distinguished approach to increase the speed of development of startups and support corporates in their challenge to create value out of working with startups. With locations in Rotterdam, Singapore and Antwerp, PortXL is covering leading maritime and logistics ecosystems around the world.

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# DAVID MOOSBRUGGER

## MANAGING DIRECTOR / CHIEF TECHNOLOGY OFFICER, KUENZ

### 1) WHAT DO YOU SEE AS THE MOST DISRUPTIVE INFLUENCE IN THE CONTEMPORARY INDUSTRY?

I see the most disruptive influence in our industry right now in the automation approach for brownfield terminals and the change in what we do if we are able to use data, which the equipment already generates.

The automation approach for brownfield terminals is a challenge because several topics, like existing operations, safety for people, existing software solutions and civil structures needs to be considered.

New technologies and the willingness of our customers will allow us to transport the data in our companies and therefore will radically change the way we work. Once we start working with data it will allow us to create better products and better services for our customers. For example, we will be able to design our next generation of cranes according to real data and therefore make the products even more reliable.

### 2) WHAT DOES THE 'INTELLIGENT SUPPLY CHAIN' MEAN TO YOU?

The intelligent supply chain means for Kuenz that we know the status of the most relevant components and also how much longer these components will last. Based on such figures we can plan our production and after sales people who need to change the parts. Together with the customer we can plan up front when the parts will be replaced based on production and human capacities. We are therefore able to optimize the supply chain for Kuenz and our customers.

For example, we know how many wheels will be replaced on our cranes in each and every year, therefore we can plan the theoretical number of wheels in our productions, plan the possible change of the wheels with the customer and as a result, we are able to minimize downtime and costs for the customer and also for Kuenz.

### 3) HOW ARE YOU FOSTERING COLLABORATION WITH PORTS, TERMINALS AND OTHER SOLUTION PROVIDERS?

Kuenz is working with an intermodal terminal and solution provider in Austria to optimize their terminals. Until now, terminals were simulated and after that the equipment and TOS then specified. With the possibility KIS (Künz Information System) provides we are able to use the data on the cranes and analyse them in a totally flexible way. The data can be put together in different ways to fulfil the needs of different systems or persons. That was also the basis for our optimizing project, we use live data and put it back into the simulation, which had been used in the pre-project phase.

Our partner also created an optimizing tool which we simply feed with the live data from the terminal. The optimizing tool uses different algorithms which optimize the traffic and container flow in the terminal. We are also able to change the key parameters in the system, for example crane speeds, to see how it changes the throughput.

### 4) WHAT DO YOU SEE AS THE NEXT BIG TREND IN THE INDUSTRY?

There are several different trends going on in our industry right now. One trend is that port equipment suppliers are trying to consolidate and getting bigger so they can equip an entire terminal with their products.

Another trend will be to find ways to make the products smarter and find ways to optimize terminals in a very quick manner. All that can be done by using the existing data on the products in the right way. This will bring the companies like TOS and equipment suppliers closer together.

In the intermodal world integrating automation, including remote operation, will become more and more prevalent, and existing concepts from the ports can be partly used. Because more people need to work underneath the crane, the safety for people is crucial. A safe way to detect people is needed, the system also needs to have a performance level for the European market.

### 5) WHAT ARE YOUR THREE TOP PRIORITIES AS A COMPANY?

The three top priorities for our company are the following. Firstly, to finish the implementation of the new technology of aerodynamic structures. The new structures are already used on our barge and automated stacking cranes and became our new standard state-of-the-art crane. We have also integrated it on our intermodal cranes and the first prototype cranes are running very successfully in Europe and North America.

Secondly, we will introduce our new Information system, the KIS (Künz Information System) at TOC in Europe, 2018. The system transfers data from the terminals to our offices, and this technology will transfer Künz into a data driven company. The first twenty machines are already online and the changes can be seen already. The way in which people work in certain departments will drastically change.


Finally, we will also launch a new type of crane during TOC Europe which has the potential to change the way terminals operate in the stacking area. The prototype crane is already commissioned and the endurance test is in the final phase of completion. Several innovations have been included in the new crane design and the outcome is fantastic. Only very few customers have seen the machine, and the feedback was very positive.

### 6) HOW DO YOU SEE KUENZ DEVELOPING OVER THE NEXT 5 YEARS?

Kuenz is still a family owned business and we will focus on innovation and technology also in the upcoming years. Constantly looking for better designs and solutions will be crucial for Kuenz in the years to come. We will focus on our core products, which are used in intermodal terminals and also stacking areas in ports. Connecting the cranes with our people will be a target, and this will allow us to change the way we work in several departments. By doing so, it will turn Kuenz in a data driven company and will enable us to optimize also our internal processes.

It is also important for us to grow in the after sales market where we still have a lot of potential. Especially with all the new technology, the cranes will become more complicated and therefore we need to have the right strategy to fulfil the needs from the customers.

# DIGITAL DISRUPTION IN AUSTRALIA AND THE GLOBAL AND LOGISTIC INDUSTRY

Michael Bouari, CEO, 1-Stop Connections, Australia

With more and more organizations and business leaders throwing around the phrases 'Digital Transformation', 'Digital Disruption' and 'Digital Density', it's important to know that while these three phrases all mean something different, in a business sense all three matter to the future and growth of a business and the economy.

Wikipedia translates Digital Transformation to be the changes associated with the application of digital technology in all aspects of human society. Digital Disruption refers to changes enabled by digital technologies that occur at a pace and magnitude that disrupt established ways of doing business and more generally our thinking, while Digital Density is the effectiveness in which digital investments are made.

In a speech that Sarv Girn, Chief Information Officer at the Reserve Bank of Australia, gave to the Committee for Economic Development of Australia for the Reserve Bank of Australia, the way he Interpreted Digital Disruption was spot on; "It's an opportunity of a lifetime, but on the other hand it is also littered with risks. If you are an executive of a business or a director on a board then the challenge is to determine if the right balance has been achieved in these extremes."

A study by Accenture Strategy contends that "for organizations to retain their global competitiveness in an increasingly digital economy, Australian organizations must reassess where their profit centres, competitive strengths and growth opportunities lie and optimize their investments in digital skills, technologies and operations accordingly."

'If the Australian economy were to improve its digital density, the study estimates Australia could enjoy a boost to Gross Domestic Product (GDP) of 2.4% beyond current forecasts – pumping an additional $46 billion into the national economy by 2020.'

It's important to understand that it's not one single organisation or country that it's effecting. It's affecting all organizations around the world. We need to remember that we can't ignore this, we must move forward and keep up with the technology as the opportunities and rewards are significant.

Digital Transformation must start from the top. Executives and board members need to push and promote the change and to make sure the organization is reassuring all employees that the disruption is a way forward for themselves and the organization.

Investing in digital technology is critical to businesses to ensure they are keeping up with the modern day and this is no different in the importing and exporting industry.

I recently reported that the rate of innovation and adoption is accelerating and will likely continue to do so. This rapid change has an impact on decision-making. Decision-makers need technologies and solutions to support this, rapid and accelerating change to help them make good decisions based on knowledge, experience, and sound logic have a much higher probability of delivering success in any business.

Accenture Strategy notes that "managing digital disruption is a complex and ongoing process" and that there are three key actions business leaders must take to exploit the growing digital economy, improve economic opportunities and drive new productivity and growth:

- **Prioritize digital investments based on value opportunities:** Balance digital investments so that an optimal combination of improvements in areas such as skills or technology helps you to deliver the best returns
- **Compete using an industry-specific digital strategy:** Be clear on which platform, what roles and which data are fundamental to compete successfully in your industry
- **Create the right environment for digital transformation:** Improve your own 'digital IQ', invest in ongoing skills training and development, have systems in place to encourage and utilize innovation across your organization

Regardless of where a business is today, the evolution of decision making in the importing and exporting goods business relies on three key factors:

- **Business Process Automation (BPA):** any operator that uses technology to tap into the benefits of business process automation is immediately improving their planning processes
- **Operational Engagement (OE):** In ports and terminals there is a clear advantage that arises for terminals that invest in a port wide vehicle booking system e.g. Vehicle Booking System (VBS)

- **Port Community Insights (PCI):** Use data and insight to improve and optimize business

These key factors fit into the three factors in Accenture's study and when they all are incorporated into a terminal's approach to planning, managing, and optimizing for continuous improvement, the benefits can be realised.

Accenture notes that "investing in digital technologies is critical to deepening an organisations digital density, but his must go hand in hand with investing to build, acquire and retain digital talent throughout an organisation, from entry level to the C-suite."

Daniel Burns commented for Business 2 Community; "Using digital technology to ease our daily frustrations by questioning traditional methods and delivering empowering alternatives or more efficient business models is something that should be celebrated rather than feared."

1-Stop has shown the Global Logistic industry the benefits of implementing technology solutions, that while it may have been disruptive at first, all users benefit from efficiency gains. So many opportunities now exist to collaborate, improve efficiency and reduce administration hours, which in turn also helps the economy by boosting productivity, saving money, and integrating all port operators (sea, port and land operations).

Ports and Terminals that are using 1-Stop's services in Australia, New Zealand and the Philippines reported results that are so impressive the rest of the world is watching. Some results reported include:

- Importers, exporters, freight forwarders, transport operators and terminals have gained more certainty in how they operate and can rely on consistent and efficient truck turnaround times and service levels
- Truck turnaround times reduced from 91 minutes to 37 minutes
- Terminals moved to auto gates with complete validation that includes container, truck rego, drier and time zone booking
- Terminals in South East Asia experienced a 20% increase in truck servicing and a 30% decrease in dwell times in the first 2 weeks of operations. Terminals are seeing benefits in terms of efficiency, transparency and flow, and the ripple effect of these is reaching into industry and congestion benefits for Manila
- The import and export community is able to clear cargo more quickly through a community payments platform that links to shipping line and terminal systems for the immediate release of cargo

In closing, here at 1-Stop we are actively ensuring 'Digital Transformation', 'Digital Disruption' and 'Digital Density', keeps us moving forward to ensure our technology and the products we are providing to our customers will always be innovative and world class that sees not only us grow, but makes our clients grow and expand.

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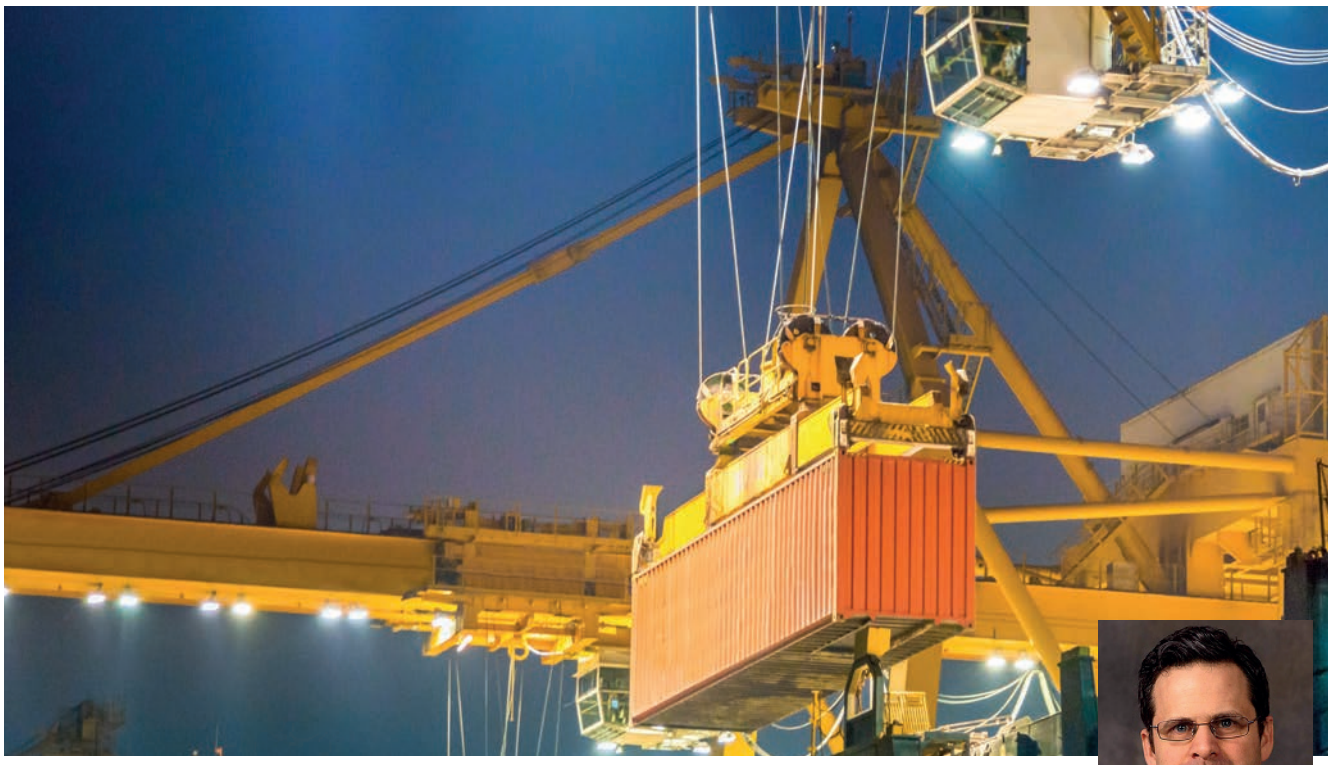
# GLOBAL ISSUES


In partnership with:

1-Stop is a world leader in developing innovative solutions for the global port community. We work closely with industry operators to understand both shared and specific challenges.



# PORT AUTOMATION

## A PARADOX FOR THE SHIPPING INDUSTRY

Jean-Paul Rodrigue, Dept. of Global Studies & Geography, Hofstra University, New York, USA

Automation is bringing a series of paradoxes to the shipping industry. Since maritime shipping is in the derived demand business, it is misleading to assume that automation does not affect the demand for shipping as well. Although automation is mostly considered by the industry at the port terminal level, it also takes place across entire supply chains, a process associated with the fourth industrial revolution (manufacturing 4.0/4IR).

The impacts of automation may thus be more significant on the activities that drive port volumes, such as manufacturing, than on port operations. This represents a paradox since automation can directly be a benefit for port terminals, but indirectly it could be a curse. Stakeholders such as terminal operators usually optimize the systems they can control and benefit from, but a common mistake is not to consider the wider contexts of the technologies they are using, both upstream and downstream of their value chains.

### DIMENSIONS OF AUTOMATION

Port terminals are particularly prone to automation since it provides direct benefits in terms of cost, efficiency, safety and reliability. Still, this automation takes place at different rates depending on the technology involved and how easy it is to implement it in a cost effective manner – the low hanging fruits are picked up first. However, since port operations and maritime shipping are heavy asset dependent activities, automation is both risky and complex, underlining the cautious stance of the industry.

Terminal automation involves six major dimensions, each having a different level of efficiency, risk and diffusion cycle. Some automation technologies are just beginning to be adopted, while others are achieving a level of maturity. The six dimensions are:

1. Automated Decision Making (Yard Management): Accounts for the earliest implementations of automation (1990s) since it improves terminal management aspects and the performance of existing assets without directly automating them. This form of 'virtual automation' is among the most widely adopted.
2. Automated Gates: Container terminal gates involve several transactions and were also among earlier forms of terminal automation. Automated gate systems are able to identify drivers, process bill of lading information electronically, scan and identify containers using optical character recognition or RFID, and direct drivers to a designed spot for loading or unloading a container.
3. Automated Tracking and Tracing: Focuses on a higher level of integration of the components of terminal operation such a ships, cranes, containers and yard equipment by accurately pinpointing their location within the terminal. This allows for a more effective use of terminal equipment and a faster storage and retrieval of containers.
4. Automated Yard Cranes: These can automatically store and retrieve containers along a stacking area but are capital intensive and require a physical reorganization of the terminal if implemented on existing facilities.
5. Automated Horizontal Transport: Involves the use of automated guided vehicles (such as automated straddle carriers) to move containers within a terminal.
6. Automated Quay Cranes: Cranes are usually the most capital intensive superstructure in a port terminal. The growing size of ships has placed

pressures to improve ship-to-shore productivity and automated quay cranes are starting to be introduced.

## THE AUTOMATION CEILING

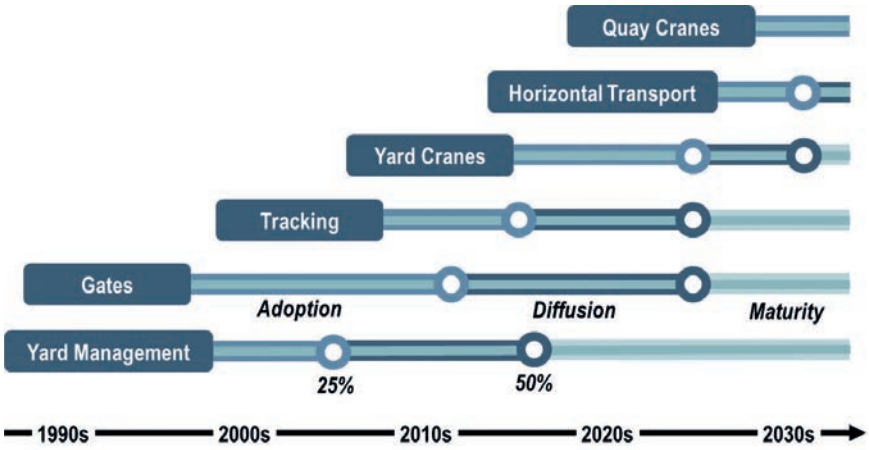
Like any technological trend, automation is often associated with unrealistic expectations. Conventional risk mitigation underlines that there is an automation ceiling representing what level of automation can be effectively implemented at a terminal from a cost/benefit perspective. Any automation strategy that is too capital intensive and that does not lead to significant benefits such as lower operating cost or higher throughput is a risk. Still, technology is improving and costs are declining lowering the automation ceiling.

Automation can be phased in an asynchronous fashion, creating disruptions of the flows and processes within terminals. This asynchrony is linked with the cost and ease of implementation of an automation segment. For instance, yard management and automated gates are the most prevalent forms of automation since they are mainly software-based as opposed to automated yard equipment (cranes or horizontal transport), which are much more capital intensive. It remains to be seen what the applicable limits of terminal automation are and at which level it does not generate significant additional value.

## UNINTENDED CONSEQUENCES

While the expected impacts of automation are rather straightforward, such as improved terminal throughput and efficiency, the unexpected or unintended consequences can also be significant. These may include:

- Shipping Networks: Would terminal automation lead to a segmentation of maritime shipping services between highly automated terminals (first tier) that can handle the high volumes and frequency requirements of mega-ships and less (or non) automated terminals focusing on second tier services? This could particularly be significant for transshipment hubs that would in addition to linking regional and deep sea services also link first tier and second tier networks. A further rationalization of shipping networks could result.
- Terminal Footprint: Could terminal automation lead to a declining global footprint of container terminals, particularly if it takes place in a low growth environment? As automation is linked with a higher level of asset usage for a similar footprint, it could incite terminal operators to rationalize their terminal assets. This could lead in some cases to the closure of terminals, particularly in multiterminal ports where automation leads to higher capacity than required and where a non-automated terminal finds itself at a competitive disadvantage.
- Terminal Facilities: Automation is changing operations and the configuration of container terminals, which is likely to lead to new terminal designs and interactions such as terminal/satellite facilities pairs. Further, automation changes the velocity of different terminal operations in a heterogeneous fashion, particularly if partially applied.
- Vertical Integration: Since terminal automation results in a higher level of integration along the transport chain, particularly through the information technologies it relies on, a question is thus raised regarding how the formation of new relations between carriers and their customers works, and opens up the possibility of new entrants.




## AUTOMATION: THE BIG PICTURE

The push towards automation appears to be an irrevocable trend further increasing the capital intensiveness of container terminals. Terminal automation must be considered in a wider context that affects both the technical aspects of terminal operations, but also the derived demand of maritime shipping. While one aspect (terminal automation) is under the control of terminal operators, the other (value chain automation) is outside their control.

Looking at value chains, recent years have seen significant changes in procurement, manufacturing, freight distribution (e.g. warehousing) as well as marketing (e.g. e-commerce). For instance, automation in manufacturing changes the comparative advantages of labour, which in turn changes location strategies. Facilities can be located closer to main markets, which puts a downward pressure of long distance shipping. The question remains in which way all these changes are going to impact the demand structure of global freight distribution and how terminal automation fits into this picture.

It would be paradoxical to transition into a fourth industrial revolution with efficient (automated) terminals and supply chains supported by transactional technologies such as blockchains, but with lower anticipated shipping demands. For the shipping industry, this would be an unwelcome development as the array of technologies from which it would benefit would also be the drivers of its stagnation.


### ABOUT THE AUTHOR

Dr Jean-Paul Rodrigue is a Professor at Hofstra University, New York. His research interests mainly cover the fields of transportation and economics as they relate to logistics and global freight distribution. Specific topics over which he has published extensively cover maritime transport systems and logistics, global supply chains, gateways and transport corridors.


### ABOUT THE ORGANIZATION

PortEconomics is a web-based initiative aiming at generating and disseminating knowledge about seaports. It is developed and empowered by the members of the PortEconomics group, who are actively involved in academic and contract research in port economics, management, and policy. Since October 2012, Port Technology International and PortEconomics have been engaged in a partnership. www.porteconomics.eu.

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# PREPARING THE NEXT-GENERATION

## THE VISION OF PSA

Ong Kim Pong, Regional CEO Southeast Asia,
PSA International, Singapore

Technology has revolutionized both PSA and the broader port sector in recent years. The once manual, labour-intensive industry is increasingly being renewed by automation and the use of cutting-edge technologies in providing world-class service to shipping line customers and making a big leap in container terminal productivity. In line with this shift, the profile of the port worker has also transformed.

Port professionals today and going forward will need to be tech-savvy, skilful, innovative and adaptable. Individuals who are able to leverage sophisticated technologies alongside the organization, and create a great workplace that enables everyone to excel, will be well-placed in PSA. Preparing our port professionals to be future-ready is the key mission as PSA undertakes this transformation journey into the future.

### LEVERAGING TECHNOLOGIES AND AUTOMATION

A fully-owned subsidiary of global port operator PSA International, PSA Singapore (PSA) is the busiest container transhipment port in the world today, handling more than 30 million TEU per year. Our excellent connectivity, ability to anticipate customer needs and provide high service levels have been key factors of our success today.

As trade, shipping, and consumption behaviour continue to evolve, we need to be agile and supple to stay ahead of the competition. With a projected tighter labour market in the long term, there is a critical need to leverage technology and automation for greater quality and productivity, as we strive for best-in-class service and create superior value for our customers as well as for the whole ecosystem.

In fact, PSA Singapore has already embarked on this journey. Over the last two years, more than 900 staff have successfully made the transition from our older City Terminals to the newer Pasir Panjang Terminals. By 2021, the first berths in our next-generation Tuas Port will also be operational.

Advancements in automation, control engineering and communications have enabled more jobs to be performed in the comfort of an office environment instead of onsite. With these technologies, staff can manage multiple pieces of equipment and systems when compared to the traditional mode of operations where one staff member handles only a single piece of equipment at a time.

Some of the projects PSA has embarked upon include Automated Guided Vehicles, automated yard cranes, and the use of Unmanned Aerial Vehicle Systems. We are also planning for a series of mechanization projects for a variety of tasks such as the use of robotics and exoskeleton suits to reduce physical fatigue and enhance working conditions.

At the PSA Living Lab, innovative solutions are being test-bedded, utilizing new technologies and digital platforms that can be adopted in our next-generation Tuas Port to ensure efficient, safe and secure port operations that are highly productive.

## DEVELOPING NEW COMPETENCIES

In enabling this transformation, PSA has been developing our staff for a range of new competencies. Training roadmaps are being updated to make sure that staff meet future needs. Some new training programmes are co-developed with our partners in institutions of higher learning.

For example, PSA engineers and ICT professionals are being trained in systems engineering competencies by the Singapore Institute of Technology. Senior technicians and service engineers are also attending part-time courses in industrial systems in Ngee Ann Polytechnic. Senior PSA leaders have also attended data analytics training to appreciate its potential so that more application projects can subsequently be brought to the line departments on a bigger scale.

Career development roadmaps are also being reviewed to nurture more multi-disciplined executives and leaders to manage complex systems and thrive in the dynamic business landscape in future. For example, PSA is developing leaders who will be competent in engineering as well as managing terminal systems. Current leaders of operational teams are also being trained in financial and commercial skills so they can be accomplished business leaders in future.

Simultaneously, PSA encourages staff to deepen their professional mastery of their craft. To enhance the recognition of mastery in engineering, PSA has worked with the Institution of Engineering Singapore to launch a Chartered Engineering Certification Programme in the port and maritime sector. This programme will provide engineers from PSA and the industry an opportunity to receive international validation of their expertise, and a mark of professional competency.

Meanwhile, PSA is making concerted efforts to raise the technology quotient for our large pool of ground staff. One of the initiatives is to have staff attend a one-day workshop on 'Gearing Up for the Digital Workplace' to understand what their future workplace will be like. It also serves as a platform to rally and inspire everyone to co-create the future together.

In this era of disruption and change, openness to learning and adapting to new roles are key to staying relevant and getting ahead. PSA is committed to engaging and facilitating the needs of our staff – who are our core assets – by providing opportunities and platforms for continuous learning, reskilling and upskilling in order to be ready for the future.

## BUILDING THE TALENT PIPELINE

PSA works closely in partnership with several Institutes of Higher Learning (IHLs) to ensure that we have a pipeline of talent that is well-trained and understand the port. We collaborate closely with the IHLs to create relevant and interesting curricula that are current and future-ready. We provide educational and training platforms for internships and integrated work-study programs for universities, polytechnics and the Institute of Technical Education. We also co-create new training programmes with some IHLs as part of new competency development efforts.


