PORT TECHNOLOGY

EDITION 118 - 2022

THE E-JOURNAL OF PORTS AND TERMINALS

CONTAINER TERMINAL AUTOMATION

THERE IS ~~NO~~ **IT** IN **INFRASTRUCTURE**!

INFORM

The world is changing. The rule of thumb that Investments in concrete and steel will deliver a strong ROI are no longer certain. It is time to challenge the age old adage that IT and infrastructure projects are separate. When planning infrastructure projects, you need to be considering the impact AI and optimization software will have on your overall requirements. Afterall, INFORM's software based solutions deliver huge ROI on their own and when factored into infrastructure projects at the planning stage strengthen the ROI proposition of your traditional concrete and steel assets as well. **#challengeyourself**

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FROM THE EDITOR

Vessel call sizes are increasing. Schedule reliability is at its lowest ever. Inland supply chains face bottlenecks at rates rarely seen in the logistics sector.

Challenges faced by ports and terminals is putting the streamlining of processes at premium value; and bringing in automated solutions will be a key investment consideration for the years ahead.

This PTI 118 Container Terminal Automation Conference (CTAC) edition of our E-Journal aligns with Port Technology International's flagship networking event held at the Chelsea Harbour on 9 & 10 March 2022.

Gathering stakeholders for our first in-person CTAC since 2019, we are thrilled to welcome so many returning – and new – faces to discuss the latest challenges, innovations, and insights into terminal automation.

And, we are delighted to bring you some of those insights in this edition of the journal!

Our partners Camco Technologies have submitted their contribution on the benefits of Optical Character Recognition (OCR) and Optical Feature Recognition (OFR) in optimising terminals. Reducing truck and container turnaround times is a vital challenge as congestion in ports continues to grow. Camco's solutions will be a factor in driving down trucking waiting times.

Partners BEUMER Group have highlighted the potential of their automated products in the bulk sector. A fascinating editorial piece on a recent project conducted on the island of Borneo shows how the company can transform ship loading through automation.

From the operational, we move to the digital side of a port complex. We welcome back Navis, giving their top three tips on minimising berth wait times. Digitalisation, data management, and leveraging AI and Machine Learning technologies: these three tenets are critical to automate processes and create a stronger, faster, and smarter terminal.

This edition is also jampacked with some of the smartest port operators in the world and their experiences in utilising automation.

The Hamburg Port Authority and HHLA Sky have continually been at the forefront of improving operations through drone technology. With a Drones-as-a-Service pilot on the way later this year, this editorial piece highlights the learnings and scalability of automating drones for a complete picture of port operations.

Further north, at the Port of Tallinn, an automated mooring solution is just one project on the agenda for the Estonian port. With prodigious potential in the container terminal sector, the port authority and local terminal operator HHLA have collaborated to discuss priorities for automation at its facilities.

Finally, I had the pleasure of speaking with the brightest minds at APM Terminals and its automation priorities for 2022 and beyond. With a plethora of terminals globally and varying degrees of supply chain maturity, we dug deeper into automation investment ethos, progress on standardisation, and the emerging cyber-threat facing terminal operators.