## CREATING A LASTING CULTURE

With the myriad of changes that lie ahead, PSA will bring everyone along in this exciting journey. Our people, armed with the right culture and a positive mindset, are critical for PSA to be successful in the long run.

PSA Singapore's goal is to forge a culture that will enable us to create a high performance and agile organization with people who are engaged, passionate, skilful, innovative, resilient, and constantly striving to improve to stay ahead of the competition.

Our culture is founded upon a framework of building positive relationships in the workplace, with everyone working for each other, and everyone for the business. We also believe in harnessing the strengths from the diversity in our workforce.

At the same time, PSA also focuses on enhancing the work environment to make it conducive for the diverse needs of a multi-generational workforce. Flexibility and trust are key tenets in updating workplace practices that will see an increasing profile of millennials, and concurrently, meeting the needs of more mature staff.

Our unions are our key partners whom we constantly engage and bring along with us on this journey. We respect the views of our staff, and value their feedback and contributions, striving for win-win outcomes in everything we do.

## CONCLUSION

PSA is now on an exciting transformation journey. We expect numerous challenges along the way, but we believe that it will bring us immense benefits in the long run. Ultimately, our people will be key for us to secure our future. Investing in our people to bring out the best in everyone is the surest guarantee for future success.

### ABOUT THE ORGANIZATION

PSA aims to be a leader in global ports and terminals business. It is our firm belief that business must not only be conducted according to the highest standards of economic efficiency but the highest ethical standards as well. These standards go beyond minimum legal requirements and reflect the Group's long-term commitment to building a business that is successful, honest and responsible that all its employees can take pride in. The Code reflects our business principles and offers guidance on what is expected of PSA employees in dealing with critical issues.

### ENQUIRIES

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# VIRTUAL QUEUING

## A GAME-CHANGER FOR DP WORLD ANTWERP GATEWAY

Alex Bäcker, CEO,
QLess, California, USA

When people think of trucking, they don't think digital. They think of very big, very tough, very analogue machines, and the men and women who operate these machines are pretty tough themselves. But as the 21st century marches on, every industry in the world stands to reap the benefits of the digital revolution, with the trucking and shipping industry already taking important steps in that direction — steps that have paid dividends in efficiency, safety, and client satisfaction. At the DP World dockyard in Antwerp, Belgium, a simple shift to virtual buffer queues led to an unprecedented leap in performance from long and congested lines of trucks waiting to pick up goods.

### GOING MOBILE

We don't often think of the shipping industry as very digital. Despite the countless innovations piled onto maritime transport and the movement of goods, we still associate the industry with the 'old economy' or big heavy ships, crates, and cranes, and not with the advanced technology and state-of-the-art logistics. But digital and mobile technologies have disrupted and reinvigorated industry after industry, and the shipping and trucking world is no different.

Even a very basic digital upgrade can yield massive benefits within an industry. People often imagine a bottom-up overhaul of everything within a business, but the digital transformation really happens one function at a time. Think of the transformation companies underwent by switching from typewriters to digital word processing in the last few decades. From awkwardly typed documents covered in whiteout, the workforce in general transitioned to digital error correction, free unlimited copies, millions of fonts and colors, free sharing on the internet, automatic redundant backups, automated proofreading, translations, and more.

This switch saves millions upon millions of dollars in man-hours alone as digital technology streamlined just one important aspect of doing business. This is the philosophy businesses should apply when seeking electronic solutions: You don't need to rebuild from the ground up, just replace one operation at a time.

### AN OVERVIEW OF DP WORLD

DP World in Belgium is a major dock site at one of the busiest harbors in Europe. Their four operating terminal locations feature 12 cranes and employ over 900 people. These employees load and unload around 2.5 million containers from almost 950 vessels every year, generating at least US$240 million in revenue. That means handling over 3,000 trucks per day.

This incredible volume of traffic creates, accordingly, incredible pressure on the staff and facilities at the DP World Antwerp Gateway to handle every crate, ship, and truck as smoothly as possible, and an ongoing reliance on analogue techniques was not yielding the desired results, creating logjams and dragging down service quality.


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More than 65% of all containers loaded and discharged from deep sea vessels arrive or leave by truck, creating lineups of idling vehicles waiting to drop off and retrieve cargo.

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## GROWTH LEADS TO TROUBLE

Between 2004 and 2014, DP World experienced an impressive rate of growth and prosperity. Opening their new Antwerp terminal in 2005, the company saw a steady rise in shipping volume, leading to healthy, organic growth of the facility and operation, as well as impressive commercial growth. With waterside and landside loading activity humming along smoothly, DP World developed an excellent reputation for efficiency and professionalism.

In 2015, however, all this growth led to unforeseen but inevitable problems for DP World. With volumes still growing and all container handling consolidated to the Antwerp Gateway, the company encountered extreme congestion in their landside operations. While waterside loading and unloading remained smooth, an unmanageable number of trucks would crowd the docks as handling each one took longer.

This led to unsightly and labour-intensive long queues, inefficient use of container handling equipment, and increased stress among employees. Worse still, the overloaded facilities and congested roadways led to an expanded environmental impact and more risk to the safety of visitors and workers. All of this combined to cost DP World some of their sterling reputation, and in an online world where a single bad review can lead to sinking fortunes in an industry where efficiency, speed, and safety are everything, DP World could not afford to be known as inefficient, slow, and unsafe.

Inspecting their operations, DP World found several major causes for this backlog. Despite a truck appointment system, road congestion in Antwerp and other external factors meant trucks did not arrive evenly spaced throughout the day. During peak hours, with many vehicles arriving at once, the backlog was simply unmanageable.

Congested roadways meant trucks waiting to go to one exchange lane would be blocking those going to one behind it, compounding the issue further and making some areas unreachable and idle while others were badly overtaxed. To solve this problem, DP World could have tried to reconfigure their entire layout for greater efficiency, paying millions of Euros for a solution that might not even work. But just as switching to digital typing was one small step that had a giant impact, DP World switched to Virtual Queuing and has never looked back.

## THE DIGITAL SOLUTION

The core problem at DP World Antwerp wasn't too much traffic. They knew how many trucks they could load and unload per day for maximum efficiency and were already scheduling each appointment. The problem was haphazard arrivals and departures leading to congestion, which led to backups, empty and underused terminals, and a slowdown that kept compounding itself with each additional truck. The solution was to institute a system wherein trucks did not even enter the dockyard (and thus add to congestion) until called for their appointment. The solution was digital queuing.

A virtual queue is a system that uses mobile technology to let users sign up for an appointment remotely or at a special kiosk and then be placed in a virtual queue. Users may go wherever they wish while waiting and will receive updates letting them know when their turn will be, as well as a timeframe to return to the premises for their turn in line. And while truck drivers aren't going to roll through Het Ellandje (the 'little island' at Antwerp Port) for a cup of coffee while on the job, they definitely appreciate a chance to wait for their appointment without being stuck in bumper-to-flatbed traffic.

For DP World, the digital queuing solution keeps trucks waiting at the staging area/parking lot until their designated exchange area or terminal becomes open. At that time, the queued truck driver receives a message shown on a call-up board within the administrative building, a text message, or a notification using the digital queuing service smartphone app. The truck driver is then free to proceed to the inspection point, exchange area, and terminal exit without anyone in his way, the digital system accounting for ongoing traffic.

## RESULTS

DP World first began implementing digital queuing in September 2015. By March 2016, key trucking companies participated in live testing on the Antwerp grounds, and one month later in April, the system was 100% operational. Since then, truck service time at the Antwerp location has improved significantly. Truck queues have disappeared from the DP World dock site and DP World employees are making more efficient use of exchange areas and gear. Customer satisfaction, environmental impact, and safety have improved across the board.

## APPLICATIONS

The shipping industry is hindered by how fast its employees can load and unload ships and trucks to keep the system moving and goods flowing around the world. By embracing new innovations in one aspect of their performance — truck queuing — DP World vastly improved their performance on a number of metrics, eliminating congestion, and reducing loading and unloading times to ensure the smooth flow of goods through the Antwerp docks. Virtual queueing and other digital advances allow businesses to make improvements in their operations and see major rewards.

DP World is only one shipping firm with a specific problem (congestion) gumming up its works. Here is just a short list of some of the benefits digital queueing can offer beyond ending gridlock among the shipping containers:

- Improved safety
- Happy truckers
- Higher landside throughput
- Improved terminal reputation
- Increased seaside volume
- Load balancing reduces traffic peaks
- Getting truck information ahead of time
- Digital queues can be used to prioritize faster transactions
- Digitizing interaction with truckers means they can get personalized driving directions to the corresponding exchange lane
- Real-time data and analytics


### ABOUT THE AUTHOR

Alex is founder and CEO of QLess and holds a degree in Biology and Economics from MIT and an M.S. and Ph.D. in Computation and Neural Systems and Biology from Caltech. Prior to starting QLess, Alex held positions at McKinsey & Co., the Center for Computation, Computers, Information and Mathematics of Sandia National Labs, and Caltech.


### ABOUT THE ORGANIZATION

QLess helps your business overcome problems that alienate customers and impact your bottom line with a simple, easy-to-use solution and eliminates waiting with an award-winning queuing and scheduling technology. QLess is dedicated to helping boost their clients' reputations through improved customer satisfaction, operational efficiencies, and sustainable growth.


### ENQUIRIES

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# CRANE OPERATOR HEALTH & SAFETY

PORT EQUIPMENT MANUFACTURERS ASSOCIATION (PEMA)

The rise of containerization has brought new challenges for ports and terminals concerned about the health of their operators. Despite increasing focus on crane cabin and workstation design, ergonomic issues such as awkward posture, and environmental factors including heating, ventilation, noise, and vibration, continue to impact crane operators' wellbeing. Beyond its personal cost, poor employee health also has detrimental effects on operational safety and productivity.

However, the global ports and terminals industry currently lacks a basic, comprehensive list of cabin characteristics that could be used to mitigate the health risks associated with crane cabins and workstations. This paper provides baseline specifications for workstations and crane cabins in relation to ergonomic and safety features.

To make such moves effective, this paper suggests that these recommendations should be included in design tenders requested by crane customers, and that they should also be included as standard features in suppliers' initial quotations.

Although critics may raise concerns that such recommendations encroach upon the functioning of the crane cabin market, if all equipment suppliers were to adopt these features as standard, it is not anticipated that competitiveness would be affected, nor should it significantly affect cranes' base prices. Furthermore, the likely improvement in safety would reduce staff injuries and equipment damage costs, and improve the reputation of the container terminal industry and equipment manufacturers in general.

## BACKGROUND

For many years, crane cab and workstation design focused almost entirely on mechanical structures and basic control layout, with little reference to their human operators. As early as the 1970s, industry studies highlighted concerns over the impact of poor cab design on musculoskeletal disorder (MSD) and other conditions. A study by Wicks et al., published in 1975, suggested that tower crane operators would often leave their jobs before they reached the age of 50 due to ill health.

A study by Zondervan, (1989), showed that 64% of the crane operators it surveyed suffered back complaints; and 42% neck complaints. Burdorf et al., (1993), found that 50% of crane drivers were prone to back problems.

In 2001, Ariens concluded that there is evidence to suggest a clear relationship between neck pain and resultant work-related risk factors: neck flexion, arm force, arm posture, duration of sitting, twisting or bending of the trunk, hand-arm vibration, and workplace design. A study published in 2002 showed that between 44 and 77% of crane drivers surveyed suffered neck complaints, and between 67 and 86% complained of lower back pain. Further, Eger et al. (2008) analysed video recordings of container crane operations, finding that operators spent significant amounts of time with their necks and trunks rotated or unnaturally bent.

An ergonomics study on grab unloaders by Courtney and Chan, (1999), demonstrated

that to look downward through the central lower front window – a necessity for around half of a typical shift of the cranes surveyed – operators' main body parts were in awkward postures involving the neck, (81%), lower back (88%), mid-back (50%), and shoulders (50%). This resulted in static loading of the neck and back, with the trunk flexed 30 to 40 degrees forwards and the neck fixed about 60 to 70 degrees forwards from the vertical to ensure a proper view of directly below the cab.

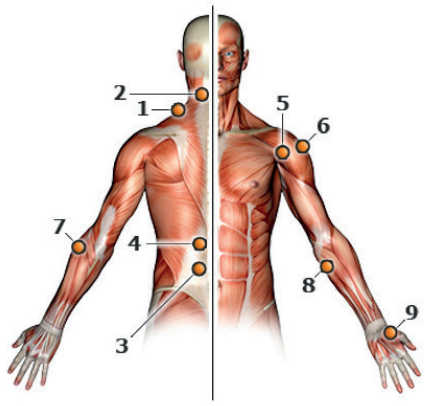
More recent research, based on European Standards EN 1005-3/4/5 and focused on biomechanical analysis by the EPM Research unit – Ergonomics of the body posture and movement and the Biomedical Technology Department of the University of Milan (2007-2008), in collaboration with PEMA member Brieda Cabins, used electrodes to accurately measure stressors on trunk, neck and limbs with electromyography.

These tests showed that awkward postures adopted by crane operators is the result of improper cabin design, and went further in demonstrating that a good ergonomic control station's configuration and control layout will alleviate poor posture and resulting injury.

International Standard ISO 11226, Ergonomics – Evaluation of Static Working Postures, establishes ergonomic recommendations for different work tasks. It provides information to those involved in the design and redesign, of work, jobs and products that incorporate basic concepts of ergonomics and working postures in particular. Recommendations contained in the standard related to trunk inclination and head posture, in combination with the studies mentioned above, appear to support the need for specific equipment for crane drivers. This report provides a brief overview of ISO recommendations.

Design also has an overall impact on safety, as it can improve poor visibility typically associated with crane cabins, mitigate forces required to operate joysticks, buttons and levers and, by helping to reduce fatigue, also help operators to remain alert.

Finally, in addition to the cost of chronic conditions among operators caused by poor crane cabin design, the detrimental effect of employees' poor health on relationships between operators and port management should also be considered.




1) UPPER TRAPEZIUS
2) CERVICAL SPINAL ERECTORS
3) LOW LUMBAR SPINAL ERECTORS
4) HIGH LUMBAR SPINAL ERECTOR
5) FRONT DELTOID
6) MIDDLE DELTOID
7) FINGERS EXTENSORS
8) FINGERS FLEXORS
9) THUMB ADDUCTOR

## KEY CONSIDERATIONS

Several issues need to be considered when drawing up specifications for crane cabins and control stations. A more exhaustive list of possible specifications is included in this paper, (see below); such stipulations do, however, fall into several broad categories.

In container cranes – STS and RTG cranes – drivers are required to look downwards almost continuously. Each type of container crane has its own specific characteristics.

STS crane cabins significantly accelerate and decelerate when moving backwards and forwards. Passing the boom junctions creates low frequency shocks. Due to the heights and speeds typical of container cranes, drivers need to be constantly highly focused. Drivers' downwards viewing angle is relatively limited due to crane height.

RTG drivers have a different field of vision. Because the spreader is relatively close to the cabin, the viewing angle is wider. As a result, drivers' legs often obscure their vision. Looking around while driving, and looking sideways under beams while searching for trucks causes awkward posturing. Sideways movement, in combination with RTG tyres, creates a swinging motion in the cab when starting and stopping.

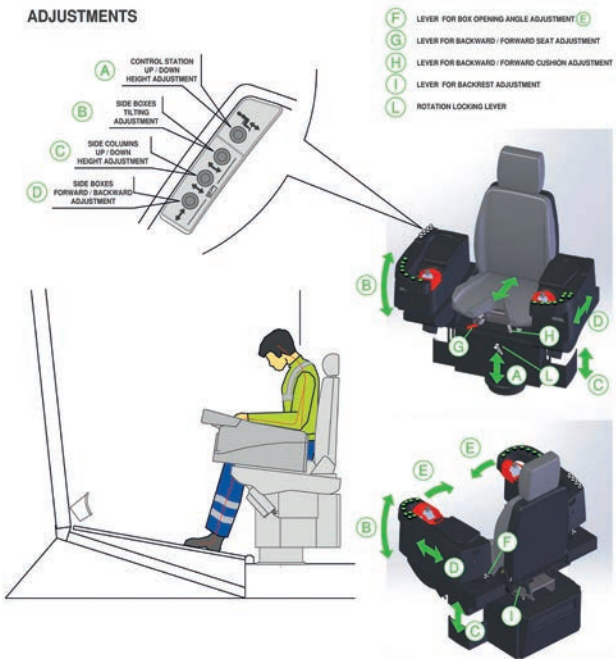
There are also structural points to consider such as 40mm safety laminate fixed floor glass. The development of glass of this thickness resolves some issues where thinner, removable glass was used to assist cleaning, the latter being protected inside and out by metal safety grills which reduce visibility.

The need for shock and vibration absorbers on cabins and control stations has emerged in part due to reports that increased speeds of modern cranes have resulted in greater vibration levels. ISO 2631-1 Mechanical Vibration and Shock should be considered a benchmark in this area when drawing up crane cab specifications. Comfort is one element here, but there is also the issue of effective control of items such as touchscreens. Similarly, correctly positioned handholds are necessary to help drivers climb in and out of crane cabs and move around inside the cabin.

Anecdotal evidence from drivers, and detailed research by the EPM Research unit – Ergonomics of the body posture and movement and the Biomedical Technology Department of the University of Milan (2007-2008), shows that seats and control stations need to be adjustable in all directions including tilt, with forearm rests to reduce pressure on the lumbar region.

Seats and control stations also need

| ITEM | RISK | SAFETY FEATURE | FUNCTIONAL REQUIREMENT |
|---|---|---|---|
| 1 | High frequency vibrations on cabin and crane driver and possible disturbing noise due to vibration. | ANTI-VIBRATION SYSTEM | Cabins should be fitted with 3D high frequency anti-vibration dampers and brackets to improve safety, control, and maintenance access. Anti-vibration mounts should be calculated according to weight, point of gravity of the cabin and platforms, and acceleration/deceleration of the trolley. |
| 2 | Maintenance and access to crane cabins. | MAINTENANCE PLATFORM AND PLATFORMS FITTED TO CABINS | Cranes should be fitted with a back platform for safe general maintenance of the cabin. Cabins should be fitted with lightweight platforms for maintenance, safe access, and the ability to rescue injured personnel. |
| 3 | High temperatures and condensation inside the cabin. | | Cabins should be equipped with a split air conditioning unit to decrease noise levels inside cabins, improve comfort, maintain an inside temperature of 21°C and take fresh air supply of 50m³/h into account. Noise levels should not exceed 68 dB(A). The capacity of the air conditioning unit should be calculated on environmental temperatures, insulation of the cabin and internal heat sources. Condensation water to be drained to the outside of the cabin to prevent sight obstruction due to condensation on windows. |
| 4 | Airflow from air conditioner apparatus. | AIR CONDITIONING APPARATUS | Main airflow not directed onto the crane driver. Direction of secondary airflow to be adjustable to improve driver comfort. |
| 5 | Low temperatures inside the cabin. | HEATED AIR FLOW ON THE MAIN FLOOR GLASS | Cabins must be equipped with heating units installed in the floor bottom, complete with thermostat with the main airflow on the main floor glass. Direction of secondary airflow to be adjustable to improve the comfort perception of the driver. Airflow strength should be appropriate to local ambient conditions; 21°C is frequently cited as a desired cabin temperature. The capacity of the heating unit should be calculated according to local ambient temperatures and insulation of the cabin. Maximum noise levels should not exceed 68 dB(A). |
| 6 | Harmful emissions and pollutants. | POSITIVE PRESSURE AND AIR FILTRATION UNIT | Cabins should be fitted with a proven, positive pressurized air filtration system, with high efficiency particulate and gas absorbers or similar to protect drivers from harmful emissions from ships or other pollutants. |
| 7 | Structural strength of glass floors. | LAMINATED, CERTIFIED FLOOR GLASS | Floor glass should be fixed, walk-on safety laminated glass, at least 40mm thick, with sliding and lockable footrest grids for optimal visibility of the working area below.Floor windows should resist a concentrated load of 2,500N/ft2, and a divided load of 1,500N/10ft2 simultaneously. |
| 8 | Fall risk to drivers during operating phases due to cranes stopping suddenly. | FOUR-POINT SAFETY BELTS | It is advisable to have safety belts for the shoulder and waist, so the driver is held safely during operations, and blocked in the event of the trolley suddenly stopping. |
| 9 | Bending and tilting of drivers. | SAFETY BELTS | Safety belts for the shoulder and waist with type-approved roller to allow the free movement of the driver. |
| 10 | Failure to monitor and control visual indicators. | FRONTAL POSITIONING OF VISUAL INDICATORS | It is advisable to install all mission-critical indicators in the lower front frame of the horizontal position, in boxes of suitable size, to avoid obstructing visibility, thereby giving drivers all necessary information, (spreader lights, container weight, container height, hoist/trim position, twist lock locked/unlocked, crane faults, windspeed, sudden high winds, overload, anti-collision alarms etc.). These are located in the driver's main working direction, which is the look through the front and floor glass. This enables the safe control of loading/unloading operations. |
| 11 | Failure to monitor and control visual indicators. | ANGULAR POSITIONING OF VISUAL INDICATORS | Display screens should be positioned between 45° and 50° to drivers' eye level while seated, ensuring the safe control of information necessary during operations. |
| 12 | Difficulties related to the use and accessibility of auxiliary devices. | LATERAL POSITIONING OF AUXILIARY DEVICES | Auxiliary control panels and radio/transmitters should be designed according to cabin vibration; and should be placed on the right- or left-hand wall and should be within easy reach of the driver by hand when seated at the control station with a maximum rotation of the head of 90°. Main (turn on/off) switches and microphones should be positioned to allow drivers to maintain sight on driving the crane while using communication equipment. |
| 13 | Failure to use touch devices, noise and vibration. | INTERNAL NOISE DAMPERS, ISULATION AND ABSORPTION MEASURES | No equipment installed in cabins should produce noise due to vibration of the cabin. Cabin structure and windows should be isolated to avoid unwanted noise entering the cabin. Cabins should be provided with sufficient sound absorbent material to reduce reverberation. |
| 14 | Lumbar spine, neck flexion and general driver overload. | | It is advisable to lean the forearms while using joysticks to minimise lumbar overload. Leaning forward responsibly makes it possible to reduce neck flexion when looking downwards. |
| 15 | Acceleration and inertial forces on drivers. | ERGONOMIC SUPPORT OF THE BODY AND LIMBS | Control station design should take into account biomechanical stress due to trolley acceleration and deceleration. |
| 16 | Incorrect control of joysticks during acceleration/deceleration. | ERGONOMIC JOYSTICK SUPPORT | The hands have to be based on an ergonomic support during the activation of the joystick to have a better control of the movements |
| 17 | Incorrect control of joysticks during acceleration/deceleration. | ERGONOMIC PLACEMENT OF CONTROL BUTTONS/ SELECTORS | Positioning of push buttons/selectors on control stations should reflect ergonomic principles during use, and frequency of use. |
| 18 | Transferral of crane vibration to driver. | ANTI-VIBRATIONAL DAMPERS | Control stations should be sufficiently robust to minimise movement of fittings. Shock absorbing devices to mitigate lower frequency shocks in the seat and control boxes are recommended. Such devices should not be installed in the seat, because they tend to wear excessively. Shock absorbers should be installed in the column of the control station's support. This ensures driver movement and joystick boxes are united/compact. |
| 19 | Control workstation conflicts with anthropometric data. | ADJUSTABLE CONTROL BOXES | Control boxes should be provided with all necessary adjustments:<br>height in relation to seat cushion<br>-forwards/backwards related to seat cushion<br>-tilting<br>For a correct definition of optimal posture, see<br>EN241 standards- 11226- 1005-11064<br>Control boxes must not prevent drivers from spreading their legs for better visibility downwards. |
| 20 | Control workstation conflicts with anthropometric data. | ADJUSTABLE CONTROL WORKSTATION | Control stations should be adjustable to correctly adapt to different drivers' heights, (P5 female to P95 male worldwide according to Dined). This includes height related to foot grills, length of the seat cushion, height of the lumbar support and the forward- backward adjustment to bring the eyes in the required position for optimal visibility for crane operation. |




to support the body through periods of biomechanical stress, while hand supports allow for precise control during joystick operations.

Related to this is the need for good quality, self-retracting safety belts – cabins are prone to sudden jolts and stops that can, in some cases, unseat operators. However, freedom of movement needs to be maintained for ease of use and to prevent drivers not using seat belts they consider unnecessarily restrictive.

The positioning of displays and lighting inside cabins is critical to effective crane operation. Experience and evidence from other industries where crane use is prevalent, shows that monitors need to be between 45° and 50° from the driver's eye level to avoid strain. Further, key system indicators, including fault and overload lights, should be within drivers' forward and downward field of vision, rather than in side panels where operators risk missing important system information. Touchscreens and other control tools also need to be adjustable.

Other important issues that need to be considered in crane cab design include adequate air conditioning and heating, with sufficient warmth being directed across glass floors to keep them free from moisture. Furthermore, cabins must be positively pressurised with clean air to keep out pollutants.

## INDUSTRY RECOMMENDATIONS

The following is not intended to be a comprehensive source of cabin and control station safety items. Rather, it aims to provide terminals, operators and suppliers a solid minimum baseline of safety features that are practical and effective.

Based on experience, records and insurance claims analysis, the table includes systems, structures, features, equipment and technology that have been shown to reduce injury or damage that are currently not standard.

*This article summarizes the main findings of a revision paper, prepared by Siro Brieda of Brieda Cabins, with input from Daan Potters from BTG Special Products BV on behalf of the Safety & Environment Committee of the Port Equipment Manufacturers Association (PEMA).*

## ENQUIRIES

Web: www.pema.org/publications

# TERMINAL AUTOMATION PLATFORMS

## OPEN INTERFACES

Timo Lehto, Jari Hamalainen, Heimo Poutanen, Kalmar, Finland

This paper argues for a systemic approach in designing a terminal automation platform. A key feature of such a platform is the availability of open interfaces that enable terminal operators to customize their automation deployments and allow third-party developers to provide their own offerings that are interoperable with the automation platform.

Kalmar will open up the application-independent core software components of the Kalmar terminal automation system (TLS) with Kalmar Platform keys, for use by developers. This will enable customers to tailor their automation system with the help of a third-party partner in ways that were previously not possible – for example, by extending the system with any brand of equipment. Platform Keys will be complemented with higher level Kalmar Application Keys. Kalmar will publish first keys in June this year.

### STANDARDISATION

In order for terminal automation to develop to the next level in speed of deployment and operational efficiency a significantly higher level of standardization is required. Currently, a major challenge for most terminal automation projects is that many design and implementation questions need to be solved anew each time. These questions range from basic connectivity and equipment functionality to user interfaces for applications and safety guidelines. With terminal operators unsure of the exact specifications needed for a terminal automation deployment, system providers often need to reinvent the wheel for each customer case.

### INDUSTRY OUTLOOK

In many ways, the development and gradual adoption of container terminal automation mirrors the steps taken by process automation in recent decades; however, some significant differences also exist. Firstly, when compared to existing highly automated major industries, the container terminal business is significantly smaller. Resultantly, automation will be adopted at a slower rate, and the development of the entire field does not have the same 'critical mass' as, for example, automotive manufacturing.

Secondly, the container shipping industry lacks a consistent force of industry consortia and/or international regulatory bodies that would have the expertise, motivation and influence to define a top-down set of industry standards for terminal automation at the needed level of detail. Simultaneously, in a highly competitive, volatile industry, port operators and shipping lines are unlikely to find – at least in the foreseeable future –common ground for defining these standards together from the customers' point of view.

As a result of these factors, it is reasonable to expect that container terminal automation will progress through a de-facto standardization effort of established automation system providers defining the required interfaces and selectively opening them for wider utilization.

### TERMINAL AUTOMATION PLATFORM

Despite the continuous advances in terminal automation over the last few years, container handling is still a relatively new industry to embrace automation. Industries such as car manufacturing began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automating their operations several decades ago, and have thus been able to develop a significantly wider perspective on how to deploy largescale automation systems.

By contrast, until recently, container terminal automation has primarily been conceived as an 'add-on' to an equipment investment, instead of a comprehensive end-to-end solution. Automation solutions have been assembled as one-off projects that have required extensive integration of diverse systems and solutions, often from several vendors.

At the same time, as terminal automation advances, the focus in industry deployments is shifting from a limited number of new greenfield sites to automating hundreds of existing container terminals. These brownfield projects require that the automation system can interface with diverse existing fleets and processes at widely differing levels of automation. To reap the full benefit of terminal automation and to fully utilize their existing equipment and software, terminal operators need the ability to flexibly customize their solutions, possibly with the help of third-party developers.

## KEY FUNCTIONALITIES

Kalmar Key automation platform with open interfaces encompasses several types of system elements. These include 'core services' that provide access to automation platform data as well as tools for presenting data; 'digital services' that enable creating new value from available data; and 'controllers' that handle the integration with equipment and automation hardware.

New Kalmar Platform Keys opens interfaces to these elements, facilitating the creation of new and customized solutions in multiple areas like visualization, history data management, integration to other systems and connecting new applications, remote monitoring and control and connecting 3rd party automated equipment to the platform. The Kalmar Key contains also a higher level integration interface concept, an Application Key that opens up Kalmar's best-practice models for systems integration in different terminal types.

## NEW OPPORTUNITIES

The Kalmar Key automation platform with open interfaces enable open and easy collaboration with all stakeholders for co-creating terminal automation solutions. It benefits all parties throughout the industry. Open interfaces enable a wide range of new possibilities for terminal operators to customize their automation and augment their solutions with the required functionality, gain enhanced access to their operational data and develop the system according to their business processes. The open automation platform enables combining data from multiple sources and creating a holistic view to terminal's operation, thus allowing terminal operators to optimize their operations with greater ease.

Technology development partners may integrate their products with the automation platform in order to extend the capabilities of the system as well as creating new markets for their own software and hardware products.

Another benefit of open interfaces is that they create a essence for an ecosystem that benefits all parties in the value chain. Terminal operators can add new equipment or features to their systems with minimal business risk; technology developers can create and market their own products that are interoperable with the terminal automation system; and the automation system provider can offer new, advanced capabilities that utilize third-party solutions.

## KEY ENABLERS

In order to be usable, the open interfaces of an automation system require a full support from the system provider. Kalmar Platforms Keys will be released with all needed development resources including SDK and other tools, test environment, API definitions, configuration instructions, demo implementations etc. Kalmar Application Key includes generic interface specifications and high-level business process descriptions to support the integration and SDK for developing the interface. All these are available for download from the Kalmar Key partner forum – a one-stop-shop for developers, customers and partners. Partner forum will also host discussion, Q&A and ticketing service.

The Keys are licensable modules. The basic structure of the licensing model is that keys are free to try for anybody, with various licensing options for development and production use. The license structure can be based on either usage volumes or fleet sizes. Optional services can include training modules, technical consultancy or a Kalmar verification service that enables independent developers to have their applications certified by Kalmar for function and interoperability.

## RISKS AND OPPORTUNITIES

Any opening up of previously proprietary interfaces always involves some degree of risk for the party sharing the technology. Competition could increase; new players may enter the market to challenge industry leaders; or clients may choose to accomplish in-house what previously would have been delegated to a system provider.

However, it is Kalmar's firm belief that in terminal automation, shared and standardized interfaces are an absolute necessity for the development of the entire industry, and that the benefits of progressively opening these interfaces greatly outweigh the potential risks. Not even the largest industry leaders have all the possible expertise in-house, and open interfaces enable a vastly expanded collaborative landscape for the benefit of terminal operators, independent developers and automation system providers alike.

## ABOUT THE AUTHOR

TIMO LEHTO: Director, Software and Automation, Kalmar, has been working on terminal automation for over 10 years. He has been designing and implementing software products for most of the Kalmar fully automated solutions. In his current role he is leading the Kalmar software development teams in Tampere, Sydney and San Jose.

JARI HÄMÄLÄINEN: (Dr Tech.), Director, Terminal Automation, Kalmar, has a background in telecommunications and the software industry, with over 300 patents in 40 global patent families helping smartphone users in their daily business and pleasure. He has been working 5 years at Kalmar, leading offering and service concept development. He is currently leading product management of Kalmar software and automation development, as well as the simulations lab and test yard automation operations. He is also project director for the Kalmar AutoRTG product development.

HEIMO POUTANEN: Product Manager, TLS platform, Kalmar, has over 30 years' experience in developing and delivering automation solutions for different industry sectors. He has experience with process industry automation in pulp and paper mills, graphics industry and nuclear power plants and mobile equipment automation in the mining and construction sector. For the last two years he has been responsible for the product management of Kalmar's TLS (Terminal Logistic Systems) platform.

## ABOUT THE ORGANIZATION

Kalmar, part of Cargotec, offers the widest range of cargo handling solutions and services to ports, terminals, distribution centres and to heavy industry. Kalmar is the industry forerunner in terminal automation and in energy efficient container handling, with one in four container movements around the globe being handled by a Kalmar solution. Through its extensive product portfolio, global service network and ability to enable a seamless integration of different terminal processes, Kalmar improves the efficiency of every move.

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# EXPANDING PERSPECTIVES

## FROM PORT FOCUS TO SUPPLY CHAIN FOCUS

Supply chains are more global than ever today, and their performances will be enhanced by improving integration, intelligent processes, digitalization and automation.

The traditional role of a gateway port includes the ship load/discharge operations serving the shipping lines and the place where customs operations are performed. Terminal yard turns into a temporary warehouse with long cargo dwelling time because rail connectivity is not always available and catchment area is limited to nearby markets.

Similarly, the traditional role of inland terminals is that of changing the modality from rail/truck focused to rail load/discharge operations, as well as that of having modest availability of value added services and serving the local market. Both have modest integration with the cargo supply chain.

Container transport is a fast changing industry, globalization expands trades and the scale of transport continues to increase while new routes such as Asia-Europe rail connections have changed transportation needs. Logistics is becoming more complex and transportation chains require reliable and high frequency connectivity, while customers aim for easy business solutions due to pressure on transport costs.

Automation, digitalization and data management are becoming the main goals for operators, but adequate port infrastructure, multimodal transport, high and frequent connectivity, value added services and sustainability still remain paramount as well.

### A PARADIGM SHIFT

Focus has shifted from port/terminal performance to supply chain performance, and maritime and logistics now needs to be innovative and adaptive to keep pace. In the past, the introduction of new technologies took place spontaneously. Nowadays with Industry 4.0 it is sustained and strongly accelerated by national strategic plans, confirming its epochal relevance.

Joint, coordinated action of whole national systems, from governments to public administrations, to educational systems and trade associations, is now necessary. There is a need to create new strategies, to explore new ways and to pay particular attention to striking a good balance between protecting legal and ethical standards and promoting innovation.

Maritime and inland terminals have to create value for the supply chain actors, ensure fast and smooth transportation, and guarantee that customer cargo is moved as booked with more integration in the end-to-end supply chain. Further, they have to reduce time to market, provide intermodal services of reliable quality, offer integrated/customized processes, and provide integration in international corridors. It will also be important to be part of the 'Digital Revolution' by managing modern interfaces.

### TERMINALS

What does a terminal need to do in the present day? It has to improve and expand the supply chain to become the sea port remote gate and to integrate maritime terminal activities. It needs to make rail transportation efficient through high frequency intermodal connections with multiple ports and other logistic nodes.

The contemporary terminal has to be ready to face these challenges by driving terminal yard performance through continuous improvement, implementing augmented intelligence and shared services, and by supplying on-demand equipment that increases overall terminal efficiency, throughput, lifetime value and reduces carbon emissions.

A concrete solution for all contemporary terminals is that they have undertaken a path of sustainability as an opportunity to innovate, be more efficient and compete with their own products and services in the supply chain.

### KUENZ

The patented Aerodynamic Crane Design is one of the improvements that Kuenz has recently introduced to the market, the newly designed portal has an oval section to reduce wind surface and provide customer key benefits.

The new design reduces gantry weight, number of wheels and wheel loads, allows for a reduction in the dynamic force on wheels, crane way and structure with a drastic reduction of energy consumption and maintenance service.

Following years of work on automated equipment, Kuenz is ready to look at what the next steps are. In fact Kuenz customers have already increased terminal operational productivity and operational safety, reached lower overall yard operational costs with better efficiency of operational control and last but not least ROI reduction.

Kuenz meets these needs with high quality RMG and ASC cranes technology, optimizing energy, high performance, predictive maintenance system to minimize downtimes and breakdowns and offering best class services by monitoring the cranes that are being used at a port container terminal and intermodal centres.

Kuenz automation now includes all type of Kuenz cranes control system, but also fast data communication via fiber optic, remote crane management system, remote exception handling control by operator, loads collision prevention, final landing system with the goal to increase reliability and productivity.

Remote operator crane control allows operator to work in a control room which is better office environment with comfortable working position, less fatigue, no exposure


to heat/cold, pollution, vibrations, noise and heavy dangerous equipment and loads.

Each crane can be operated from each desk with maximum security and in a shortest time at maximum efficiency level. Not only crane operator can be in the same control room but also technical team to plan preventive service, operate corrective maintenance that can manage failure in remote to minimize troubleshooting.

## PORTFOLIO

Kuenz terminal automation includes TOS interface, management of transfer zone, container block, reefer handling but also people and equipment recognition. Each equipment is equipped with ELS (Equipment Locator System) and People are equipped with an RFID tag named PLS (Person Locator System) detecting the position.

All positions data are sent to the central control unit by wireless network and continuously verified. People and Equipment Locator System knows all position within the terminal, calculates routing of equipment to avoid collisions and manages safety related stop to avoid people accident.

Current trends of automation and data exchange in global supply chain includes the Internet of things (IoT), cloud computing, cyber-security issues, transform information into meaningful data. Big volume of data still need to be extracted and analysed.

Digitization make possible the decentralization of the global supply chain system through the creation of autonomous, interconnected subsystems and located where the best skills are available.

Supply Chain actors are located anywhere in the world, are connected and they continuously generate huge volumes of data. This process produce further changes in the global supply chain. The result is an increase in the speed of innovation.

Kuenz is ready to look at what the next steps are pursuing innovation approach, think out of the box, investing in new ideas to be successful in creating best class equipment to support digital supply chain.

## ENQUIRIES

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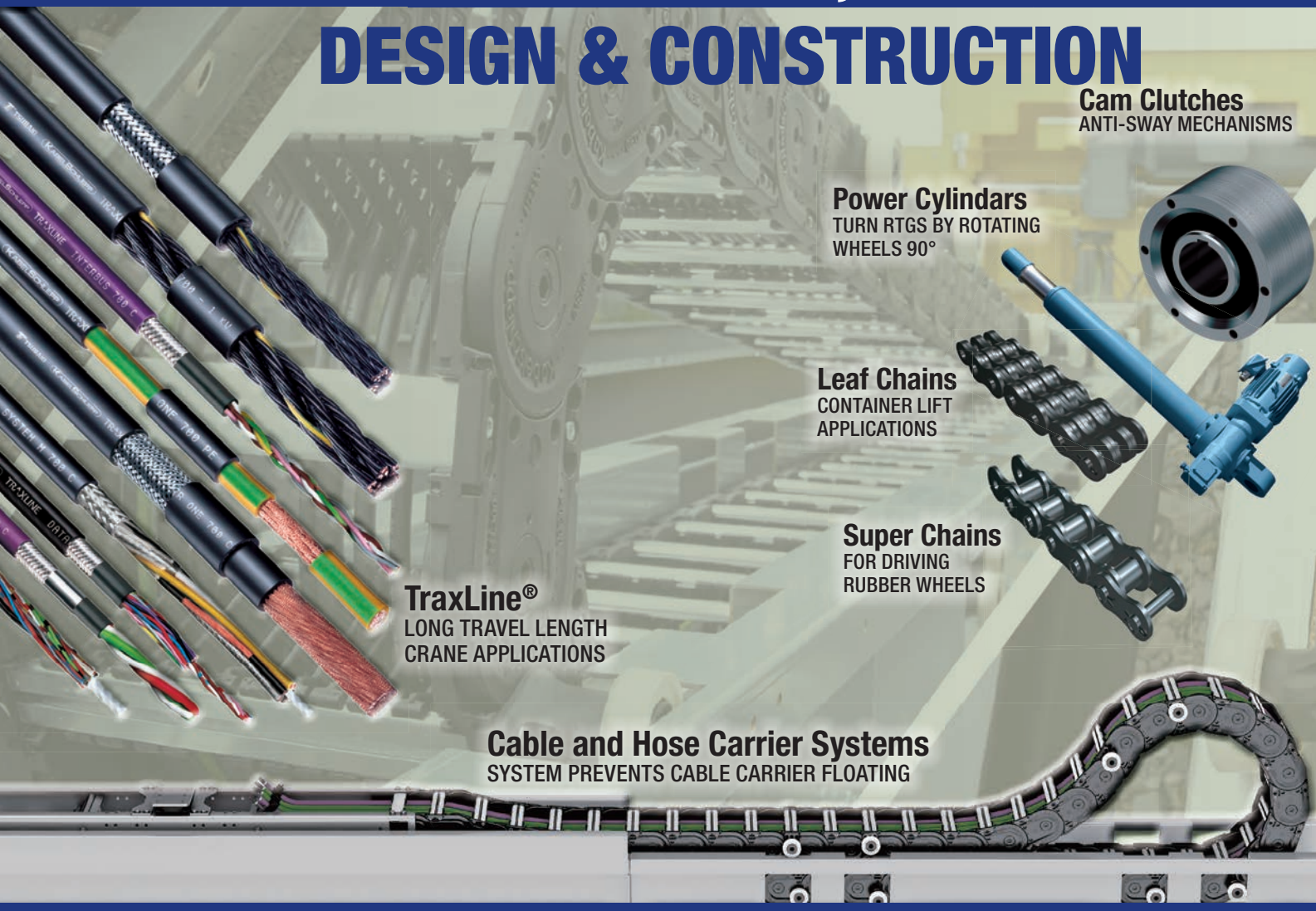


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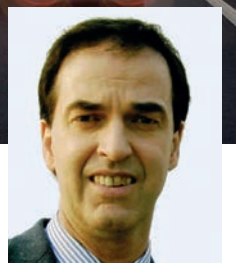

# THE INTELLIGENT SUPPLY CHAIN

## FROM VISION TO REALITY

Dr Leonard Heilig and Prof Stefan Voß,
Institute of Information Systems, University of Hamburg, Germany

Faster, cheaper, safer, more transparent and reliable: whether products need to be delivered within the same city or across the globe, the requirements on today's supply chains and freight transport networks are higher than ever before. Driven by the rising opportunities of the current era of digitalization, complete industries strive to transform their business processes and redesign their business networks in order to keep up with competitors. The intelligent supply chain combines modern technologies, such as blockchain and IoT, with intelligent decision-making and analytics capabilities in order to improve visibility and predictability, flexibility and customer interaction, interconnectivity and collaboration as well as risk awareness and resilience. Considering those four themes, the article discusses the characteristics of intelligent supply chains and how modern technologies and intelligence can be employed to realize visions.

### VISIBILITY AND PREDICTABILITY

The adaption of sensors, smart devices and other IoT technologies can realize real-time monitoring of almost every part of the supply chain. Companies making use of these technologies, such as Walmart and Metro, only need a few days to react to market trends, or are even able to anticipate demand, in order to work with zero safety stock, i.e., just-in-time inventory strategies [1].

Maersk uses sensor data to not only track conditions in reefer containers, but also to operate their fleet of vessels and manage empty container repositioning in a more efficient and sustainable way [2]. The issue of visibility will not be a lack of data, but to select, clean, unite, and standardize the right data in order to extract reliable and useful knowledge for managing supply chains in an adaptive and responsive manner. Thus, the use of data in intelligent supply chains goes beyond traditional descriptive and diagnostic analytics, asking "what is happening?" and "why did it happen?", respectively.

Modeling and analytics capabilities, such as predictive analytics, assist in reducing uncertainties regarding future scenarios ("what is likely to happen?") and help to identify and understand causes of inefficiencies, disruptions, and anomalies in supply chain networks. Amazon, for example, holds a patent for anticipatory shipping, meaning that products are shipped before customers place an order. This data-driven perspective is fundamental for prescriptive analytics, optimization and automation, providing automated decision support regarding the final question "what is the best course of action?"

### FLEXIBILITY AND CUSTOMER INTERACTION

The high level of transparency and information density allows new forms

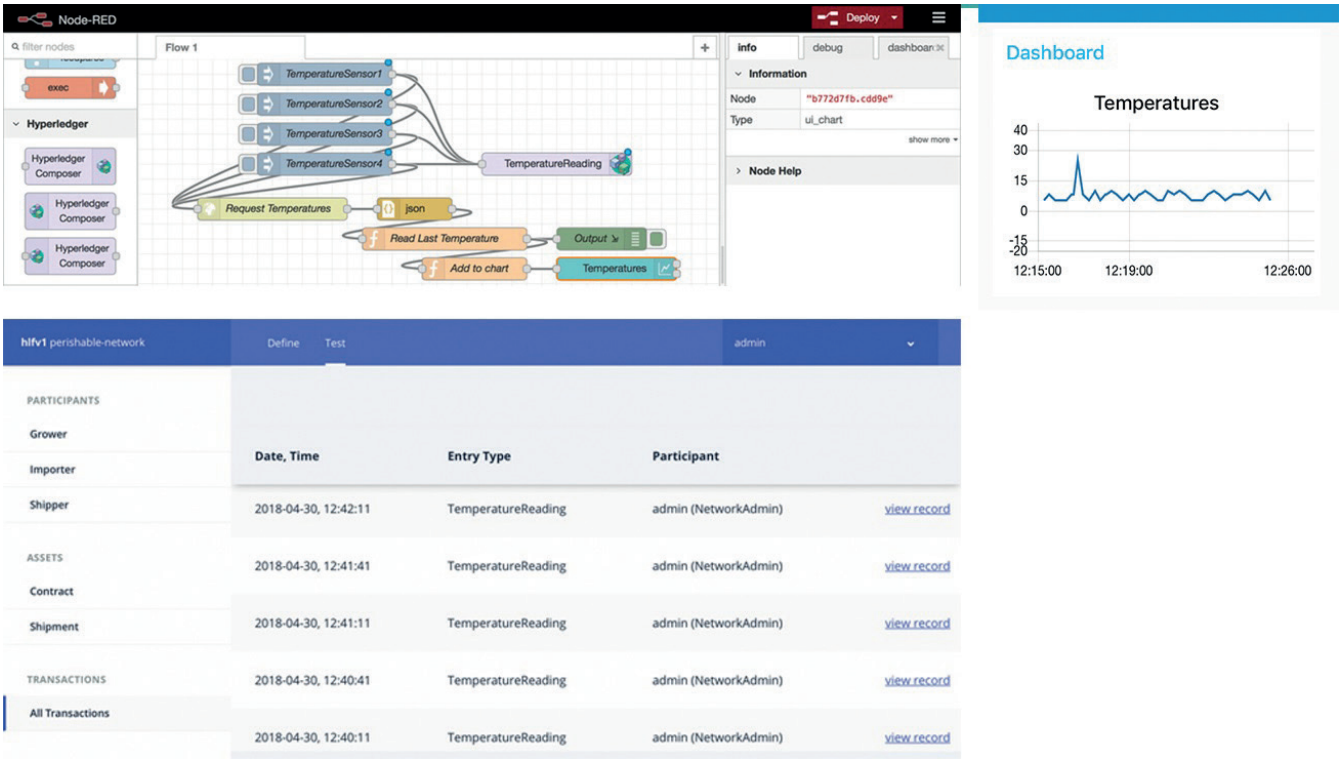


Figure 1: Simple blockchain and smart contract application for temperature monitoring based on an integration of open-source solutions like Hyperledger and node-red

of managing supply chains in a highly adaptive and intelligent way. Operational decisions related to the transport of cargo, such as regarding the mode and speed of transport (e.g., slow steaming) or its final destination (e.g., following a postponement strategy), are made based on the current conditions and market demands, respectively. Synchromodality, defined as an evolution of inter- and co-modal transport concepts [3] and part of the 'physical internet' vision, promotes mode-free bookings allowing to switch between modes or routes during transit. The aim is to better utilize available resources and adapt plans based on real-time information about delays and other circumstances like traffic, weather, or environmental conditions.

A higher flexibility usually requires a high degree of integration, coordination, and collaboration among multiple supply chain actors. Nevertheless, first pilot studies, for example in the transport corridor between Rotterdam, Moerdijk and Tilburg [4], demonstrate the feasibility and potentials of such concepts.

## MAJOR PLAYERS, NEW NETWORKS

Thinking one step further, future transportation networks might involve new technologies, such as Hyperloop or drones, allowing to switch to on-demand and autonomous transport modes (e.g. in case of time-sensitive goods or critical delays). New partnerships, such as between DP World and Virgin Hyperloop One in DP World Cargospeed, pave the way for moving from vision to reality [5]. Synchromodality, however, is only one of many possible concepts for increasing the flexibility in intelligent supply chains.

Pervasive computing further enables intelligent supply chains to better integrate customers and to directly sense, adapt, and respond to individual demands and signals, such as from retail shelves, smart maintenance solutions, or virtual assistants (e.g., Amazon Alexa, Siri). With special regard to retail, the focus of analytics will further shift from the product to the customer. Companies like Amazon, having a deep knowledge about its customers and a huge expertise in data analytics, are increasingly entering new supply chain related sectors, such as shipping and retail, to fully exploit their capabilities. Moreover, the increasing customer awareness requires reliable and detailed tracking and tracing information, for instance, to reconstruct whole food chains from the farm to the plate.

## BLOCKCHAIN

With the above in mind, blockchain is an essential driver of intelligent supply chains as it allows to process transactional data without the need of a central authority. It is built upon essential security principles, applying means to ensure the authenticity, validity, and integrity of transactions.

In Figure 1, a simple blockchain application for tracking and tracing the temperature in containers is shown using Hyperledger and node-red (for more information, please contact the authors). In this system, transactions are automatically generated by using sensors, smart devices or other IoT technologies. A smart contract between supply chain participants allows us to define rules, for example, regarding temperature thresholds, and automatically triggers a transaction if a rule applies or is breached. A business intelligence dashboard allows the tracking of metrics and key performance indicators of the whole supply chain network based on the transactional data.

## INTERCONNECTIVITY AND COLLABORATION

Forming end-to-end delivery networks is a common strategy to respond to new challenges and remain competitive. Integrating large parts of global supply chains under one roof provides more control in optimizing cargo flows based on a unified view on data. Recently, the CEO of Maersk, Søren Skou, once again highlighted that the company's strategy is to become the only point of contact for shipping customers [6]. However, it is often not possible to have all actors of a supply chain network under one roof.

In general, the future challenge is to better integrate different parts of the

supply chain and provide tools to facilitate trust and collaboration. This involves the technical integration of enterprise applications and ERP-to-ERP integration. An example is the integration between supply chain management systems (e.g., transportation management systems) and terminal operating systems. Without a sufficient integration and collaboration support, operations remain a black box and it is even difficult for global companies like Maersk, providing shipping, port and freight forwarding services, to operate supply chains in a visible, responsive, and efficient way.

XVELA is an example of one company bridging the gap between the different parts of value chains. Technologies, such as cloud computing, blockchain and smart contracts, might further facilitate trust and collaboration in intelligent supply chains. Moreover, the 'uberization' of the sharing economy, using digital platforms to match demand with available resources, will play a greater role in intelligent supply chains.

An example is port-IO, a mobile cloud platform to manage and optimize truck drayage operations in a network of independent truck operators based on real-time data and prescriptive analytics [7].

In order to facilitate a high degree of inter-organizational transparency, integration, and collaboration in supply chain networks, information systems need to facilitate trust and data security so that companies not only see potential risks in sharing information, but the necessity and chances of doing so. In this regard, blockchain is a promising technology for improving the information sharing and collaboration in supply chains.

## RISK AWARENESS AND RESILIENCE

Global supply chain operations are exposed to a range of internal and external risks that might cause disruptions with a low or severe impact on businesses. The increasing digital penetration and advanced analytics capabilities will help in detecting potential supply chain disruptions before they occur. A high visibility is key for a continuous risk assessment and real-time predictive analytics. Decision support systems, e.g., using scenario analysis and hedging strategies (see, e.g., [8]), as well as collaboration tools facilitating joint mitigation strategies will help to better ensure business continuity.

DHL Resilience360, for example, is a cloud-based risk management platform to assess, visualize, and track events in order to identify potential disruptions and mitigation strategies, like alternative transport modes or routes (see synchromodality). A high resilience requires an adoption of plans at all individual nodes of the supply chain in case of a disruption. Container terminals, as essential linking nodes, for instance, may need to recover berth and the crane split plans at the seaside [9] or cope with deviating truck arrivals at the landside [10]. From a scientific standpoint, more research is needed to find appropriate response strategies that neutralize the impact of disruptions and maintain a high resilience.

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## ABOUT THE AUTHOR

Dr Leonard Heilig is a researcher and lecturer at the Institute of Information Systems at the University of Hamburg. His research interests are in cloud computing, machine learning, optimization methods and related applications in maritime ports. He serves as guest editor in highly-ranked journals in the area of cloud computing, information systems, and maritime logistics. He spent some time at the University of St Andrews (Scotland) and, most recently, at the University of Melbourne (Australia) as a visiting scholar. His professional background includes positions at Airbus Group Innovations and Adobe Systems. He consults companies in different sectors and international projects.

Stefan Voß is professor and director of the Institute of Information Systems at the University of Hamburg. He also holds a visiting position at PUCV in Valparaiso, Chile. His current research interests are in quantitative / information systems approaches to supply chain management and logistics including public mass transit and telecommunications. Stefan Voß serves on the editorial board of some journals including being Editor of Netnomics and Editor of Public Transport. He is frequently organizing workshops and conferences. Recently, his institute hosted the Global Port Research Alliance (GPRA) conference. Furthermore, he is consulting with several companies.

## ABOUT THE ORGANIZATION

The Institute of Information Systems of the University of Hamburg (Germany) specializes in interdisciplinary research for supporting decision-making within various application areas. A strong research focus is on quantitative methods, data mining, and cloud computing for supporting the planning and management in port logistics. Numerous publications in highly-ranked journals emphasize the quality of the institute's research. Several projects in the port industry have been successfully carried out in recent years.

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# THE AUTOMATED EMPTY CONTAINER DEPOT

## A WORLD-FIRST FOR ROTTERDAM

Joost Achterkamp, CEO, Solid Port Solutions,
Dubai, UAE

Container terminal automation is reaching a mature stage of development and most new projects incorporate some elements of automation. One of the new areas for process optimization that until now has been mainly ignored is the handling and storage of empty containers. Whilst the optimization of empty container flows has received widespread attention, the cost to shipping lines for depots to process and handle empty containers is hidden within the total of container repositioning. The crucial role in the process of preparing an empty for delivery to the next client or for repositioning to another location is the 'Empty Container Depot'.

Traditionally depots have consisted of minimal civil infrastructure and have relied on 'Empty Container Handlers (ECHs)' with basic inventory systems and have been limited to the extent to which they can optimize their processes. Typically, empty container depot operations are performed in an ad hoc manner and achieve low levels of efficiency.

Recognizing the mature state of container equipment automation, the Kramer Group sought to assess how to implement automated handling processes within empty container depots. In 2017, the Kramer Group assisted by Solid Port Solutions started to develop plans for the first fully automated empty depot, this resulted in the New Generation Robotized Empty Depot (NG-RED™).

### WHY AUTOMATE?

The project team, consisting of staff from both KRAMER and Solid Port Solutions, was given the objective of developing a new empty depot process that would:

- Reduce the costs per container per visit
- Provide higher throughput capacity on the area footprint
- Improve the efficiency and quality of the processes and services provided

The team was also challenged to ensure the concept would utilize fully electric equipment, reduce damages and accidents, and significantly improve turnaround times for truck drivers.

With primary objectives and targets set, a business case was developed for a facility which would be focused on shipping containers with a relatively short dwell time, rather than long stay lease containers. The depot's location would be close to deep sea terminals and well connected to different transport modalities to provide the volume of throughput to justify investment in automated systems. A location within Maasvlakte, Rotterdam ticked all the boxes, with the added benefit that it would be able to be connected via the container exchange route (CER) to all deep sea terminals.

## HOW DOES IT WORK?

The main principle of the design is based on well proven overhead bridge crane (OHBC) technology. The OHBC gauge of 30 metres covers four TEU wide stacks with containers stored perpendicular to the gantry driving direction. Each OHBC lane has the same specification and covers both stacking areas, as well as separate areas for empty depot services such as inspection, cleaning and repair.

The service areas are within fenced zones that allow the blocking of automated OHBCs from working within a zone when workers are present. NG-RED is a combination of existing technologies, the majority of which are commonly found in automated yard systems for deep sea terminals. The system is also comparable to those found in assembly line systems for the product fabrication of products where workers are constantly found working alongside automated equipment.

## TRUCK HANDLING

A common complaint of container depots is the slow gate process which results in the frequent queuing of trucks adding to the cost of transporting empty containers and causing congestion on surrounding roads. At NG-RED this problem is solved. The truck enters the depot driving through an automated gate system with OCR and LPR, the truck will have been pre-announced, and the truck-visit is matched with the empty depot's equivalent of the terminal operating system.

The next process point is a short drive away at the entry kiosk where the driver swipes a cargo card. Next the driver gets his route plan and continues to the truck exchange point for the assigned OHBC. At this point, technology similar to the ASC exchange process at automated terminals is used with the driver leaving his truck and going to a kiosk where the driver again swipes the cargo card. The job is confirmed within the TOS and the container is handled with the OHBC in full automated mode or with a remote operator. The truck then leaves the exchange point and goes on to its next job in the depot or leaves the depot following a similar process on the way out with OCR technology and an exit kiosk.

In contrast to the process at traditional empty depots, containers delivered to the depot are not inspected prior to being dropped off, allowing the truck process to be performed very quickly and reliably and enabling truck turnaround times of less than fifteen minutes.

## INSPECTION PROCESS

After the drop-off by the truck, the container is placed by the OHBC in a buffer area until it is to be inspected.

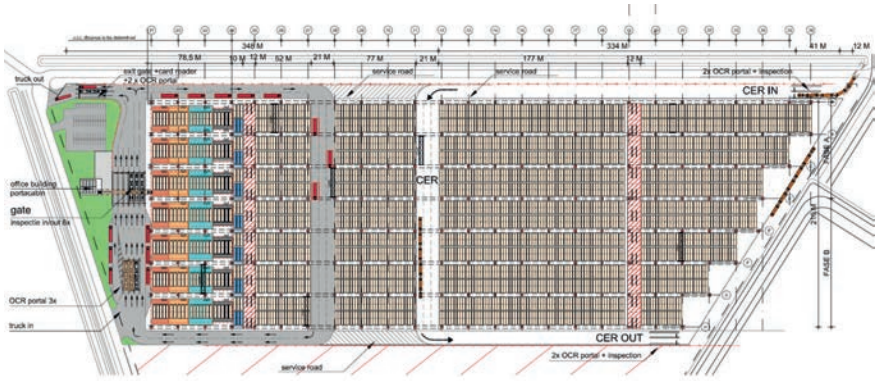


Figure 1. Masterplan NG-RED depot

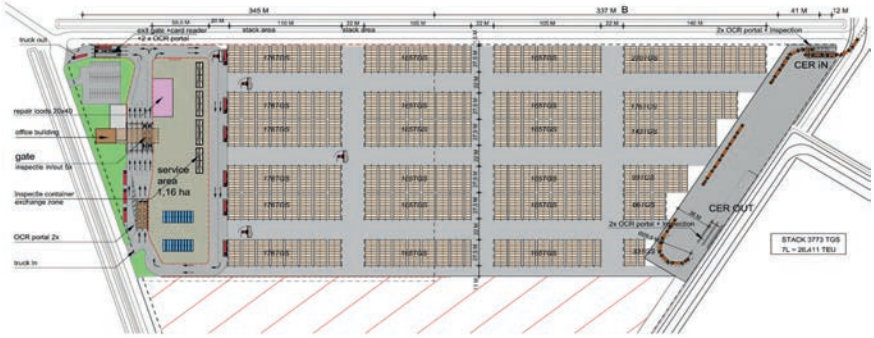


Figure 2. Traditional design on same footprint

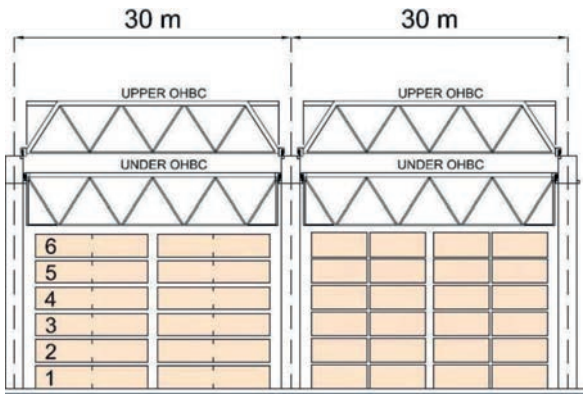


Figure 3. OHBC Principle

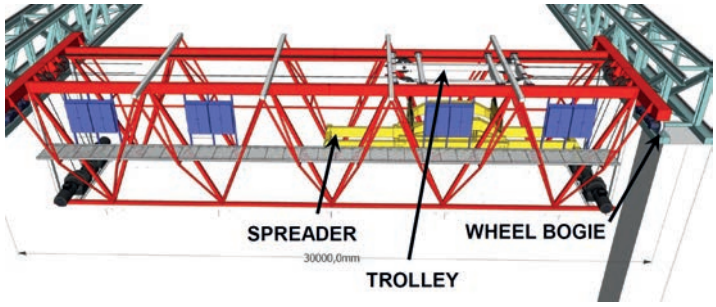


Figure 4. Lower OHBC

Prior to inspection, the container is transferred by the OHBC to the inspection area where it is placed on steel frames. Each inspection area has capacity for six containers, allowing surveyors to be given job assignments when the buffer area is full and the OHBC is blocked from entry or passing overhead. The steel frames provide access by qualified surveyors to carry out a full inspection of the boxes including the bottom and roof. The inspection is carried out without the time pressure or safety risks of working in an area of queuing trucks waiting to be served, or being repositioned to align themselves with the ECHs, by which the workload of surveyors can be managed more evenly. The condition of the container can then be reported, and it will be decided in communication with the shipping line which services are to be performed prior to releasing the container in good condition for its onward move.


Figure 5. Truck Gate

## SERVICES PROCESS

After being inspected, the container can be transferred back to the buffer area or directly to the designated service area for cleaning or repair – all movements of the container being carried out by the fully automated OHBC. Each OHBC lane has the same services area to avoid moving containers between stack rows. The service areas are worked according to the same principles as the inspection areas, they can be claimed by the OHBC or by the people working in the area and are fenced with a controlled access gate. The layout of the service areas is such that service areas requiring longer processing are located further away from the buffer area. Included within the solution is the pre-trip inspection (PTI) for refrigerated containers with racks equipped and with electrical plugs being also serviced by OHBC.

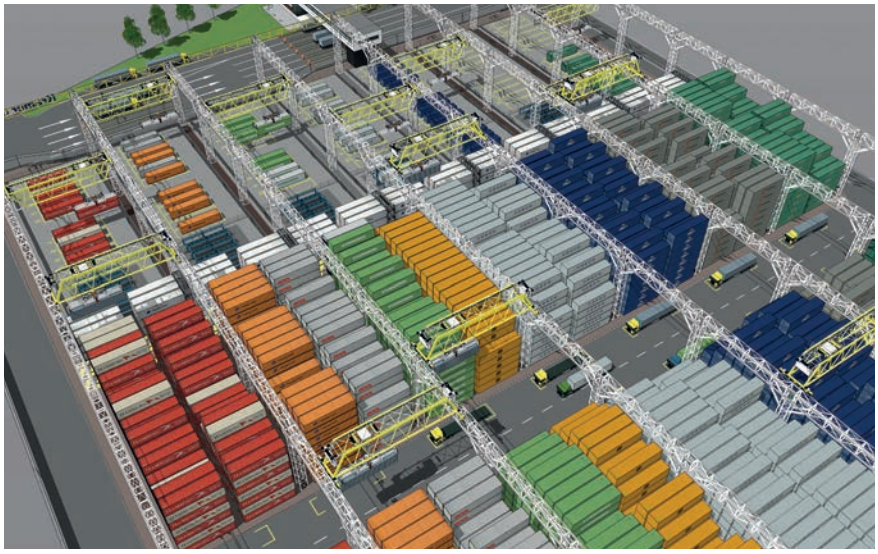

Figure 6. Truck handling lane

## AVAILABLE YARD

A container can go to the available yard when it gets the status "Available" directly from inspection or after the required services are executed. The main advantage of the yard system is the density; there is no space needed for roads for the ECH's and containers can be piled eight high. The storage capacity is calculated to be at least 40% more than traditional depot systems. The containers will be stored in blocks of the same client, type size and condition for use. In such blocks, the containers can be densely stacked with the automated OHBC minimizing wasted space between container tiers. The blocks can vary in width, but are planned to be a maximum of six wide to support the use of FIFO (first in, first out) principles to prevent aging of certain boxes.

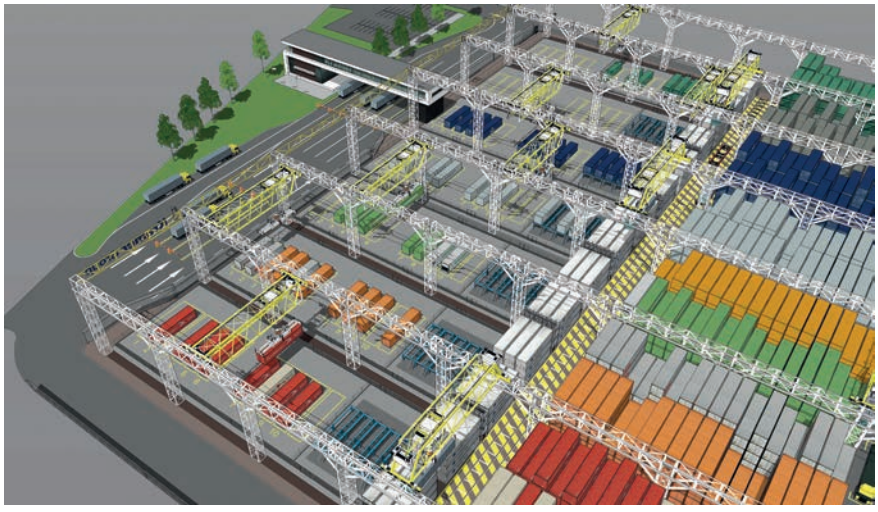

Figure 7. Inspection & Services areas

## SPECIAL FUNCTIONALITIES

For optimizing the process and the system productivity, the following special design functions are included:

- To move containers from lane to lane, an automated 'shifter' system is available
- The OHBC's are designed with an "UPPER" and a "UNDER" crane that can pass each other independently
- A separate road lower the OHBC lanes will be used to handle the (automated) vehicles arriving via the CER from the deep-sea terminals

## BUSINESS CASE

The ROI of the system will be based on two principles. Firstly, the cost per move will be much lower because of the use of fully electric automated OHBC cranes. Secondly, the throughput per hectare will increase by about 40% due the higher stacking density of the solution. A differential financial comparison of a traditional concept with the NG-RED system on the same footprint showed that the payback period of the automated system will be around eight years. It works two ways; the revenues will be higher and the operational cost lower.

## THE PROJECT

The Kramer Group NG-RED™ terminal at the Maasvlakte Rotterdam will be realized by a team of experienced companies including ZPMC for mechanical and crane structures and SIEMENS for the electrical and automation solution, both with a proven track record in the automation of container terminals. Solid Port Solutions will participate as designer and project manager. The terminal is planned to be operational at the end of 2020.

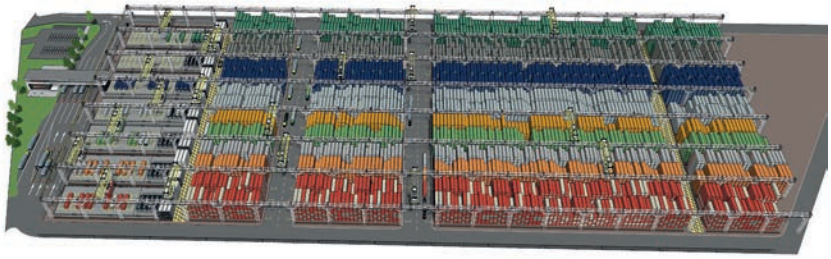

Figure 8. Highest density in the "available" yard

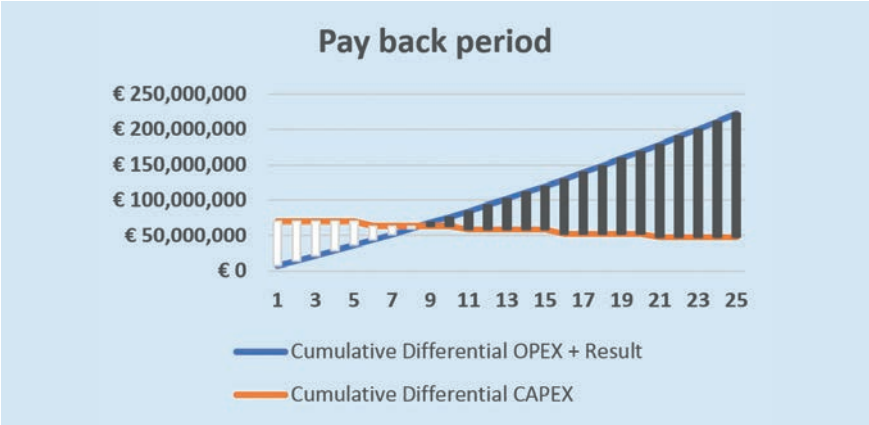


Figure 9. Financial Comparison Traditional with NG-RED


Figure 10. Project Location Maasvlakte Rotterdam, Netherlands

## ABOUT THE AUTHOR

Joost Achterkamp is the founder and CEO of Solid Port Solutions. He has worked on several automated container terminals and has operational as well as engineering knowledge. After finishing his civil engineering study in 1981 he started as a structural engineer for the Rotterdam municipality. He joined Europe Container Terminals (ECT) in 1992 as a Project Leader on the civil construction of automated container terminals. In 1997 he switched to the position of Operations Manager at the first fully automated container terminal in the world. By the end of 2001 Joost became the Project Manager Operations of the Euromax Terminal, responsible for the operational design of the next generation fully automated container terminal. In 2009 he joined ADPC to design and build Khalifa Port, the first semi-automated terminal in the Middle East.

## ABOUT THE ORGANIZATION

Solid Port Solutions was established by Joost Achterkamp in 2013 and is made up of high-level technical and project management experts in the ports, transport and marine industries. The company is based in the UAE with most of the members European. Their expertise is based on practical experience and knowledge gained over 25 years in a wide range of countries.

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Web:
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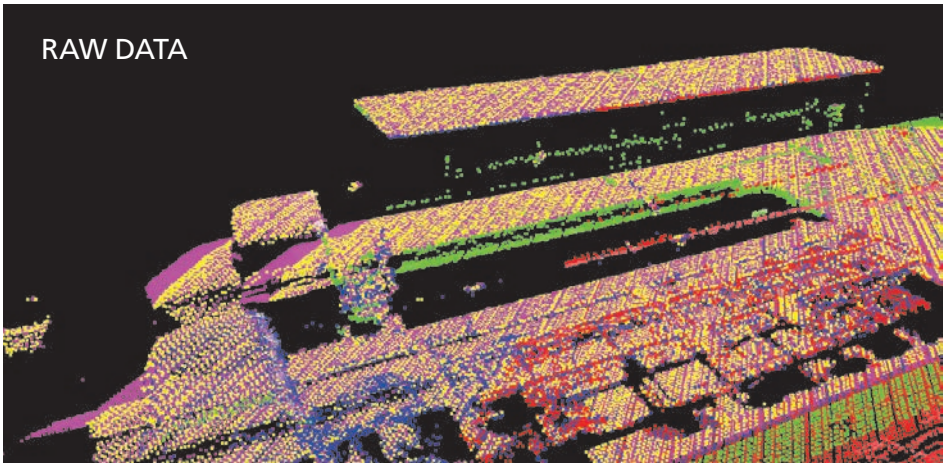


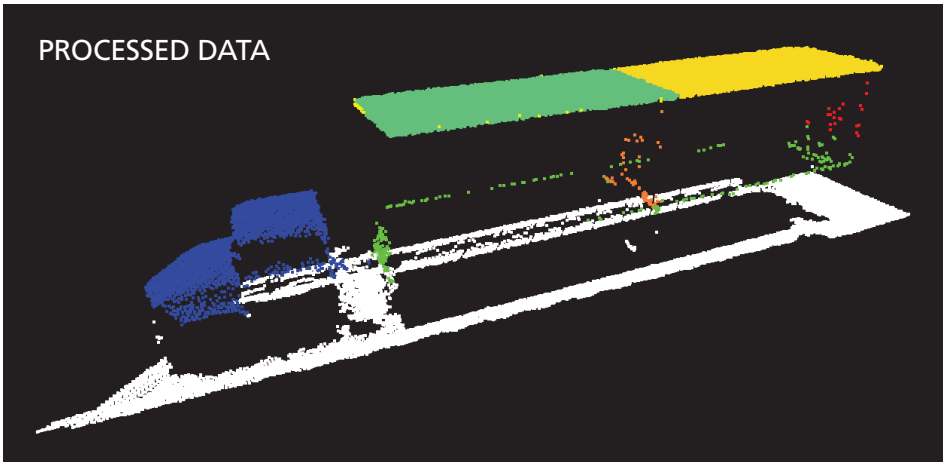


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# VTS, NAVIGATION, MOORING & BERTHING

"When autonomous ships become a reality, our present model of vessel traffic management will completely change. New legal regulations and traffic management strategies will be a necessity. Planning for this has already begun."

Yang Zhou and Xavier Bellsolà Olba, Delft University of Technology. **Page 94**

# OPTIMIZING BERTH SCHEDULING AT MARINE CONTAINER TERMINALS

## IT'S TIME TO GO GREEN

Maxim A. Dulebenets, Ph.D., P.E., Assistant Professor,
Department of Civil & Environmental Engineering, Florida A&M University-Florida State University

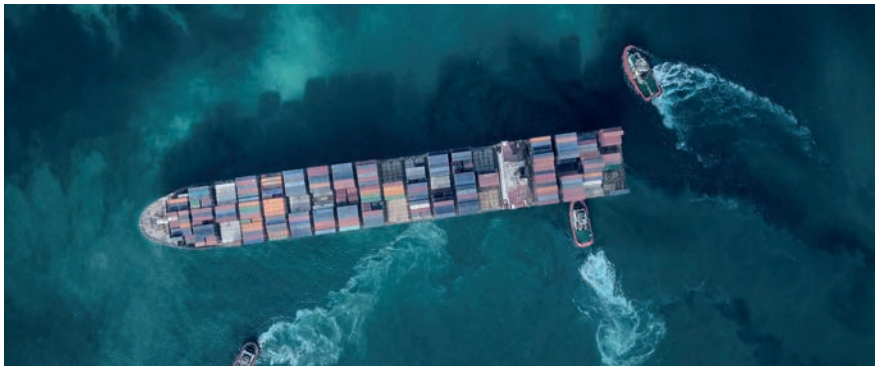
Freight transportation plays an extremely important role for the economy in many countries, as it substantially contributes to the national Gross Domestic Product (GDP). Based on information released by the United States (U.S) Bureau of Transportation Statistics, the transportation-related products and services constitute around 10% of the U.S GDP. Sea serves as a primary mode for distribution of cargo across the world, as more than 90% of the global trade is carried by oceangoing vessels. The international seaborne trade volumes have been steadily growing after the world's financial crisis of 2007-2008. There are different alternatives that can be used by marine container terminal (MCT) operators, who are responsible for the service of arriving vessels, in order to cope with the growing demand for the international seaborne trade. These alternatives include, but are not limited to, expanding the existing infrastructure, purchasing more advanced equipment, automation, deployment of innovative information technologies, optimizing MCT operations planning, and others. Many MCT operators focus on optimizing planning of their container handling processes, as such an alternative can significantly improve the MCT productivity and does not require substantial monetary investments.

### BERTH SCHEDULING PROBLEMS

Optimizing MCT operations is a quite difficult task, considering the fact that MCT operators have to deal with various decision problems at the same time. The berth scheduling problem is considered one of the most challenging decision problems in MCT operations planning. The berth scheduling problem aims to assign the vessels arriving for service at a given MCT, and determine the service order of vessels at each one of the available MCT berthing positions. Without efficient berth schedules, MCT operators will not be able to provide a timely service of vessels. Violation of vessel departure times, which are generally negotiated between a given MCT operator and liner shipping companies in contractual agreements, may cause negative externalities for the MCT operator and, in the worst case, may result in diversion of vessels to other ports or even in a customer loss.

For example, significant vessel service delays were observed at the Port of Los Angeles (U.S) due to labor strikes in 2015, and certain liner shipping companies had to divert their vessels from the U.S West Coast for service at the East and Gulf Coast ports.

In some instances, liner shipping companies are willing to request handling rates with higher handling productivities at ports of call. The latter will allow liner shipping companies to save time at ports. Such time savings can be utilized at sea in order to reduce vessel sailing speed and fuel consumption when sailing at the next port of call (i.e., allow vessels to sail at a lower speed to the next port, which will require less fuel). Efficient fuel consumption management is crucial for liner shipping companies. An increase in fuel prices in the first quarter of 2017 resulted in a $66 million loss for Maersk Line, the largest liner shipping company in the world with more than 18% market share (as of April 2018).



## COMBATTING EMISSIONS

Optimizing MCT operations plays a critical role in supporting maritime commerce and achieving goals of MCT operators and liner shipping companies, but it cannot be accomplished at the expense of the environment. The International Maritime Organization highlights that the maritime sector is responsible for approximately 1,000 million tons of carbon dioxide and around 2.5% of the global greenhouse gas emissions which cause global warming. Based on predictions of the Intergovernmental Panel on Climate Change, the average global temperatures may rise by up to 5.8 °C towards the year of 2100. Certain MCT operators already started taking necessary actions to improve environmental sustainability of the container handling processes.

Many U.S West Coast ports (e.g., Long Beach, Los Angeles, Oakland) are mandated to use 'cold ironing' for a significant amount of the arriving vessels. A cold ironing technique allows the use of electrical power for the vessels, which are moored at berthing positions, instead of diesel-burning engines that are used in sea for generating power. A significant amount of emissions is produced not only by vessels, served at a given MCT, but also by conventional container handling equipment with diesel generators (e.g., Rubber Tyred Gantry cranes that are used to handle containers at the MCT storage yard, yard trucks that are used for transfer of containers between the seaside and the storage yard).

Nowadays, a lot of MCT operators in Asia, Europe, and U.S are replacing conventional container handling equipment with electric handling equipment, aiming to reduce greenhouse gas emissions. The Port of Vancouver (Canada) and the Port of Montreal (Canada) have been using advanced information technologies for several years to assist their trucking companies with selection of the appropriate arrival time for pick-up of the import containers, which were delivered by vessels. The latter strategy helps MCT operators reduce congestion at the gates substantially and decrease emissions produced by drayage trucks while waiting at the gates for the container pick-up.

## ENVIRONMENTAL CONSIDERATIONS

Thus, MCT operators across the world have been using different strategies for reducing emissions produced by the vessels, served at the assigned berthing positions, as well as emissions produced by the handling equipment responsible for container transfer at MCTs. However, the question "How do we design efficient berth schedules considering negative environmental externalities?" still remains open. The majority of mathematical models and solution algorithms completely ignore emissions produced by vessels and container handling equipment.

Only a very limited number of previously conducted studies accounted for emissions generated by diesel engines of vessels waiting for service at the MCT or being served at one of the MCT berthing positions. As discussed earlier, vessel handling rates, negotiated between a given MCT operator and liner shipping companies in contractual agreements, are an important factor that influences not only vessel departure times from the MCT but also affects the design of berth schedules (e.g., if a handling rate with higher handling productivity is requested, a given vessel will be able to finish its service earlier, and its berthing position would become available for service of another vessel earlier).

However, in order to provide a higher handling productivity, the MCT operator will have to allocate additional handling equipment for service of vessels (e.g., deploy more quay cranes for loading and unloading containers at the seaside, allocate additional internal transport vehicles for transfer of containers between the seaside and the storage yard, deploy more yard cranes for handling containers at the storage yard), which will increase the amount of emissions produced through container handling. Furthermore, the design of berth schedules will affect the arrival pattern of drayage trucks and may even result in congestion at the gates without efficient management of the MCT operations.

Congestion at the MCT gates will further increase emissions produced by drayage trucks. Therefore, new mathematical models and solution algorithms are needed for berth scheduling, which will assist MCT operators not only with providing timely service of the arriving vessels, but will also account for emissions, produced by vessels and container handling equipment. Moreover, these models should capture the conflicting nature of certain objectives (e.g., allocating additional handling equipment to reduce vessel departure delays and emissions from vessels that are being served at berthing positions vs. reducing emissions from handling equipment). Enough damage has been done to the environment by the transportation sector at this point. It is time to focus on environmental sustainability and preserve nature for future generations…

## ABOUT THE AUTHOR

Maxim A. Dulebenets, Ph.D., P.E. is an Assistant Professor in the Department of Civil & Environmental Engineering at Florida A&M University-Florida State University. Dr. Dulebenets holds B.Sc. and M.Sc. degrees in Railway Construction from the Moscow State University of Railroad Engineering (Moscow, Russia), and M.Sc. and Ph.D. degrees from the University of Memphis (Memphis, TN, USA) in Civil Engineering. His research interests include but are not limited to: operations research, optimization, simulation modeling, metaheuristics, and transportation engineering. Dr. Dulebenets is actively involved in activities of more than 10 Standing Committees of the Transportation Research Board of the National Academies of Sciences (USA). He is a licensed Professional Engineer registered in the State of Michigan.

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# THE VALUE OF MARITIME SIMULATORS

## A MUCH NEEDED NEW APPROACH

Erik Hietbrink MSc, Technical Director,
Simwave, Barendrecht, Netherlands

Does the international community accept the risks of human failure to lives, ships and the very vulnerable marine environment? Does the international community accept the already enormous pollution the ships are causing to the environment: sea and air?

The international community will over the coming years expect and demand a change in the safety at sea. This goal can be reached by diminishing (almost) 100% of human failure by demanding better educated and better trained seafarers and assignment on board based on clear assessments.

Now is the time for action. A new thrust for the future of simulator training, applied research, and assessment should entail:

- Enhancing applied research with innovative simulators and complex environments
- Having a place for each person who wants to have a prominent role in the maritime industry
- Enhancing social responsibility and care for the environment in the maritime field
- Assessing the impact of new technologies in maritime education and assessment
- Ensuring safe, secure and efficient shipping by employing more competent crew and better technics
- Applying research in complex operational circumstances such as tug/cruise/offshore/wind energy/heavy lifts/float overs/port design/ice passage/ship-to-ship transfer

### HUMAN INVOLVEMENT

The human factor is key in all developments. With a better use of modern interactive maritime simulators, human error can be diminished. Based on the creativity and the knowledge of specialists in didactics, specialised in human error, in the causes of near misses or accidents, in simulator technics, in blended learning and in formulating the right objectives of training, with simulators this goal can be achieved. Every Euro spent on the right simulator training is a great investment in people, ship (sea and inland), machinery and the environment.

A new innovative approach with the available high-end simulator capacity means a better crew, a happier crew, and leads to economically feasible shipping, the protection of environment and people. Modern educated and trained, competent and assessed officers and other crew members from all nationalities will guarantee a safe, financially sound, environmentally acceptable and healthy future for the maritime sector. But that goal will not easy to be reached. However, we can succeed by using the best integrated and intense simulator training and assessment with the best simulators available.

## MARITIME SIMULATORS

For over five decades maritime simulators have been used in maritime education and (re) training of mariners for specific but limited competences like radar training, ECDIS-training, bridge/engine room resource management, ice navigation and so on. Only rarely simulators were used for assessments but most of the time simulator capacity was used to be compliant in line with the minimal requirements of the STCW '78 as Amended and requirements from other rules and regulations. Many governments and ship operators seem to forget that the STCW and other rules only give minimal requirements.

During the last 50 years the capacities of the maritime simulators have developed but they could have developed much faster. The conservative maritime training requirements and the human resource approach, almost entirely directed by wages, overtime, leave discussions and the hunt for cheap labour indifferent the nationality of the flag, have delayed the introduction of many new possibilities in maritime simulators and training outside the minimal requirements of the international agreed 'model course' levels. Crewing agents and manning agents sometimes just "deliver" in accordance with STCW-78 as Amended even with COC's and/or certificates sometimes "bought" on the corner of the street.

Of course, there are positive examples within the HRD approach of some international ship owners.

The wrong structure with ship management companies, outsourcing the crewing and manning to others somewhere in the world minimizes worldwide safe shipping. Too often the crewing managers have a bad reputation and a track record of misconduct, as well as a record of unfair treatment of sometimes poorly educated, poorly trained and seldom assessed seafarers. The many reports of the different governments, flag-states and the International Transport Workers Federation (ITF) and national seafarers unions are clear about this.

Many disasters over recent years show the lack of dedicated and advanced training, communication techniques and experiences gained in circumstances on a simulator. The training and assessments can be done so much better with the right scenarios, the best teachers and the best simulators. The fear of what can go wrong on the landside of the ports and coasts is not experienced because most people ashore have no idea about disasters which could take place if near their city or coast a catastrophic human error is made. The public opinion even in old seafaring countries is not aware and is silenced by promises done by the industry and too small steps by new treaties.

The crew on board vessels has already been dramatically reduced over the years. In general, ships have become faster and bigger, cargoes more valuable and many times more dangerous. Modern cruise vessels will carry up to 8000 people and more the coming years.

## OTHER INDUSTRIES

Any passenger on an airplane expects that the captain/first officer will be trained on simulators in any possible scenario. An air plane pilot is even trained and assessed on a type specific flight-simulator. Any passenger expects that the persons in the cockpit will bring the airplane safely back on earth. In the maritime sector we should expect the same.

High-end maritime simulators should be employed much more for training, experiencing, assessment, team work, resource management but also for familiarization for the captain and officers for new ships, new ports and new areas to sail. The simulator capacity to handle with all these challenges and expectations is available in only a few places in the world but that capacity is growing the coming years. They are available for the requests and interests of ship-owners, crewing agents, port and terminal operators, tug companies, offshore companies and ship management companies.

The approach of concentric simulator training, embedded learning with integration of simulators and virtual reality technics, the tailor made scenarios, ship-to-ship transfer, LNG-bunkering and LNG-fuel, own ships and the right sailing areas for the navigation officers and captain and the fault finding capacities of the most modern engine room simulator are better learning tools than anything else.

## ABOUT THE AUTHOR

Erik Hietbrink received his master all ships in 1981. After becoming a teacher and graduating with a Master of Science in mathematics and seamanship, he became Director of the Rotterdam Maritime Academy in 1987. From 1990 onwards he was the Chairman of the Board of Directors of the STC-Group. He founded many schools around the world and many simulator centres.

## ABOUT THE ORGANIZATION

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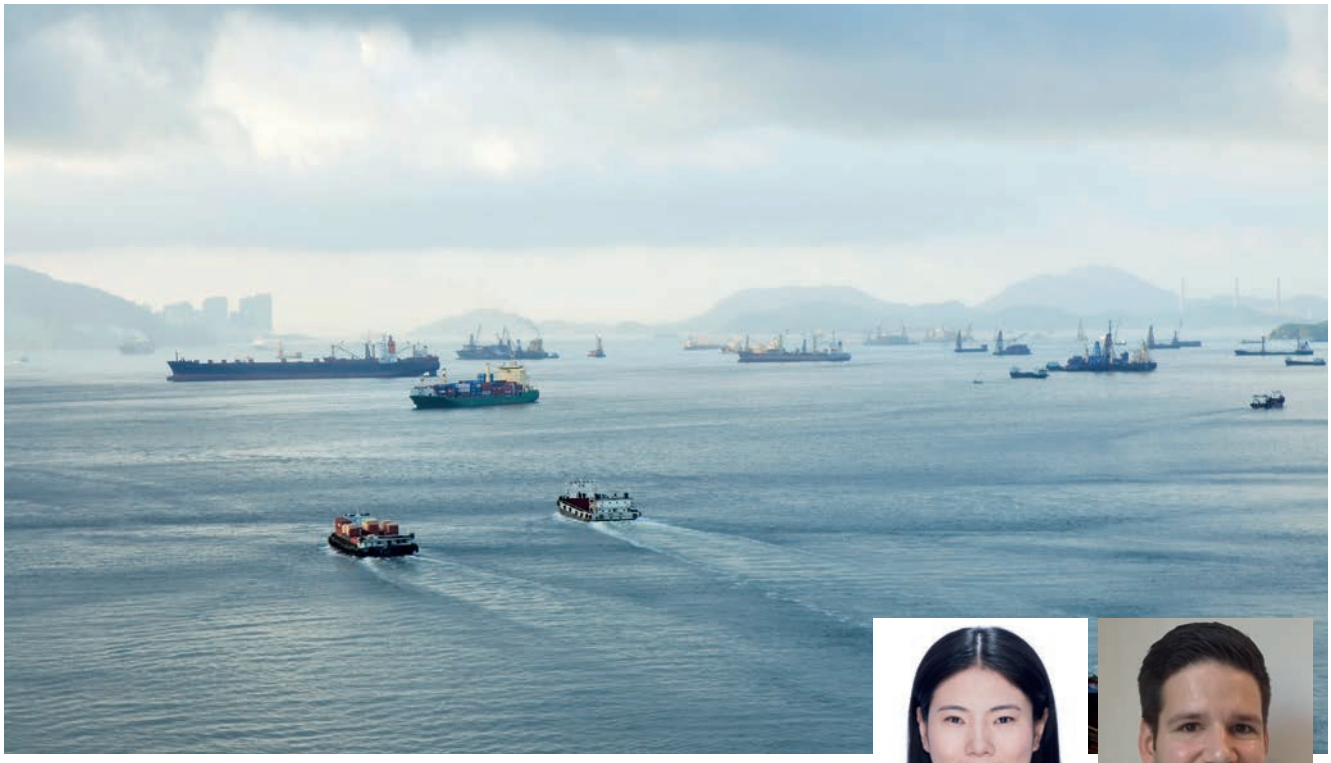

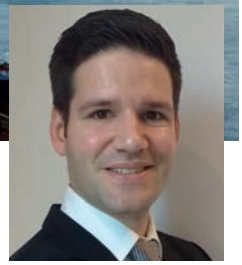

# AUTONOMOUS SHIPS

## NAUTICAL TRAFFIC IN PORTS

Yang Zhou and Xavier Bellsolà Olba,
Delft University of Technology, The Netherlands

With ongoing trade globalization, waterborne cargo transportation has notably grown in recent years. Due to the growth in ship sizes, with lower manoeuvrability, and higher flows, the safety in these confined areas needs to be guaranteed. Nautical traffic operations in ports are now impacted by more data availability and the disruption of automation processes, and port stakeholders need to adapt to these changes.

### ACTUAL AND FUTURE NAUTICAL TRAFFIC

The implementation of automatic identification systems (AIS) in vessels was a turning point in the evolution of nautical traffic in information acquisition. Nowadays, nautical traffic in ports is mainly organized by VTS operators from port authorities, where the AIS information of each ship is known by the other ships. Previously, VTS operators were in charge of guiding incoming and outgoing ships sailing into ports, such operations are performed in a manual way based on operator knowledge. The drawbacks in such expert knowledge-based operation are the possible human errors or the non-optimal on the spot decisions.

A lot of new data and tools, such as the recently launched Port Call Optimization platform (PRONTO) by the Port of Rotterdam, allow seafarers and harbour coordination centres to better schedule ship arrivals and improve the operational efficiency of the whole port. However, most of these operations are still experience based, while there is much more information available to avoid or resolve future nautical conflicting situations. Simulation models are already applied by captains and pilots to simulate manoeuvring in some ports. They can choose specific environmental conditions and ship characteristics to assess their entrance in the port and foresee difficult manoeuvring along the port infrastructure. These tools are not used yet to forecast future encounters with other ships or to predict their individual manoeuvring, so they cannot anticipate possible complex encounters. However, they could be developed further to be applied for this purposes.

The trend for the future seems to be automated intermodal transport, where not only the warehouses are automated but also rail, road and nautical traffic too. With the introduction of autonomous ships in ports, there will be great challenges with both manned and autonomous ships, – ranging from the management of port traffic through to safety and legal issues. Therefore, the departments of Transport & Planning and Hydraulic Engineering (Section Ports & Waterways) at Delft University of Technology (TU Delft) are developing a new nautical traffic model and are proposing methodologies to evaluate the traffic efficiency of ports (risk and capacity). This generic nautical traffic model is expected to simulate real ship behaviour as closely as possible. Thanks to a detailed AIS data analysis, the ship sailing behaviour pattern in a port area and its relation to external factors can be determined. AIS data from real ports can be used for its calibration and validation. A tool like this would allow the prediction of a future situation given a certain port layout and environmental conditions.

There are two areas of great interest for port authorities and port stakeholders: the capacity and safety of the port. Terminal capacity has been extensively studied before and there are many risk assessments

focused on historical accidents. However, the estimation of future capacity for different nautical traffic situations and a dynamic risk indicator would be extremely useful. The model under development will include a systematic methodology based on simulation results to evaluate nautical risks and port capacity. The integration of decision-making methods in such a detailed model can be used as a dynamic assessment tool for changes in traffic rules, future fleet compositions, or new port designs. This can help the port authorities to improve their future port planning or manage traffic in different ways, with the eventual purpose of increasing port capacity while keeping risks below the desired threshold.

## AUTONOMOUS SHIPS

When autonomous ships become a reality, our present model of vessel traffic management will completely change. New legal regulations and traffic management strategies will be a necessity. Planning for this has already begun. Some companies, such as Rolls Royce, are sourcing knowledge and support from other companies and universities. Another collaborative research initiative is the MUNIN project which aims to develop and verify the concept of autonomous ships to overcome the current challenges in increasing transport volume and a possible shortage of seafarers.

As defined by Lloyd's Register, there are generally six levels of autonomy resulting in different phases of autonomous ship development. The current manned ship is has the lowest autonomy. For the ships with the first two levels of autonomy, all actions are still taken by a human operator but there is decision support from shore. In the third and fourth levels of autonomy, humans are present on-board, but only in supervisory roles. For the highest two levels of autonomy, ships are fully autonomous with decisions made and performed without human intervention.

All the stakeholders (VTS operators, pilots, terminal operators, port planners) need to adapt to the communication and operation of autonomous ships during the transition period. Only then can the goal of making navigation safer, cheaper and more efficient be achieved.

## THE TRANSITION PERIOD

Ports with only autonomous ships and intelligent terminals are expected to be smart with a high level of safety and capacity. Considering the life cycle of existing ships and the time for autonomous ship building, the transition period with both manned and autonomous ships will be long. Thus, the challenges with regard to the coexistence of both types of ships needs to be assessed in advance with the use of advanced simulation tools to evaluate a variety of situations.

During the transition period, ports will be challenged to adapt to this situation. First of all, the communication between manned ships and autonomous ships needs to be changed. The communication between two manned ships is usually through instant VHF calls during encounters for a safe passage. The cooperation between autonomous ships during encounters is based on the shared information of path planning for both ships. When one ship is manned while the other is autonomous, the communication could be unbalanced before a global protocol is issued, which would lead to a wrong decision-making process.

Secondly, the coordination role of VTS centre needs to be adapted due to the change in communication. The report of ship arrival and departure can be automatically performed by autonomous ships. But in emergent situations with different types of ships, the VTS operator needs to coordinate with the remote operator which takes decisions based on information sensors.

In cases of technical failures on board, there is hardly a remedy to solve the problem, which may lead to serious consequences. Thus, it can be expected that the ships at autonomy levels three and four will be important during the transition period. Most of the time, ships will manoeuver autonomously. But in unexpected situations, the human operator on-board can take over responsibility in communication and making decisions. When the autonomy levels five and six are achieved, it can be expected that the goal of fully autonomous navigation is close.

## CONCLUSION

Most research on autonomous ships focuses on the situation with only ships operating at the highest levels of autonomy, while there is seldom research investigating the impact of autonomous ships on port traffic during the transition period, with both manned and autonomous ships.

Unlike the assumption of fully autonomous ships for the whole port, the authors and the research team started their approach of the problem from the current real-life situation. Based on the simulation model for the manned nautical traffic in ports, where the traffic situation in different scenarios can be presented. This way, thanks to simulation-based evaluation methods, port authorities could forecast the traffic through the port, assess the possible risks and the capacity expected, and adapt the traffic management rules and strategies for future mixed traffic.

The upcoming challenges during the transition period will make the forecast of uncertain situations more important where ships have different levels of automation. It is expected that a simulation modelling approach should be applicable when dealing with situations. Hence, the development of further research in advanced simulation models, such as the one being developed in TU Delft, will help to maintain an efficient ship traffic model and better prepare stakeholders for autonomous ships. Based on a prediction overview of port operations, port stakeholders can be prepared for the uncertainty after the introduction of autonomous ships, and have the necessary tools to support the changes from human-based operations to complementary supervision.

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## ABOUT THE AUTHOR

Yang Zhou is a PhD candidate at Delft University of Technology, having a Bachelor in maritime management, and a Master in traffic information engineering and control from Wuhan University of Technology (China). Her research focuses on developing a new nautical traffic model to reproduce ship behaviour. She has experience in AIS data analysis and simulation model development based on background knowledge of navigation technology, especially for ship collision avoidance.

Xavier Bellsolà Olba is a PhD candidate at Delft University of Technology (the Netherlands). He received his Bachelor and Master in Civil Engineering from Universitat Politècnica de Catalunya (UPC) from Spain. Since 2014, he is doing research focused on the assessment of nautical traffic in ports and waterways. He has expertise in the analysis of nautical traffic data, development of simulation models and the evaluation of risk and capacity of port traffic.

## ABOUT THE ORGANIZATION

Delft University of Technology is international and multi-disciplinary organisation that promotes research, innovation and education in many technical fields. The Transport & Planning department englobes all transportation related projects, such as road traffic and safety, public transport, active modes (bicycles and pedestrians) and freight and logistics. The Ports & Waterways section, within the Hydraulic Engineering department focuses on the fields of port and waterways design, shipping, nautical matters, safety and capacity. Their project is partly funded by NWO (Netherlands Organisation for Scientific Research) and supported by the Port of Rotterdam Authority and SmartPort Rotterdam.

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# CYBER RISK & SECURITY


"New cyber technologies represent both risks and rewards for the marine industry. Organizations must train, empower, and instill a sense of responsibility in the people who operate, monitor, and rely on these systems. For all of its technical complexity, cybersecurity is ultimately about people."

Captain Andrew Tucci, US Coast Guard. **Page 98**

# CYBERSECURITY AND THE INTELLIGENT SUPPLY CHAIN

Captain Andrew E. Tucci, U.S. Coast Guard, Commander, Sector Long Island Sound,
Captain of the Port Long Island Sound (COTP), Federal Maritime Security Coordinator (FMSC)

As readers of this journal know, technology and innovation are everywhere in the marine industry, and are key drivers in making global supply chains more efficient, safe, secure and sustainable.

Cybersecurity has sometimes taken a backseat to all of this innovation. In 2012, when I first began looking into cybersecurity issues related to the maritime industry, it was a challenge to convince some companies that cybersecurity was even a concern. While most maritime companies were taking responsible measures, a significant portion believed that they were not targeted by cyber attackers, or that their proprietary, air gapped or simply out of date systems somehow made them immune.

The industry's recognition of cybersecurity is now much more widespread, and for good reason, as cybercrime continues to grow. For example, Juniper Research estimates that the cost of data breaches will reach $2.1 trillion globally by 2019[i]. Well-publicized cyberattacks have impacted every industry imaginable, including the maritime sector. Last year the notPetya incident impacted container terminals around the world, causing significant shipping delays and an estimated $300 million in costs.

In the face of these threats, industry groups, classification societies, private firms, and organizations including the U.S. Coast Guard, The Institution of Engineering and Technology, and the International Maritime Organization have developed cybersecurity guidance and products for the maritime industry. Smart companies are requiring evidence that contractors and business partners abide by appropriate cybersecurity standards before connecting to the network.

While these efforts are encouraging, no one should believe that these emerging standards and best practices are comprehensive, or that abiding by them will provide complete protection against cyber threats. Indeed, a recurring refrain is that organizations must be resilient, and develop strong cyber response and recovery plans.

The maritime sector has many attributes that make it vulnerable to cyberattack. Consider that the marine industry:

- is mobile, necessitating wireless connections,
- is global, bringing in international players and transactions,
- is high volume, meaning that even where profit margins are small, financial transactions are large, creating incentives for cybercriminals,
- requires and provides connections to global customers, contractors, government agencies, and other players in the supply chain,
- faces cost-control and customer service pressure to add new technologies quickly, often in advance of prudent risk analysis and configuration management practices,
- uses Operational Technology (OT) for industrial control activity, information technology (IT) for business operations, and the Internet of Things (IoT).

IoT represents a qualitative and quantitative growth in how the industry uses cyber technology. IoT devices are used for information sharing (routers, modems), decision making, and industrial processes. They are quite literally integrated everywhere from the propeller shaft to the stack emissions. Ships and port facilities are moving to an operating environment rich with sensors, controllers, in-house analysis and complex communication nodes. These devices improve safety and efficiency.

Properly employed, the "big data" generated by these systems combined with artificial intelligence create value for companies and enables a more flexible and customer focused supply chain. Emerging "Smart Ship" technology uses onboard analysis, real-time collection, transmission, and analysis to improve safety and efficiency, and meet customers' needs. INMARSAT estimates that smart ships will generate up to 60 GB of data per day, and process much of that data onboard (via "fog" computing) to optimize autonomy.

The downside is that every new connected device, be it a small sensor or a sophisticated industrial control system, creates some level of cyber risk. Given the ease at which individual devices can be added, few organizations are even fully aware of what IoT systems they employ, much less how well they are protected. The Internet Security Threat Report for 2017, published by Symantec, notes a 600% increase in IoT attacks from 2016 to 2017.

One might wonder why cyber crooks are targeting IoT devices. While a terrorist might try and disable a security camera or hazardous gas sensor, there are also more routine reasons why hackers attack IoT devices.

First, it is important to understand that some of these devices do not have a simple method for updating firmware, or the memory or processing power to host security features. In other words, many are inherently insecure. As such, they provide a gateway to more valuable aspects of a computer network. Also, hackers can use compromised IoT devices to launch distributed denial of service attacks, or exploit them for crypto-currency mining.

Regardless of why or how, IoT security breaches can lead to the same consequences as other systems: fraud, theft of intellectual property or privacy data, business interruption, liability and reputation impacts. For some IoT devices, compromise could lead to significant safety, security, or environmental consequences. Terrorists and criminals may even target IoT devices as part of a combined cyber-physical attack to disable critical infrastructure or disrupt trade.

## BLOCKCHAIN

IoT devices are perhaps the most tangible systems in the cyber world. That is not the case with another mover and shaker, the blockchain. Typically described as a "shared ledger", blockchain technology underlies bitcoin and other crypto currencies – an abstract concept if ever there was one.

Blockchain technology works by creating an online record of transactions that are jointly shared and verified. Unlike other aspects of cyber technology, blockchain is designed to promote security, albeit in a very different way from, say, firewalls. Criminal ingenuity being what it is, I'm sure there are ways of manipulating blockchain for ill intent, and some studies have shown vulnerabilities in blockchain enabled smart contract applications. Nonetheless, blockchain is well suited to information sharing among networks and supply chain partners, and is arguably much more secure than many other options.

IBM and Maersk have formed a company to use a blockchain to help share information between shippers, ports, customs offices, and others in trade. Dupont, General Motors, Toyota, Walmart, and other major shippers are also getting in the act. Blockchain will improve transparency and help these organizations to streamline and authenticate record keeping, whether it is for the movement of cargo, or the associated financial and administrative transactions. Note that blockchain can be used with IoT – for example an IoT device senses stack emissions and sends the data to a blockchain.

The tangible world of IoT and the abstract field of blockchain both represent opportunities for the marine industry. These technologies are changing the way companies operate, connect with customers, and create value. They promote agility, proficiency, and efficiency.

These benefits are at risk if we don't address the corresponding cybersecurity concerns. We are now giving cyber technologies primary control over processes that control huge financial transactions, day to day operations, and even the safety of human lives. Cybersecurity is not a technical responsibility of the IT department, it is a risk management and governance responsibility at the highest level of an organization. It should come as no surprise that the U. S. Securities and Exchange Commission recently updated its guidance concerning the disclosure of cybersecurity risks to investors[ii].

New cyber technologies represent both risks and rewards for the marine industry. Organizations must train, empower, and instill a sense of responsibility in the people who operate, monitor, and rely on these systems. It is people who will decide whether to delete a suspicious e-mail, report suspicious activity, or incorporate a cybersecurity provision into a routine maintenance contract. For all of its technical complexity, cybersecurity is ultimately about people.

### CYBER THREATS AND DEFENSES

The volume and sophistication of cyber attacks continues to grow, with crypto-coin mining and ransomware being especially prevalent in the last year. In addition to financially motivated exploits, industrial, energy, and transportation sectors can expect intelligence gathering exploits that lay the groundwork for future disruptions. The presence of such intruders in an infected system is difficult to detect. Despite the much-publicized Advanced Persistent Threats, most attackers use simple tools to exploit known vulnerabilities, simply seeking those systems without the right patches. Keep your systems updated, use complex passwords and double-factor authentication, and train your employees to not click on suspicious links or e-mail attachments, and to be alert for phishing and spear phishing attacks.

[i] *https://www.juniperresearch.com/press/press-releases/cybercrime-cost-businesses-over-2trillion*

[ii] *https://www.sec.gov/spotlight/cybersecurity*

### ABOUT THE AUTHOR

Captain Andrew Tucci is an officer in the U.S. Coast Guard. He is retiring this summer after 28 years of service as the Sector Commander and Captain of the Port in New Haven, Connecticut where he was responsible for all Coast Guard operations in Connecticut, Long Island, and the surrounding waters. In his previous tour at Coast Guard Headquarters in Washington DC he developed national policy related to port and facility safety and security, and was one of several key authors of the Coast Guard Cyber Strategy.

### ABOUT THE ORGANIZATION

The United States Coast Guard is a branch of the U.S. Armed Forces and is responsible for maritime safety, security, and environmental stewardship in U.S. ports and waterways. The Coast Guard is also a first responder and humanitarian service that provides aid to people in distress or impacted by natural and man-made disasters at sea or ashore. The Coast Guard is a member of the Intelligence Community, and is a law enforcement and regulatory agency with broad legal authorities associated with maritime transportation, hazardous materials shipping, bridge administration, oil spill response, pilotage, and vessel construction and operation.

### ENQUIRIES

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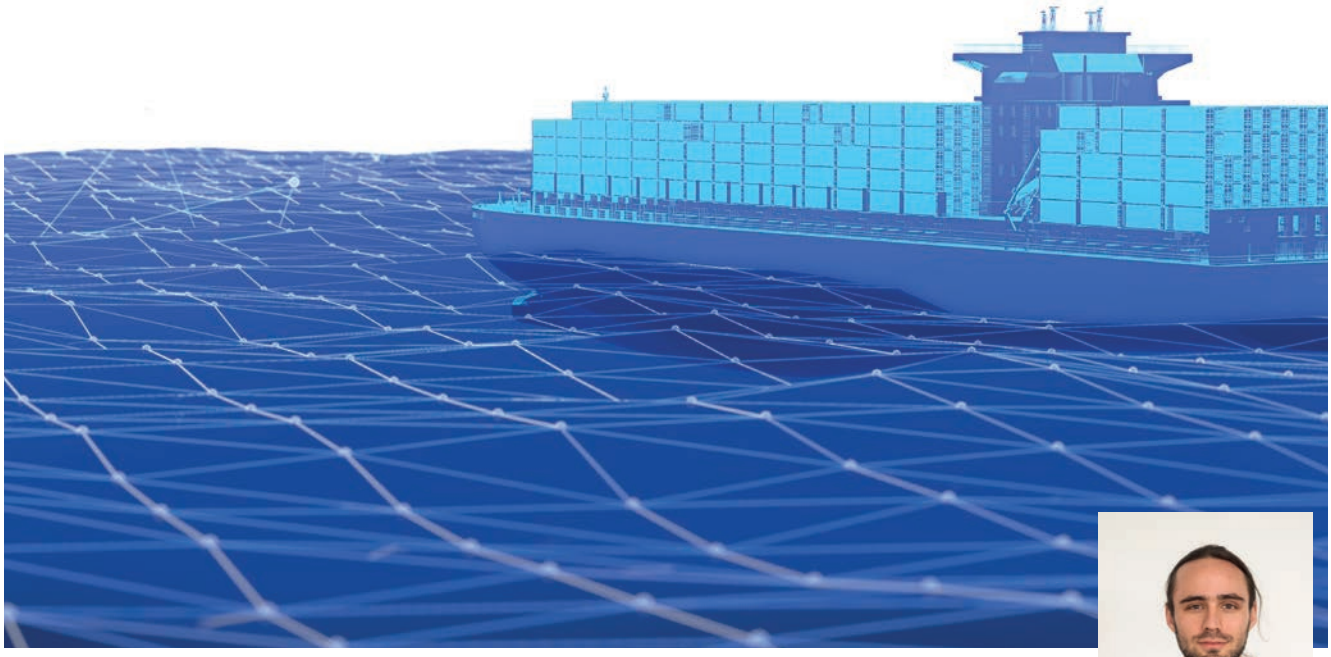


# BLOCKCHAIN FOR MARITIME

## SECURING THE CYBER ENVIRONMENT

Darko Djuric, Blockchain Business Integration Advisor, CargoX, Ljubljana, Slovenia

Blockchain is being introduced in an already fragile digital landscape, with reports of hacking being ubiquitous. A single cyberattack in late June last year cost Maersk up to $300 million. Maersk responded with "different and further protective measures" to contend with a "new type of malware". This highlighted a growing problem for the shipping industry. Blockchain is hailed as a safe, robust alternative to existing systems with central points of failure. If this claim is factual, could the maritime sector be facing an inevitable transition to such solutions? As a provider of a Blockchain-based platform for trade related documentation processing, CargoX has put extensive thought into the sensible adoption of Blockchain for the maritime industry. Many of the concerns around adopting blockchain regard the peripheral points of failure rather than Blockchain as a protocol itself.

### PARALLELS FROM THE EARLY DAYS OF INTERNET?

This is not the first time industries have faced these questions. In the very beginnings of the internet there existed a dichotomy of the two widely diverging attempts at cyber security that are still being used and played out on the stage of society; security either by isolation or obscurity.

In the early 90's, companies and banks were deciding on the best way to integrate emails into their corporate structure. The innovation was met with many of the same critiques that Blockchain-based solutions for data flows are facing today; "None of our clients are using it, who are we going to transact with using Blockchain?" "The implementation looks daunting and overridden with complexities that might be risky and require scrutiny".

But the veracity of Blockchain as a technical impetus of innovation continues to beckon us, as providers of commerce, into examining all possible modes of operation. Additionally, in the context of cyber security, it calls us to re-examine the practices of previous decades, which should serve as a testing ground from which conclusions can be derived for the creation of differing approaches to information security. Not only do systems need to be updated, but the calibration of solutions for organizations handling large transactions must be in sync with the current flows of technical evolution. This evolution sync must also encompass the minds of talented individuals who are pushing the fronts of digital boundaries — the cyber experts who are seeing a picture much more troubling than unsuspecting users do, as well as the wide range of Hacker types, some of whom simply like to discover systemic faults in new hardware and are very important in driving the discovery of the weaker elements of the current digital landscape.

### CYBER HACKING... STIGMATIZED OR NECESSARY?

Barnaby Michael Douglas Jack, a hacker and cyber-security expert who famously demonstrated an ATM exploit in 2010, once commented: "Sometimes you have to demo a threat to spark a solution". We live in a time when companies will no longer be able to rely on the good will of 'White Hat' Hackers, and trying to repressively fight all hacking comes at the cost of stifling innovation. This is an

element of society we simply cannot control. Last year, over 2 billion records were lost or stolen, and in many cases it takes months for the news of these attacks to reach the public. The UN estimates that 80% of these attacks are committed by ultra-sophisticated criminal organizations. If correct, this would represent one of the largest illegal economies in the world, with a capitalization of over $400 billion, greater than the GDP of many nations. To call them criminals falls short as a designation of their relevance, given the complexity of these issues.

We innovate, learn and recreate our systems, until they become so advanced that we maximize our potential as a civilization. Blockchain is only at the beginning of this larger societal pursuit of technical eminence, which would signify an era of no further obsolescence. But today we are far from that point in time. We must consider the reality that cyber security is inadequate today. Saying "our current systems of old are impenetrable" should be weighed against the measure of rationality which is attained only by being constantly up to date. New ways of hacking, and along with it the process of discovering obsolescence of our technical solutions, are emerging with certainty and traces of the effects they have on the shipping industry.

## LESSONS FROM PAST MISTAKES?

As large corporations first attempted to join the internet revolution, they did not just blindly connect straight to TCP/IP and build applications on top of it. They built firewalls, using military analogies such as perimeter security to wall themselves in. The prevailing idea was that this made their organization more secure.

Today we see a rising trend of permissioned ledgers and isolated Blockchains. The problem with private Blockchains is that at some point the system which existed in isolation gets exposed to the outside world, and it may have such low resilience that it is not immune to real world peculiarities of the internet. If it has any bugs, we will not know about them until exposing it to external variables. A public Blockchain exposed to attacks all the time however, is one where bugs are constantly found and fixed, making the system more resilient.

The digital products and services of the past few decades were designed to exist within a wall. But the problem with walls is that we cannot trade through them easily. As businesses we do commerce, and commerce cannot happen if we are walled in. We implement all modern prerequisites of cyber security, but what is the salesperson going to use on the field? A laptop, which is vulnerable to external threats or infection, which can then distribute malware within the confines of the firewall and the full trust of his colleagues.

## HARD-WIRED PROBLEM?

Malicious data-harvesting is a reality all businesses must face. We tend to underestimate hackers, be they of a malicious or benevolent sort. Wireless devices are still very vulnerable to exploits. How many OEMs are still flooding the markets with obsolete Wireless Modules? And how conscientious are they in rectification of known issues, when capital losses are taken into consideration?

The design parameters of general purpose PC hardware is arguably the most concerning area of cyber security development we face today. Intel and AMD hold the vast majority of the market share, and both currently ship their hardware with back doors that have been exploited by professionals to various degrees of concern.

Modern intrusion methods enable hackers to perform exploits without the need to sneak into your offices. One of the most vulnerable devices today are printers. An exploit can be delivered to the printer via a resume, which is designed to re-write the firmware to do basically whatever the hacker wants, including taking control of webcams, phones and microphones in the room.

## HOW SECURE ARE OUR COMPUTERS?

Employees handling sensitive data need to be well informed about information security fundamentals. More emphasis should be directed at projecting the importance of these concerns, even demonstrating how easy it is to collect network packets on an open public network using a cheap WiFi adapter from Amazon and Kali Linux operating system.

At this time we cannot think of personal computers as secure. By definition, trust implies that there is a way to compromise the system. We generally want to avoid trust in anything — trusted 3rd parties, certificates etc. This 'trustless' functionality can be thought of as an intrinsic characteristic of Blockchain applications.

## BLOCKCHAIN TO THE RESCUE?

A viable solution to cyber threats today is something for which the Blockchain seems to be ideal: a strict separation of the trusted element from the hardware. Crucial information should be kept apart from the computer — think along the lines of cloud computing. However, cloud computing still relies on data centers — critical centralized infrastructure that is demonstrably inferior to Blockchain in terms of data integrity.

Modern encryption techniques and the advent of decentralized computing underlying Blockchain have brought about a torrent of innovation at the foundation of which is digital data integrity that, ideally, we can trust. In the current landscape, we are still faced with many questions which will surely be resolved in the coming years.

One of the qualities of businesses that succeed in challenging times is that they have a rational paranoia of failure. The question of why some companies should take the leap into the wild west of digital frontiers bears with it a reminder that success is a struggle, and fleeting once we attain it. Blockchain may be indistinguishable from inevitable digital progress. Technical adaptation to Blockchain and all related security and management concerns can be perceived as markers of innovative success in the future. We do not want to be absolutely certain of any claim of security today, besides the fact that we have done our due diligence to be contemporaneous with emerging predicaments. Yet this is not to be construed as a lack of trust fatal to Blockchain adaptation, but rather as a rational assessment of the integral parts of future innovation.


## ABOUT THE AUTHOR

With 7+ years experience in the CNC machining industry at Danfoss, Darko recognized Blockchain as a viable alternative to existing ERP systems such as SAP which he used on a daily basis. Studying and writing papers about supply chain applications of blockchain, he crossed over into logistics in 2018 as a Blockchain Business Integration Advisor for CargoX, providing educational and technical support for clients and early adopters of the technology.


## ABOUT THE ORGANIZATION

CargoX is an independent supplier of blockchain-based Smart B/L solution that enables extremely fast, safe, reliable and cost-effective global Bill of Lading processing for the logistics industry and supply chains. The company has developed a decentralized platform based on the Ethereum network, and they have a pipeline of future products for the supply chain industry. They have introduced their working solution, live, on stage, in front of 250+ experts and managers, and their respected partners are already testing their solution. CargoX has been founded in 2017 by a group of professionals in logistics and software development industries, and whose aim is is transform the global shipping industry by securing the Bill of Lading documents using blockchain technology.

## ENQUIRIES

Web: https://cargox.io

# DRY BULK & SPECIALIST HANDLING

"Never before have seaports and maritime industries faced such a dynamic time for their businesses. Traditional trade lanes have been redrawn thanks to new developments like the expanded Panama Canal and the resurgence of American energy production."

Sean Strawbridge, CEO, Port of Corpus Christi Authority. **Page 108**


Source - JZ Creation

# SAMALAJU INDUSTRIAL PORT

## USING RENEWABLE ENERGY TO HANDLE BULK

Daniel Mahr, P.E., Energy Associates, P.C.
Montville, New Jersey, USA

Malaysia's SCORE initiative is developing hydro-electric power, as an economical and reliable source of renewable energy. SCORE's Samalaju Industrial Park is a greenfield development that hosts major international companies in the specialty metals and petrochemical industries. They are fundamental parts of the energy-intensive manufacturing process for aluminum, high-strength steels, plastics/vinyl, and other products.

These process and manufacturing industries require large tonnages of a multitude of inbound raw materials and produce outbound bulk commodities and semi-finished products. To maintain continuous and reliable plant operations, they are rightly concerned about the availability, quality-integrity, and security of their inventory of these commodities. That was the challenge for developing the Samalaju Industrial Port, which is adjacent to and serves the industrial park.

### PORT OR PARK?

In undertaking any major development, a key question is: 'What comes first?' The hydro-electric power and high-voltage transmission lines were first needed to attract energy intensive industry to the industrial park. For the port's justification, it is customers, those who have committed to building their new energy intensive processing and manufacturing plants in the industrial park that are imperative.

As a result, the industrial park is being constructed ahead of the port. Indeed, some process plants were already in production while tender documents for different portions of the port were just being prepared. While this impacts the initial ramp-up of plant production, it gave each industrial park company the opportunity to influence design aspects and details for port facilities. The industrial park came first and is the reason for the industrial port.

Press Metal Bintulu is a good example of a Samalaju Industrial Park resident. They import alumina and produce aluminum ingots and billets at their energy efficient smelter. They are now the largest aluminum producer in South East Asia. Because Press Metal's smelter was ahead of the port, an interim transport option was adopted. Press Metal constructed an alumina receiving terminal on an existing wharf at Bintulu Port, which is approximately 60km from Samalaju. Trucks then transport the alumina to Press Metal's smelter.

### PORT DESIGN

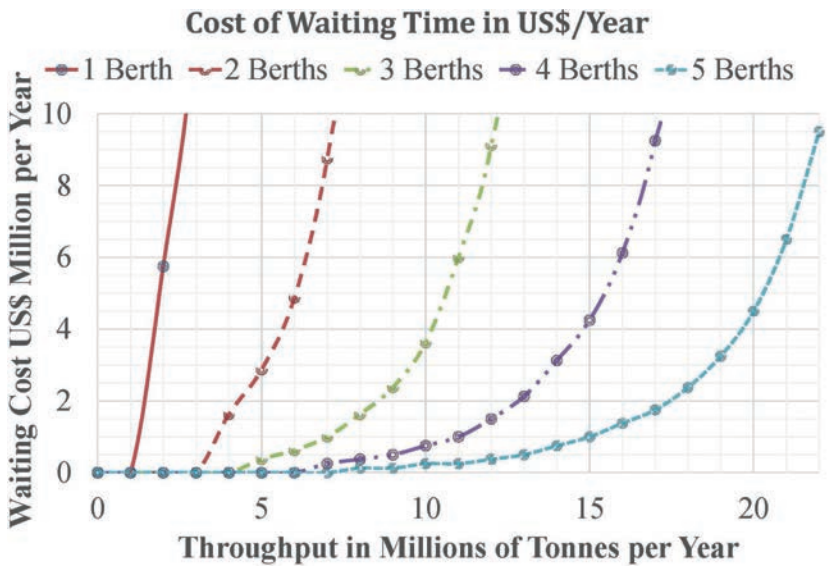
Port elements were examined in a series of studies. A variety of concepts were considered and designs evolved as site information became available and Samalaju Industrial Park tenants committed to the development.

The expected vessel waiting time and demurrage cost increases rapidly with

higher berth occupancy values. It is a key factor used to establish the number of berths needed for port economics.

Figure 1 illustrates the evaluation completed at the inception of the tender document stage for the wharf and bulk material handling system. It examines waiting time costs for one-to-five berths for a capacity range of up to 22 million tonnes per year and demonstrated that four berths would satisfy dock occupancy objectives for a 12.0 MTPA capacity, in comparison to three berths, for instance.

The values reported in Figure 1 might be viewed as a reasonable analysis, however the final completed design differed somewhat from the assumptions used. For instance, alumina can only be unloaded at Berth 4, not all berths.




## MULTI-BULK COMMODITY CONVEYING SYSTEM

The initial development of the port is primarily a four berth jetty for Handymax size vessels. This 50,000DWT maximum vessel size was selected based upon the feedback from port users. The berths are arranged in-line, along the roughly 0.90km jetty. The complex includes four import conveyor systems and provisions for one export conveyor system. These belt conveyor systems include multiple ship unloaders, storage for different commodities, and provisions for distribution to Samalaju Industrial Park facilities via a future industrial park's belt conveying system or a truck loading terminal.

The assortment of dry bulk materials handled by Samalaju Industrial Port have rather different properties and characteristics. They range from alumina with a bulk density of 920kg/m3 and particles that are less than 100 microns in size to manganese alloy with a bulk density of 3000kg/m3 and a top particle size of 50mm. The conveying system had to be design to handle the specific attributes of each commodity.

Commodity contamination was also a concern, for some products more than others. As a result, features were adopted to segregate commodities to minimize the possibility of contamination.

Source: NEUERO Industrietechnik

Figure 2: NEUERO's Pneumatic Alumina Ship Unloader

## ALUMINA CONVEYING SYSTEM

Alumina easily aerates. It will disburse into a white dust cloud in the wind or fluidize into an uncontrolled stream as it flows through transfers and finds chute openings and gaps. For Press Metal, cross-product contamination of their primary raw material, the imported alumina, was a concern.

Press Metal chose to employ pneumatic ship unloaders, and Figure 2 illustrates one of the three unloaders and the gallery for the pipe belt conveyor.

To convey the alumina to the port's interface with the industrial park, pipe belt conveyor technology was elected. At Berth 4, the pipe conveyor is 'open', with the top strand configured as a conventional troughing belt conveyor, but it is enclosed in an elevated gallery. The three traveling ship unloaders can discharge anywhere along the full length of Berth 4, as needed for ship unloading plans.

Berth 4's gallery has a slotted roof that is protected by a roof closure/cover belt. The roof's closure/cover belt loops over the discharge chute of each ship unloader. At the shore end of Berth 4, the top troughing strand of the pipe conveyor closes into the circular pipe configuration, protecting the alumina as it is conveyed shoreward. The 2km pipe conveyor negotiates both vertical and horizontal curves, which eliminates a transfer. This is a much more economical than the 60km interim trucking arrangement.

## GRAB BUCKET UNLOADERS

For commodities other than alumina, a variety of unloading technologies and design features were considered. Level-

luffing grabs with an integrated machine-mounted, hopper was selected by Bintulu Port Holdings, the operator of the port.

### FUTURE SHIPLOADER

Provisions for a future, separate shiploading system were provided. Because some export commodities have to be protected, the shiploading conveying system is enclosed and fitted with hinged doors on harbour side of the gallery that are actuated by a cam mechanism on the shiploader's tripper.

### STOCKPILE STORAGE

The port provides strategic storage capacity for the industrial park's plants. The stockpile areas are arranged to accommodate multiple commodities. For any given commodity, terminal rules-of-thumb are to provide at least 1.5 times the tonnage of the largest vessel (50,000DWT) and 10% of annual throughput. Figure 3 illustrates these two stockpile sizing rules and how they intersect at 75,000 tonnes. Providing adequate, economical storage capacity for customers who have annual receipts that are less than 750,000 tonnes was considered.

Since each industrial park plant has their own plant-site stockpile, the strict application of these rules-of-thumb was considered to be inappropriate. A different approach was adopted. The number of individual pile and their sizes would vary and continually expand and shrink with storage allocated per ever changing operating conditions.

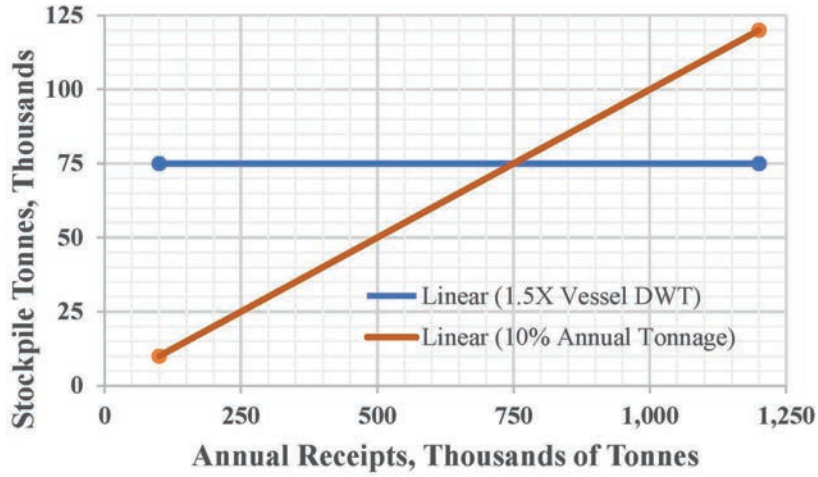
### TRUCK LOADING

Commodities are currently being shuttled between the port and the industrial park by trucks. To reduce initial capital cost, mobile equipment is being used to load trucks directly from the stockpiles. As port receipts ramp-up, the inefficiencies and limitations of a mobile equipment mode of operation become excessive. Provisions for a future, truck loading terminal were provided. This facility will better manage truck queuing to mitigate traffic congestion automatically weigh commodities loaded into the trucks, eliminating the inefficiency separately weighing each load on a truck scale.

### FUTURE SYSTEM

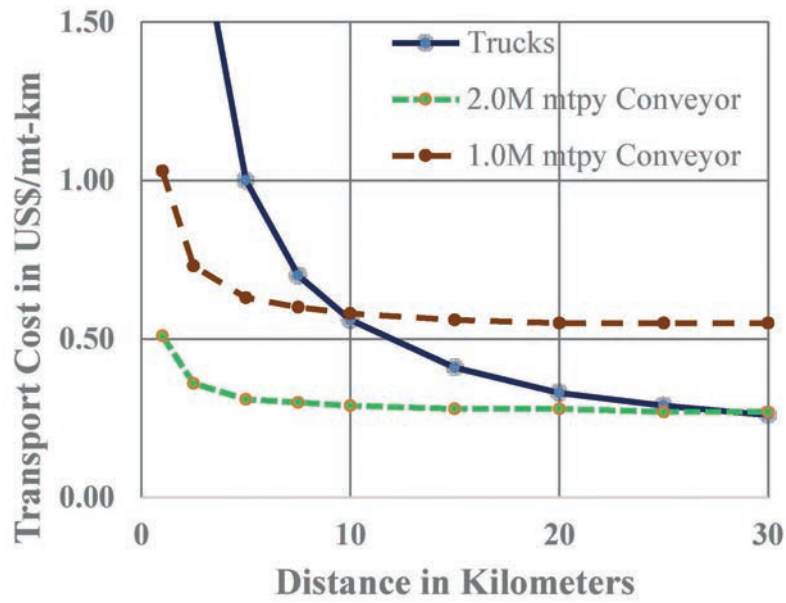
While the truck loading terminal was conceived during the specification stage as a useful feature, it would not be the most effective option for Samalaju. The proximity of the port to the process plants makes an industrial park conveyor distribution system the ideal solution. Belt conveyors are the most efficient and economical mode of transportation for short distances. The common factor for comparing different modes of transportation is their cost in US$/mt-km. What makes truck transportation expensive for short distances is their time spent waiting: queuing, loading, weighing, and unloading. As the travel distance gets longer, the influence of these factors significantly lessens.

Figure 4 illustrates an example cost relationship for trucks and a belt conveyor for distances up to 30km. The cost in US$/mt-km steeply drops for trucks as the travel distance increases. Two different scenarios are also illustrated for conveyors. The major cost for a belt conveyor is its capital cost, which is a fixed cost per kilometer. This capital cost is the same for both conveyor scenarios. As a result, the tonnage being handled by each is what makes a dramatic difference. A conveyor system handling 2.0 million mt/yr has half the cost in US$/mt-km than when this system only handles 1.0 million mt/yr. That does not happen for trucks, which are assessed on an hourly basis. If there are fewer tonnes to transport, fewer trucks are required. Trucks are advantageous in situations where tonnage varies. Conveyors are advantageous in situations where the annual tonnage is relatively high and stable.




Source: Energy Associates, P.C.

Figure 3: Stockpile Size Using Rules-of-Thumb




Source: Energy Associates, P.C.

Figure 4 – Transport Cost for Trucks vs. Belt Conveyor


Source - JZ Creation

The cost advantage for conveyors for relatively short haul distances is the reason why a future Industrial Park Conveyor Distribution System will benefit the industrial residents. The truck loading terminal was conceived due to concerns that a common distribution conveying system for the industrial park is a new idea that would have to be approved and funded. Trucks will likely be the distribution mode of transportation for some time.

## MAKING IT WORK

The design challenge was to enable the port to simultaneously manage an assortment of different tasks for multiple different commodities, with the utmost simplicity. A "Spine Design" was conceived for the belt conveyor system. It is the backbone of the system. The spine design will allow Samalaju Industrial Port to direct receipts to storage, truck-loading, and/or to the industrial park interchange transfer. Receipts can be split and routed into two different directions. Receipts can also be cycled between stockpiling and truck loading, for instance. The ability to bypass the port's stockpiles without slowing ship unloading reduces the port's stacking and reclaiming costs without burdening the ship unloading operation. Some commodities can be stacked while others are being reclaimed from adjacent stockpiles.

The system is operated from a control room tower, located above a central transfer hub. From this elevated position, operators have a 360-degree view of the harbor, stockpiles, future truck loading station, and future transfer to the industrial park conveyor distribution system – providing visual feedback to the operators, in addition to the computer displays of controls, system graphic diagrams, system status, stockpile inventories, fault/alarm announcements, and other screens.

Samalaju Industrial Port has a host of features and flexibilities that a greenfield development can provide. It minimizes the handling and transport costs for the raw materials and semi-finished products of Samalaju's resident process plants.

### ABOUT THE AUTHOR

Daniel Mahr is a Professional Engineer and bulk material handling specialist, responsible for numerous projects at ports, terminals, power plants and industrial facilities. He is a past chair of ASME's FACT Division and its FSHT Technical Committee. Mr. Mahr is currently a member of ASME's B20 Safety Committee and Society of Mining Engineers. He has published over 50 articles on technology advancements, features, and issues; and assists as an Expert Witness in legal matters.

### ABOUT THE ORGANIZATION

Energy Associates provides bulk material handling engineering/consulting services, from initial project planning through design and implementation. Responsibilities include improvement assessment, retrofit, conversion, remediation, and failure investigations.

### ENQUIRIES

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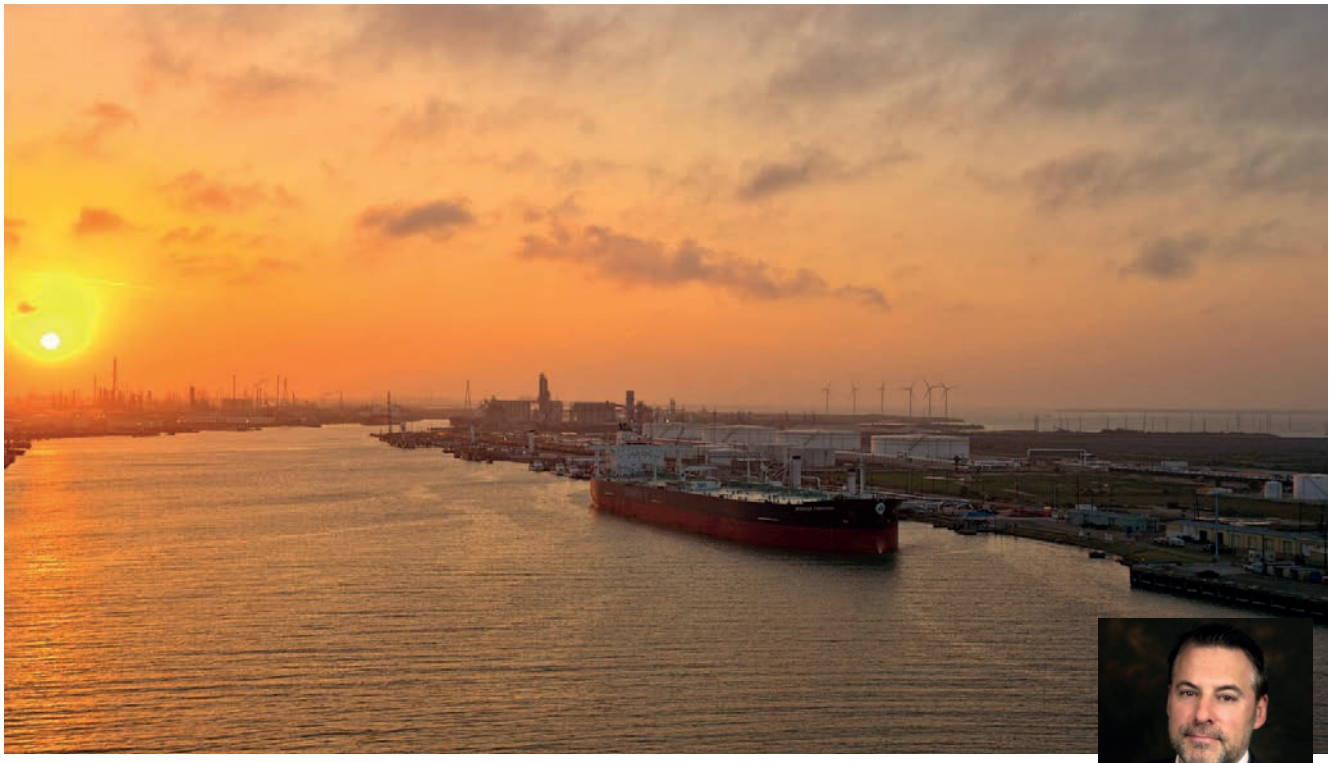

# A RENAISSANCE PORT

## MOVING AMERICA'S ENERGY

Sean Strawbridge, Chief Executive Officer,
Port of Corpus Christi Authority, USA

Never before have global seaports and maritime industries faced such a dynamic time for their businesses. Traditional trade lanes have been redrawn thanks to new developments like the expanded Panama Canal and the resurgence of American energy production. The repeal of the ban on exporting U.S. crude oil and the first U.S. liquefied natural gas (LNG) export facilities coming online are certainly recent game changers for U.S. energy ports. By the end of 2017, over 1 million barrels per day of crude oil were being exported to more than 35 countries, while 890 trillion cubic feet of LNG were shipped to 27 countries.

### RISING IN THE REGION

The Port of Corpus Christi is at the forefront of the re-emergence of the US as a dominant player in the global energy trade. Since 1926, Corpus Christi was an important, though relatively obscure, port. Originally designed as a way for South Texas farmers to send their crops to global markets faster, the Port soon emerged as a modest energy hub thanks to oil production and refining in the 1930s and '40s. For decades, the Port was land rich and cash poor. All of that changed a decade ago with the shale renaissance, when producers in the Eagle Ford Shale and Permian Basin formations began extracting record-setting amounts of crude oil and natural gas, effectively thrusting the U.S. forward as a net energy producer. This cheap, abundant supply of energy, coupled with a deep-water port, large swaths of available land for industrial development and a business-friendly climate propelled the South Texas Coastal Bend to the enviable position as the most desirable region in the entire U.S. Gulf Coast for new industry investments.

Today, more than $50 billion of private industrial development projects are in various stages of completion. These include new manufacturing facilities in petrochemicals, polymers and steel pipe, and world-class energy terminals designed to receive and transfer vast quantities of oil and natural gas products. Nearly 20% of the projects come from foreign direct investment. Exports of U.S. crude oil are now responsible for 40% of our total liquid cargo volumes. And in FY18 alone we will move to international markets more than 200 million barrels of crude oil – more than half of total U.S. crude oil exports.

The growth of American energy is not only good for our trading partners, but also for U.S. fuel manufacturers, our economy and our trade deficit. For every dollar we keep here at home buying U.S. barrels, coupled with a dollar we make selling U.S. barrels overseas, has a two-dollar exponential impact on the U.S. trade deficit. We estimate the forecasted energy exports to China over the next five years will reduce our trade deficit with the Chinese by at

least 10% through the Port of Corpus Christi alone.

The economic opportunities for America's next generation cannot be understated, nor should they be squandered either. To-date, the businesses in and around the Port of Corpus Christi are responsible for more than 80,000 direct jobs, approximately 1.2 million induced jobs, and generate more than $120 billion in economic output annually, while moving nearly $40 billion in goods value each year and growing.

## LESSONS LEARNT

Yet with rapid growth comes organizational challenges and generational differences of opinion. In looking back over the past three years, a few lessons stand out as especially notable and worth sharing:

- **Thinking and acting both locally and globally.** Maintaining close and consistent communications with investors and customers (globally) and stakeholders (locally) at all levels is crucial to building trust, addressing issues and evolving operations in a responsible and transparent way. Globally, that means a continuous evangelizing of the value of doing business and investing in the South Texas Coastal Bend. At the local level, it means keeping core constituencies informed on what the global markets are saying, how they impact our vision for success and how we are spending our dollars. Further informing our lawmakers and appropriators of the economic significance of the Port on the local, regional and national economy is mission critical. Communicating the true value of an American barrel of energy to our allies and trading partners around the world is key, and thus far has wide-spread bi-partisan support.
- **The value of smart management and planning.** Never underestimate the significance of planning at all levels – strategic planning, master planning, urban planning, transportation planning – all have a role in achieving success. But rigidity is the enemy of planning. Anticipating a wide range of issue scenarios and having contingencies in place to address them has an elevated place in the planning process. As much as a project's planning can appear to be linear – with natural start and end points – anticipating new paradigms and continuous improvement and being as flexible as possible without compromizing core values, will ultimately serve an organization well.
- **Embrace change.** Change is challenging, change is difficult ... and change is essential. Without change, one can expect nothing more than what has already been achieved. Maybe less. As the great British Prime Minister Winston Churchill said, "to improve is to change; to be perfect is to change often." A critical look at an organization's culture, policies and process is essential at least every five years. In its absence, private companies become stale, rigid and uncompetitive. Without change, public governmental agencies become obstructionist, bureaucratic and cumbersome. At the Port of Corpus Christi, we harnessed the power of investing in our greatest asset – our people, with one goal in mind, to help them develop as better professionals ... and as better people. We did this through an array of coaching, training, exercises and instilling a set of values: our SEAPORT values. SEAPORT is an acronym for our core values of Safety, Empowerment, Accountability, Preparedness, Optimism, Respect and Teamwork. All seven of these values are evident in all aspects of work our employees are engaged in, and no activity will be undertaken without them. Period. Our priorities have changed, but our values will not.

Finally, it is important not to understate the value of supportive policymakers and federal investment to reinforce the growth and prosperity of our nation's 926 seaports. Recently, the Port of Corpus Christi was awarded partial federal funding for its Ship Channel Improvement Project (CIP), which will deepen and widen the Corpus Christi Ship Channel. Once complete, the project will allow for greater vessel traffic and larger vessels designed to carry more product than ever before – and unleash America's full ability to export still greater quantities of U.S. energy to our allies and trading partners.

## CONCLUSION

For us, the recent expansion of U.S. energy exports has brought change at a remarkable rate. To fully leverage this change – for our own prosperity and that of our customers and the broader region – it will require the unwavering attention of federal policymakers to ensure the steady and recurring stream of funding necessary to continue fostering private investment and driving economic growth and prosperity. While we certainly are not the only port experiencing a business paradigm disruption, the sheer scale of ours is hard to fathom. Our disruption is a dream come true. The test will be to keep the dream alive by embracing change and challenging our lawmakers to make the right decision, or ignore the tough decisions and accept the status quo. Not much of a choice as far as I can tell from my front row seat to America's energy renaissance.

## ABOUT THE AUTHOR

Sean is currently the Chief Executive Officer (CEO) of the Port of Corpus Christi Authority, which is the 4th largest Port in the United States in tonnage. Handling in excess of 100 million tons annually, the Port of Corpus Christi is one of the largest energy ports in the world. In his role as Deputy Executive Director & Chief Operating Officer, Sean empowers the Port's high performance team of talented women and men to achieve greater success. Sean has over 25 years' experience in the global transportation and energy sectors in both public administration and private sector disciplines, holding senior leadership roles in Business & Corporate Development, Large Infrastructure Development, Capital Structuring, Finance, and Public Private Partnerships.

## ABOUT THE ORGANIZATION

As the leading U.S. Crude Oil export port and a major economic engine of Texas and the nation, the Port of Corpus Christi is the 4th largest port in the United States in total tonnage. Strategically located on the western Gulf of Mexico with a 36-mile, 47 foot (MLLW) deep channel, the Port of Corpus Christi is a major gateway to international and domestic maritime commerce. The Port has excellent railroad and highway network connectivity via three North American Class-1 railroads and two major interstate highways. With an outstanding staff overseen by its seven-member commission, the Port of Corpus Christi is "Moving America's Energy."

## ENQUIRIES

Web: http://www.portcorpuschristi.com

# ENVIRONMENT & SUSTAINABILITY

"It's important to set the record straight about the enormity of what has been achieved and the great credit which the industry deserves for persuading IMO Member States to respond to the Paris Agreement in such an ambitious manner. This includes the detailed proposals the ICS made about what the strategy might look like, which we first submitted to the IMO within weeks of the Paris Agreement being adopted."

Simon Bennett, Deputy Secretary General, International Chamber of Shipping. **Page 112**

# THE IMO GREENHOUSE GAS STRATEGY

## AN UPDATE

Simon Bennett, Deputy Secretary General,
International Chamber of Shipping, London UK

In April, 2018, the International Maritime Organization (IMO) adopted a truly ambitious strategy for the further reduction of greenhouse gas emissions for which the international shipping industry is responsible. In this paper, I will try to set the great ambition of this agreement into context, consider whether what has been agreed is enough, and what may come next in the form of additional CO2 reduction measures.

It's important to set the record straight about the enormity of what has been achieved and the great credit which the industry deserves for persuading IMO Member States to respond to the Paris Agreement in such an ambitious manner. This includes the detailed proposals the ICS made about what the strategy might look like, which we first submitted to the IMO within weeks of the Paris Agreement being adopted.

### THE SHIPPING INDUSTRY

The shipping industry is, very unfairly, often criticized for foot-dragging. But this new IMO agreement makes it absolutely clear that shipping is now far and away ahead of the rest of the world economy in the scale of its ambition. Most importantly, we are confident that the high level of ambition now agreed will give the wider industry the clear signal it needs to get on with the job of developing zero CO2 fuels, so that the entire sector will be in a position to decarbonize completely, consistent with achieving the 1.5 degree climate change goal identified by the UN.

Let me begin by recapping on what the IMO has agreed. The IMO has agreed on a vision to phase out CO2 from shipping completely, a vision promoted by the ICS from the start of these negotiations. No ifs, no buts – this is the clear goal. The ICS is confident that new technology will eventually deliver; whether through the use of fuel cells or batteries powered by renewable energy, new fuels such as hydrogen, or some other solution not yet anticipated.

In the meantime, the IMO has set a radical goal of cutting the total CO2 emissions of shipping by at least 50% by 2050, compared to 2008. A 50% total cut is very ambitious indeed, especially when taking into account the current projections for trade growth. To put this in context, the aviation sector's regulators have so far only agreed to hold its total CO2 emissions at 2020 levels, with no clear plan for absolute reduction.

Moreover, compared to the 50% cut agreed by the IMO, the commitments made by governments under the Paris Agreement with respect to the rest of the global economy will not see total CO2 emissions begin to reduce until the 2030s. The total CO2 emissions from shipping are already about 8% lower than in 2008 despite a 30% increase in maritime trade — and the IMO has already adopted regulations requiring ships delivered from 2025 to be at least 30% more efficient than those constructed before 2013.

## GLOBAL DEMAND

Some governments would have preferred to see the adoption of even more aggressive targets. But a 50% total cut by 2050 can realistically only be achieved with the development and widespread use of zero CO2 fuels. If this 50% goal is successfully met, the wholesale switch to zero CO2 fuels should therefore follow very swiftly afterwards.

The IMO has also agreed an efficiency goal, as an average for the sector, for a 40% improvement by 2030 compared to 2008, and a 70% improvement by 2050. This is also extremely ambitious, and will only be achievable if governments recognize the enormity of this challenge and help facilitate the rapid development of new technologies and fuels.

To be clear, while LNG and biofuels will probably form a part of the interim solution, the very high goals the IMO has now set for 2050 can only be achieved with the development of zero CO2 propulsion systems. But while the technical challenges are huge, we do not think they are insurmountable.

Most importantly, the new IMO strategy includes a list of possible candidate measures to achieve further CO2 reduction, including additional measures that could be ready for implementation before 2023.

## CANDIDATE MEASURES

This list of candidate measures contains a number of proposals by governments for potential new regulations, some of which may prove controversial. These include: the possibility of mandatory speed measures; operational indexing of individual ships; and consideration of further improvements to the existing IMO Energy Efficiency Design Index for future ships.

The ICS is already now developing detailed input to IMO on all these proposals, but the most controversial is the further consideration of applying some kind of Market Based Measure (MBM). The ICS remains deeply sceptical of MBMs as a means of further incentivising CO2 reduction. Fuel, of course, is already by far the largest cost for ship-owners and this is expected to increase dramatically as a result of the global IMO sulphur cap in 2020. Ship-owners already have all the incentive they need to explore every possible means of reducing their CO2 through technical and operational measures alone, as demonstrated by the impressive fuel efficiency improvements achieved since 2008. As the IMO debates how best to implement its strategy we would much prefer that it concentrates on further technical CO2 reduction measures, not least promoting the development of zero CO2 fuels.

However, in the event that the IMO decides that there is a political need to develop an MBM, the clear preference of the global industry would be for a bunker fuel levy payable to some kind of IMO climate fund. If such a levy was developed, the funds should be deployed to support research into new low carbon technologies or to support the roll-out of the expensive new bunkering infrastructure that will be required to supply zero CO2 fuels, particularly in the ports of developing nations.

If the IMO should decide that an MBM is necessary, the ICS believes that a fuel levy would be the mechanism least likely to cause serious market distortion, as opposed to some kind of emissions trading system – something to which the industry is completely opposed. However, these are discussions for the future. With regard to the ambitious IMO strategy that has now been adopted, the ICS is very encouraged by the willingness of governments, on all sides of the debate, to co-operate and move to a position that demonstrates, unequivocally, that the IMO is the only body that can meaningfully address the CO2 emissions of international shipping.

## CONCLUSION

What is most important is that the IMO agreement will be sufficient to discourage those who mistakenly advocate regional measures which, as well being very damaging to global trade, would not be effective in helping the international shipping sector to further reduce its total CO2 emissions. As a result of this historic IMO agreement, the ICS now expects discussions at the IMO to begin in earnest on the development of additional CO2 reduction measures, including those to be implemented before 2023. As the representative body of global shipping, the ICS looks forward to participating constructively.

## ABOUT THE AUTHOR

Simon has worked within the shipping industry for over 20 years. A graduate of Oxford University, he initially worked for the General Council of British Shipping. He has subsequently held various positions within the International Shipping Federation (ISF) and the International Chamber of Shipping (ICS) where he is currently Deputy Secretary General. Working for ICS, Simon has represented the global shipping industry at the various inter-governmental organisations which impact on shipping including the IMO, ILO, OECD, the UN, UNFCCC and the WTO.

## ABOUT THE ORGANIZATION

The International Chamber of Shipping (ICS) is the global trade association for merchant shipowners. Its membership comprises national shipowners' associations from 36 countries representing over 80% of the world merchant fleet.

## ENQUIRIES

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# ARCTIC CONTAINER SHIPPING

## THE RISKS OF HEAVY FUEL OIL

Dr. Bryan Comer, Senior Researcher,
International Council on Clean Transportation (ICCT), Washington D.C., USA

Arctic shipping is possible for longer periods of the year as climate change unveils new, previously inaccessible routes connecting Asia, Europe, and North America. Ice-free navigation enables more, and larger, ships to transit the Arctic, including containerships. Globally, and in the Arctic, most containerships use heavy fuel oil (HFO), the world's dirtiest transportation fuel. HFO poses serious environmental and economic risks, especially in ecologically sensitive areas like the Arctic. When spilled, HFO breaks down slowly, particularly in cold water. Unlike other fuels, which float on the surface when spilled, HFO emulsifies in sea water, making it nearly impossible to clean up, especially if it sticks to sea ice.

Using HFO is risky not only because of its spill potential, but also because burning it produces harmful air and climate pollutants including black carbon (BC), a small dark particle that settles on Arctic snow and ice, absorbs sunlight, accelerates melting, and contributes to Arctic and global warming. Containerships use and carry HFO in the Arctic today and larger containerships are expected as countries exploit Arctic shortcuts. In this article, I describe the prevalence of HFO-fueled containerships in the Arctic, with a focus on those burning and carrying the greatest quantities of this dangerous fuel.

### HFO IN THE ARCTIC

For ships, Arctic waters are defined in the International Maritime Organization's (IMO) Polar Code and exclude the less icy waters around Scandinavia (Figure 1) which we call the IMO Arctic. Under the Polar Code, ships plying polar waters are subject to additional environmental and safety rules and, at the South Pole, ships operating in Antarctic waters (south of 60° S latitude) are prohibited from using or carrying HFO onboard as a means of protecting the polar environment. The Polar Code recommends that ships not use or carry HFO in the Arctic, but it is not mandatory. As such, ships operating in the IMO Arctic, including containerships, are free to use and carry HFO.

In 2015, 2,086 ships operated in the IMO Arctic, according to ongoing research by the ICCT. The most common ships were fishing vessels, which tend to operate on cleaner marine distillate fuels; however, many cargo ships, and more than a few fishing vessels, operated on HFO. About 42% (889 of 2,086) of ships operating in the IMO Arctic in 2015 were HFO-fueled. While less than half of ships operating in the Arctic burned HFO, HFO represented 57% of fuel used by weight, 76% of fuel carried by weight, and 56% of distance-weighted fuel carried (calculated as the fuel onboard the ship times the distance the ship traveled). Additionally, 68% of the 193 tonnes of BC Arctic ships emitted in 2015 resulted from burning HFO.


| A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|
| 60°00'.0N 056°37'.1W | 58°00'.0N 042°00'.0W | 64°37'.0N 035°27'.0W | 67°03'.9N 026°33'.4W | (Sørkapp, Jan Mayen) 70°49'.56N; 08°59'.61W | (by the Island of Bjørnøya) 73°31'.6N; 019°01'.0E | (Cap Kanin Nos) 68°38'.29N; 043°23'.08E |

*Source: International Council on Clean Transportation*

Figure 1. The Arctic as defined in the Polar Code (the "IMO Arctic").

## CONTAINERSHIPS IN THE ARCTIC

Forty-three containerships sailed the IMO Arctic in 2015 and all of them used and carried HFO as their primary fuel. Of those 43, only a handful of them operated for significant amounts of time in the IMO Arctic. Seven ships stand out, each operating in the IMO Arctic for more than 1,000 hours in 2015: five Danish-owned and flagged ships operated by the Danish government's Royal Arctic Line, and two Russian-owned and flagged ships operated by Russian companies Trident Trust Group and FESCO. For comparison, the other 36 containerships each spent 60 hours or less operating in the Arctic in 2015, meaning that they didn't transit the Arctic. However, several ships that are technically classified as 'general cargo' ships, which can carry all sorts of cargo but can also carry containers, have transited the Arctic in recent years, including China's HFO-fueled Yong Sheng, which first transited the Northern Sea Route in 2013, with return voyages in 2015 and 2016. The Yong Sheng can carry up to 19,150 tonnes of cargo, including up to 1,226 twenty-foot equivalent unit (TEU) containers. Thus, trans-Arctic container shipping has already come to the Arctic.

Focusing on dedicated container shipping (i.e. ships classified as containerships), it's no surprise that the most active container ships are owned and operated by Danish and Russian companies, as both Denmark and Russia are prominent Arctic nations. The Arctic state of Greenland is an autonomous country under the Kingdom of Denmark, and Russia controls the majority of the Arctic coastline. Together, these seven Danish and Russian ships are capable of carrying 3,870 TEU. These ships are small compared to the 20,000+ TEU behemoths launched in recent years, but as Arctic sea ice dwindles, we expect to see more, and larger, containerships taking advantage of trans-Arctic routes, which can be up to 50% shorter in length than transiting the Suez Canal.

Among the seven most active containerships in the Arctic, the 24-year-old, 424-TEU Irena Arctica was the most active. The Irena Arctica serves the various towns that dot Greenland's southern coastline, with typical calls on the Greenlandic ports of Nuuk, Paamuit, Narsaq, and Ilulissat, among others. The ship has ice-breaking capabilities; in fact, it's rated by the DNV classification society as ice class ICE-1A*, which means that it can usually operate in heavy ice conditions without the assistance of an icebreaker. Even so, operating in heavy ice conditions while carrying HFO onboard is risky business.

From a spill perspective, the risks of using HFO in the Arctic are related to the amount of HFO carried in ships' fuel tanks, any hull

and tank protections, and the distance HFO-fueled ships sail in Arctic waters. From a climate perspective, the risks of using HFO are related to the amount of HFO consumed, as burning HFO emits climate warming pollutants, including carbon dioxide ($CO^2$) and BC. The Irena Arctica sailed nearly 51,000 nautical miles within the IMO Arctic in 2015 and she typically carries over 500 tonnes of HFO in her fuel tanks at any given time, resulting in distance-weighted HFO carriage of over 26 million tonne-nautical miles. Over the course of the year, the Irena Arctica burned more than 3,500 tonnes of HFO (~22,500 barrels), emitting 2 tonnes of BC, approximately equivalent to the annual BC emissions from 800 heavy-duty trucks.

Interestingly, the Irena Arctica didn't always operate on HFO. In 2010, she switched from using cleaner, but more expensive, distillate fuel to exclusively using HFO. According to DNV, Royal Arctic Lines would prefer to operate its fleet on distillate fuels because it lengthens the maintenance interval for ship engine and fuel systems, but it's significantly cheaper to use HFO. As ships continue to use HFO in the Arctic, the spill risks and climate risks will persist.

## THE FUTURE OF HFO IN ARCTIC SHIPPING

As long as HFO continues to be the cheapest maritime transportation fuel, it's hard to imagine ships capable of burning HFO using anything else. And with Arctic ice receding, it won't be long before more, and larger, containerships take advantage of trans-Arctic routes. Indeed, we're already seeing large general cargo ships, with containers onboard, regularly transiting the Arctic. As more HFO-fueled ships take advantage of Arctic shortcuts, the risks of an HFO spill and the damaging impact of BC emissions will grow.

Upcoming regulations mean that, beginning in 2020, the maximum allowable sulfur content of marine fuels will drop from 35,000 parts per million (ppm) to 5,000 ppm. According to the IMO, the average sulfur content of HFO is about 26,000 ppm and the average for distillate fuels is approximately 800 ppm. At first glance, the regulation appears to prohibit the use of high-sulfur HFO, including in the Arctic. However, it's possible to blend HFO with low-sulfur distillate fuels to make a fuel that is cheaper than distillate, but still contains HFO, and complies with the 5,000 ppm sulfur requirement. Additionally, ships can comply by installing exhaust gas cleaning systems (more commonly known as "scrubbers") that allow the ship to continue to use high-sulfur HFO because the scrubber removes sulfur from the exhaust stream, thereby achieving "equivalent" compliance. DNV reports that more than 350 ships have or will have scrubbers installed by 2020, with cruise ships making up the biggest market, but with containerships accounting for 10% of installations. Thus, even in 2020 and beyond, there's no guarantee that HFO will be eliminated in the Arctic under current regulations.

To ensure the Arctic receives the same protections as its polar sister (Antarctica), a group of environmental NGOs called the Clean Arctic Alliance have campaigned to ban the use and carriage of HFO for ships sailing Arctic waters. (HFO cargo, as opposed to the fuel in the ships' fuel tanks, would be exempt from the ban.) Their efforts have gained traction. In April, the IMO agreed to develop a ban on the use and carriage of HFO as fuel in Arctic waters, subject to an impact assessment to ensure that Arctic communities are protected from potential undue economic consequences of a ban. While others, namely Russia, have proposed other options, including navigational measures, infrastructure development, emergency preparedness, and crew training, banning HFO in the Arctic is the simplest and most effective way to protect this unique and pristine environment. Using distillate marine fuels is the obvious replacement for HFO, but other fuels such as LNG, hydrogen, batteries, and fuel cells are possible alternatives as well. Early next year, the IMO's Pollution Prevention and Response subcommittee will begin its work, to develop a ban on the use of HFO in the Arctic. When a ban might enter into force is anyone's guess; it's easy to stall in the international environmental policy realm. Until then, you can expect HFO to continue to be used in the Arctic, in some form, for several years to come.

### ABOUT THE AUTHOR

Bryan Comer, PhD, is a senior researcher at the International Council on Clean Transportation. His work informs policies that reduce the environmental and human health impacts of air pollution from ships and ports. Dr. Comer specializes in emissions inventories, health impact assessments, and Arctic shipping.

### ABOUT THE ORGANIZATION

The International Council on Clean Transportation is an independent nonprofit organization founded to provide first-rate, unbiased research and technical and scientific analysis to environmental regulators. Its mission is to improve the environmental performance and energy efficiency of road, marine, and air transportation, in order to benefit public health and mitigate climate change.

### ENQUIRIES

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# ENERGY PEAK SHAVINGS

## FOR SHIP-TO-SHORE CRANES

Harry Geerlings, Professor in Governance of Sustainable Mobility, Erasmus University Rotterdam
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Robert Heij, Delft University of Technology

The size of containerships is increasing continuously. After a containership has berthed at the seaside of a terminal, the STS cranes start unloading the incoming containers according to the unloading plan. Container terminals are under high pressure to handle ships as fast as possible against a low price to improve their competitive position. The handling capacity of a container terminal is highly dependent on the number of STS cranes and their capacity, as the cranes determine the handling time per ship as well as the throughput of containers to the stacking process.

During the loading/unloading of a containership, two criteria are important: the ship's stability and the number of unproductive moves. When more and more STS cranes are simultaneously executing a lifting movement, peak demand and energy-related costs increase. For an intermediate container terminal with eight STS-quay cranes, the peak-related costs can account for up to 25–30% of total energy costs.

### PEAK SHAVING

Peak shaving implies the lowering of the highest observed peak in energy demand to reduce the energy-related costs. This enables container terminals to lower the handling costs of containerships, giving them a better competitive position. Another advantage of peak shaving is that terminals' energy demand is more stable; this is especially important for container terminals in countries where grid operators cannot prepare the energy system for unexpected high energy peaks (Duin et al, 2018).

STS cranes are connected to the electricity network — for all quay crane processes (moving of crane and spreader, crane lighting, and auxiliary processes), electricity is supplied by the network. Vertical movements have the most volatile energy demand, showing high peaks for hoisting the crane spreader and low falls for lowering the spreader, as can be seen in 'Error! Reference source not found' (MSC Terminal Valencia, 2009, field data).

The gantry (horizontal) movements and auxiliary energy consumption are

less volatile in character. In 1, the total energy consumption for one STS-crane is visualized. In total, two peaks can be identified for handling a container: the first for lifting a spreader and container above the ship and the second for lifting the spreader after the container is positioned in the terminal. When all STS cranes in a terminal are lifting at the same moment, the potential peak demand is very high. It is therefore important to visualize the peak demand of a terminal while it is handling a containership and to investigate the opportunities to reduce the peak demand.

## SIMULATION OF THE ENERGY DEMAND

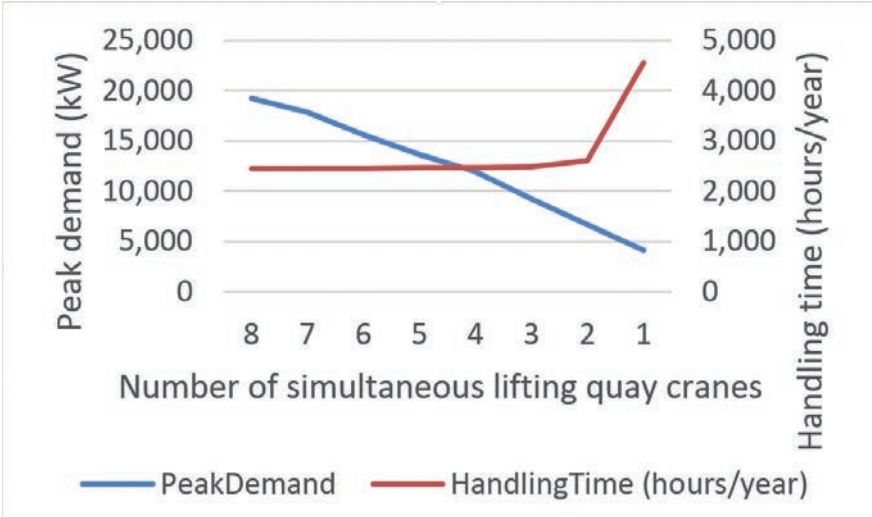
The growing need for container terminals to handle containerships as fast as possible leads to more automation and more simultaneously operating STS cranes, with a direct impact to high peaks in electricity demand. Because an observed peak demand is charged for the next 12 months, the highest peak is responsible for nearly 25–30% of the total electricity costs. This implies that higher handling speeds of containerships result in more peak-related energy costs, leading to higher handling costs. Because container carriers require both higher handling speeds and lower handling costs, terminals are confronted with a dilemma. The challenge is therefore to find opportunities to reduce the peak-related costs without reducing the handling speed too much. Researchers from the Erasmus University Rotterdam, Delft University of Technology and Rotterdam University of Applied Sciences developed a discrete-event simulation model which is constructed to apply the consumption model (Geerlings et al., 2018).

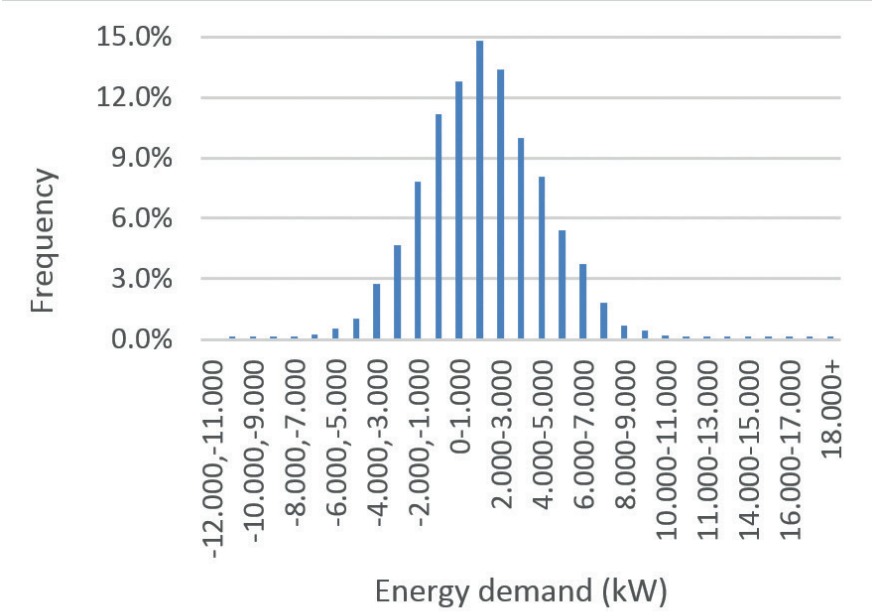
## RESULTS

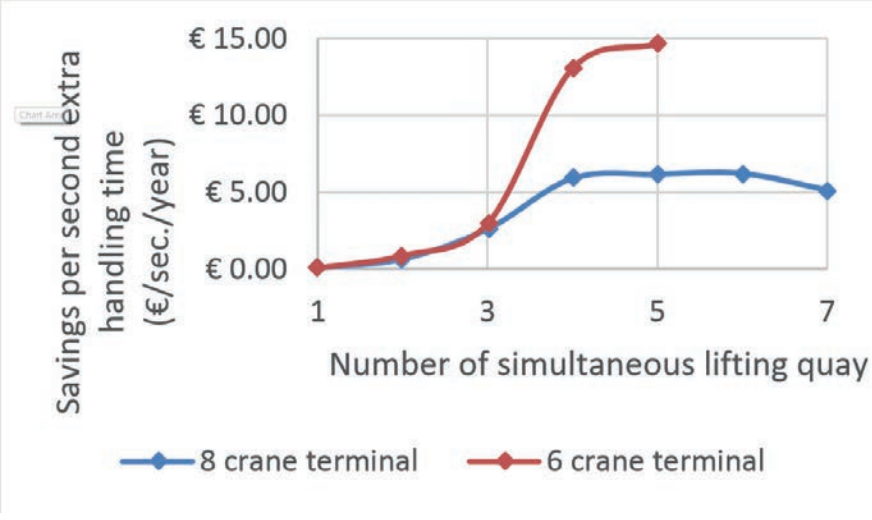
*Option 1: Limiting number of lifting quay cranes*

If the number of lifting STS cranes is reduced, the peak demand decreases, as shown in fig 1. What is striking is that the handling time does not increase in the same proportion. A reduction to four lifting cranes leads to an extra handling time of 0.37% (i.e. less than half a minute per hour). The handling time is not impacted significantly because of the fact that the maximum peak demand with eight cranes (around 19,000kW) occurs only briefly. As shown by fig 2, for a peak demand of 19,000kW, an energy demand of more than 9,000kW occurs only 1.1% of the time. Most of the time, the energy demand is lower than 9,000kW.

As can be concluded from fig. 1, restricting the number of simultaneously lifting quay cranes has a positive influence



on reducing peak demand. If one looks at the impact on cost savings on the one hand and handling time on the other hand, one can see the most cost-effective scenario (i.e. yearly savings per extra second handling time) and the total cost reduction against a particular extra handling time. The optimal cost-effective implementation is to reduce the number of lifting quay cranes to six (eight-crane terminal) or five (six-crane terminal) as can be seen in fig 3. In these cases, the savings per extra second handling time are higher than for other scenarios.

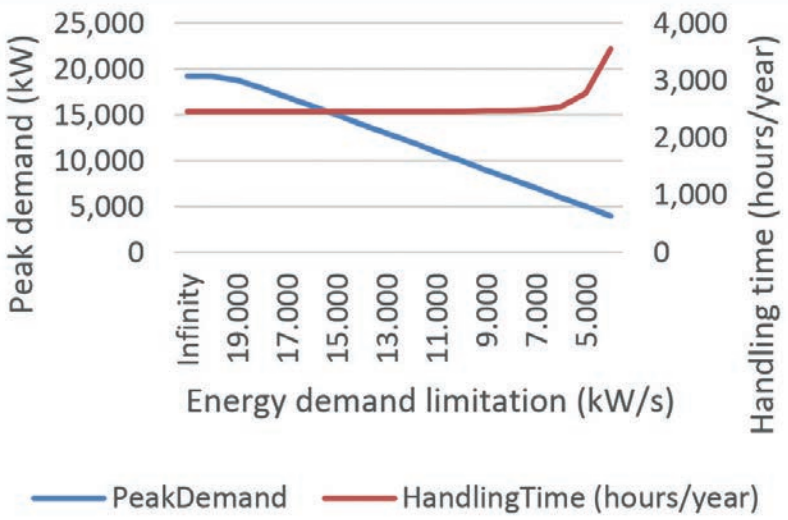
If one looks at the total yearly savings against an extra handling time of less than 1.0%, the number of quay cranes can be limited even more. In the case of an eight-crane terminal, this could result in a reduction to four lifting cranes. This saves $231,500, which is 39% of the peak-related costs. For a six-crane terminal, this would result in a reduction to three lifting cranes, which saves $184,000 (reducing total peak demand costs by 38%).

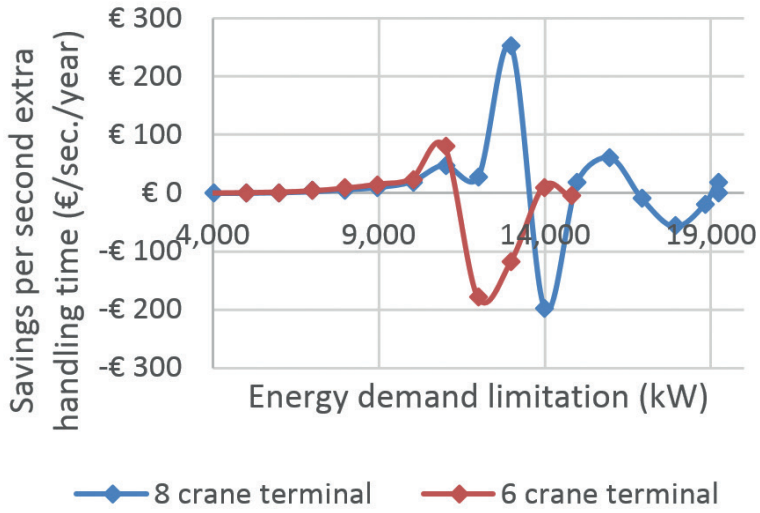
*Option 2: Results for limiting maximum energy demand*

To limit the maximum energy demand per second, the relation between the maximum allowed energy demand and handling time (see fig 4) is comparable to the situation where the number of simultaneously lifting STS cranes is limited. The maximum energy demand can be reduced by almost 50% (from 19,000kW to 9,000kW), while the handling time increases by 0.1%. Only by restricting the energy demand too much (to less than 6,000kW) does the handling time increase by 3–45%.

Restricting the maximum allowed energy demand has a positive influence on reducing terminals' peak demand. The influence on handling time is only minimal when the allowed energy demand is reduced by approximately less than 50%, whereas it enables terminals to reduce their peak-related energy costs hugely.

When the total savings per year are divided by the extra handling time needed to handle all containers on a yearly basis, the savings per second are obtained, as shown in figure 5. For the eight-crane terminal, there is a clear optimum if the maximum demand is reduced to 14,000kW. In this case, the savings are $167,450 per year, while the handling time is 0.01% faster. This results in a negative saving of $234 per second. Restricting the energy demand to 17,000kW, 18,000kW, or 19,000kW also results in a negative saving. However, in these cases, the total savings are only $14,253 to $72,453. Restricting the energy demand to 13,000kW gives a saving of $298.76 per second, absolutely the highest saving seen.




For the six-crane terminal, the highest (negative) saving per second is obtained by reducing the maximum energy demand to 12,000kW (-$214.12 per second) or 13,000kW (-$137.60 per second), saving the terminal, respectively $95,020 or $62,951 per year. The highest positive value (meaning a saving against extra handling time) is achieved by reducing the energy demand to 11,000kW. This saves $94.29 per second against an extra handling time of 0.01% and a total cost saving of $127,073.

## ANALYSES OF RESULTS

The outcomes show a clear result: it is possible to reduce peak energy demand, saving up to $296,858 per year against a little extra handling time (in some scenarios without extra handling time). The bigger the restriction of the rules of operation is, the larger the effect on the operations, as visualized by the number of temporarily delayed containers. However, since more and more container terminals are operating automatically, this can be integrated in the terminals' software. The delay of containers should not be a problem if one of the rules of operation is implemented.

Regarding total cost savings, the optimal solution is to reduce the maximum energy demand per second by 50% of the original highest observed energy demand. By doing this, $189,989

to $295,671 (40–48% of peak-related costs) can be saved annually. The impact on terminal operations is small, as the extra handling time is only 0.1% and the number of temporarily delayed containers is 2.2–3.7%. The savings per second are $18.44 to $23.88.

If the savings per second extra handling time are considered to be more important than the total annual savings (for example to compensate container carriers, see next section), the maximum energy demand can be reduced by 30–35% (13,000kW/s–14,000kW/s) for an eight-crane terminal or by 5–15% for a six-crane terminal (12,000 kW/s–13,000kW/s). Because the handling time is hardly affected, the extra savings per second are very high, especially because some of these scenarios showed a small quicker handling time against a restricted energy demand.

If the number of lifting quay cranes is reduced by 50%, the peak-related costs are reduced by approximately 40% (saving up to $231,537 per year). The extra handling time is only 0.37–0.44% (less than half a minute per hour handling time) against a saving of $3.51–$7.02 per second extra handling time. By reducing the number of simultaneously lifting quay cranes by less than 50%, the total savings are less, but the savings per second do not increase. By reducing the number of lifting quay cranes by more than 50%, peak energy demand decreases even further, but the handling time increases drastically. The optimal solution would therefore be to reduce the number of simultaneously lifting quay cranes by 50%.

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## ABOUT THE AUTHOR

Harry Geerlings is (port) professor in Governance of Sustainable Mobility at the Erasmus School of Social and Behavioural Sciences (ESSB) of the Erasmus University Rotterdam, The Netherlands. In his research he covers a wide range of topics such as the energy consumption of container terminals and the future of ports.

Ron van Duin is Research Professor Port & City Logistics at the Rotterdam University of Applied Sciences and Assistant Professor at the Department Engineering Systems and Services at Delft University of Technology. As a researcher he has worked on numerous studies concerning, (city) logistics, (intermodal) freight transport, infrastructure, ports, and terminals. His main interests are in research in sustainability, efficiencies, cost and quality impacts of new technologies in freight transport and logistics.

Robert Heij studied Engineering Systems and Services at the Delft University of Technology, the Netherlands. Robert suffered from an aggressive form of cancer and on 7 June 2015, Robert Heij passed away after one year of illness. Robert's work was excellent and he was awarded in 2015 with the SmartPort "best thesis award" in Rotterdam. We promised to continue his work. Therefore, in tribute to his memory, this contribution is dedicated to Robert.

## ABOUT THE ORGANIZATION

Founded in 2013, Erasmus University Rotterdam is a highly-ranked international research university within the Netherlands, with a student population of 23,000 and a research community of circa 1,400 scholars.

The Rotterdam University of Applied Sciences, also known as Hogeschool Rotterdam, is a vocational university located in the city of Rotterdam, the Netherlands. It was created in 1988 by a large scale merger of 19 higher educational schools.

Delft University of technology, also know as TU Delft, is 175 years old in 2017. It is the largest and oldest Dutch public technological university, located in Delft, the Netherlands.

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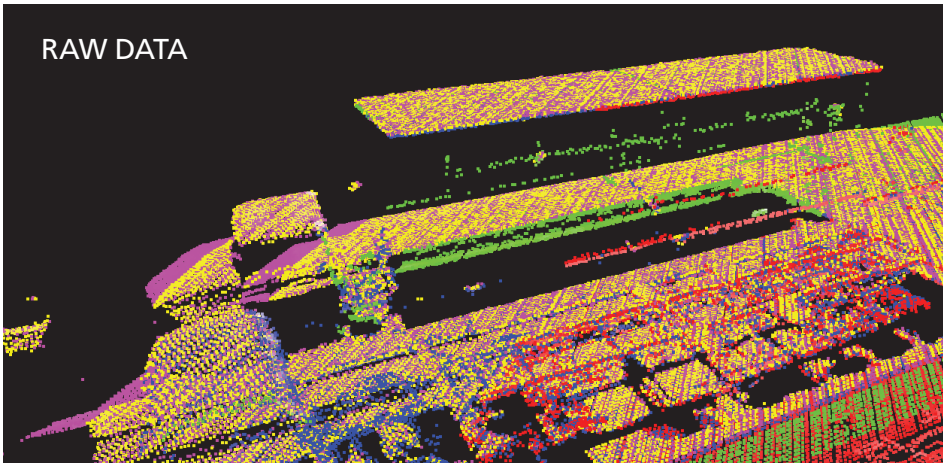


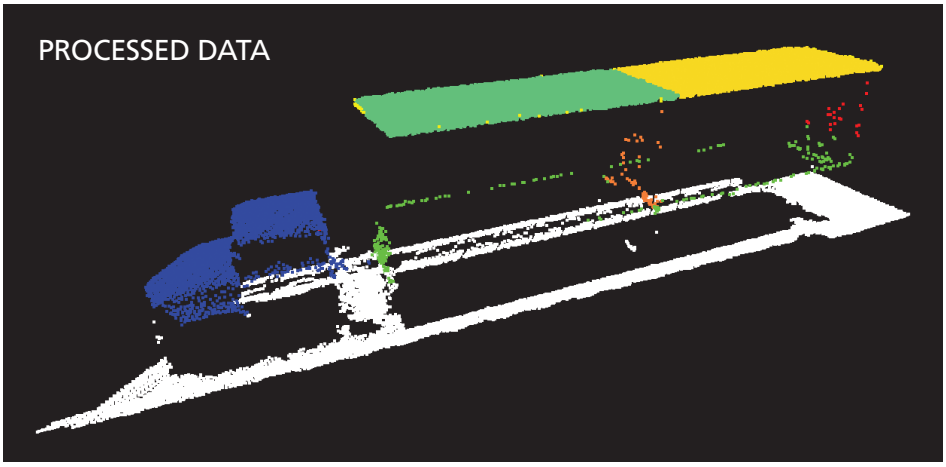


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