Jack Donnelly
Head of Editorial

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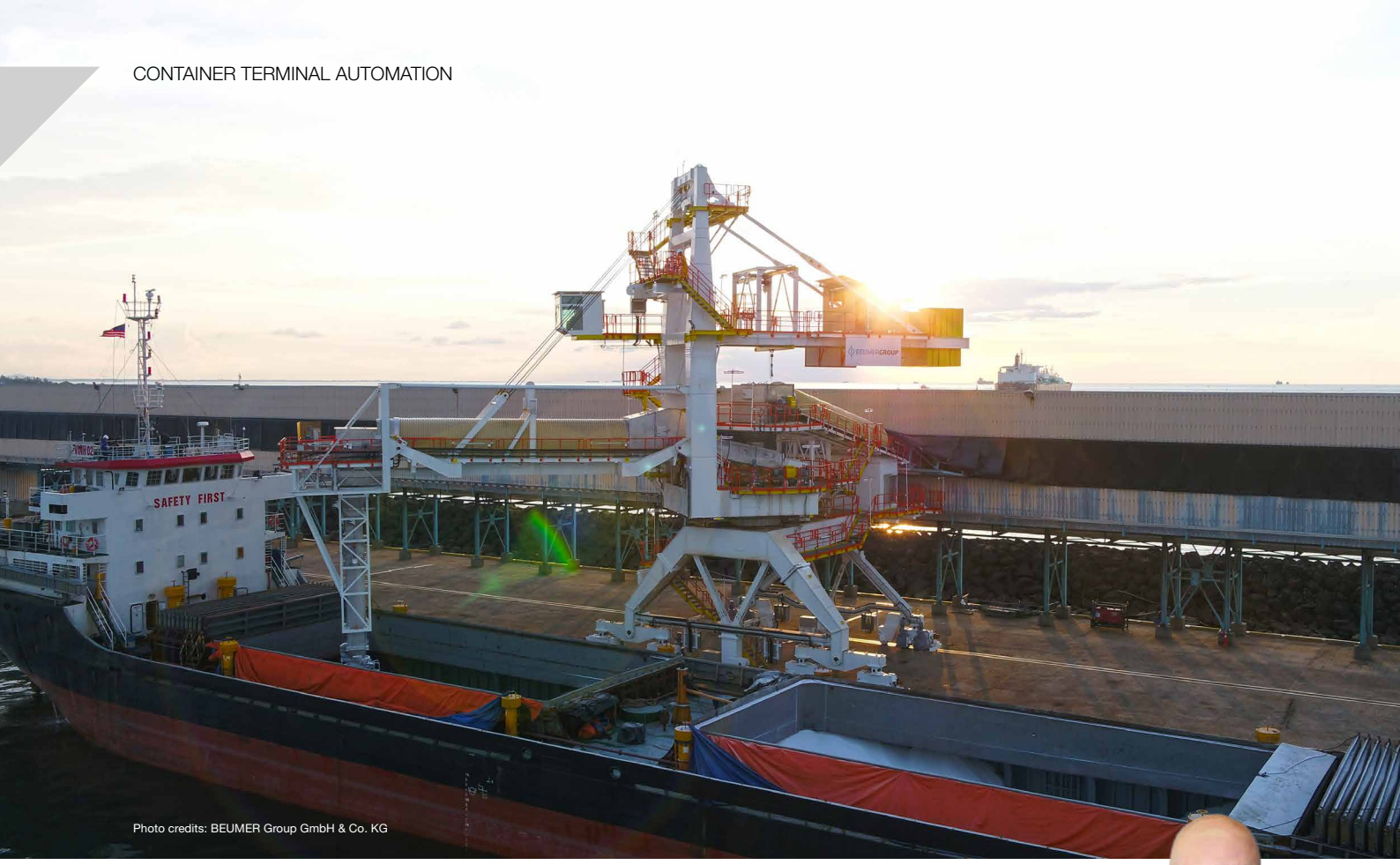


Photo credits: BEUMER Group GmbH & Co. KG

The new system loads the urea fertiliser fast and reliably onto ships in the port of Bintulu.

PERFECT TIMING

Heinrich Beintmann, Senior Project Manager, BEUMER Group

Since the 1980s, Asean Bintulu Fertilizer (ABF), a subsidiary of the leading Chemical manufacturer in Southeast Asia, Petronas Chemicals Group Berhad, has a production location for carbamide fertiliser (urea) in the Malaysian coastal city of Bintulu (Sarawak) on the island of Borneo. To meet growing demands, BEUMER Group was contracted to modernise and increase the performance of the plant between the longitudinal stockyard and the ship loading system. The scheduling was very streamlined.

Carbamide, also known as urea, is currently the most widely used nitrogen fertiliser in agricultural industries worldwide, mainly due to its comparably low costs. The demand is continuously increasing due to our growing global population. The manufacturing plant in the coastal town of Bintulu on the Malaysian island of Borneo has been one of the biggest of its kind in Asia for many years. It is operated by Asean Bintulu Fertilizer Snd. Bhd., a subsidiary of Petronas Chemicals Group Berhad (PCG).

PCG is one of the largest manufacturers of chemical products in Southeast Asia and the leading producer in Malaysia. 25 companies are part of the group, offering a wide range of chemical products, such as olefins, polymers, methanol and fertilisers, which are urea-based for example. Their customers are based in about 30 different countries. The most important markets include Malaysia, China, India, Thailand, Indonesia, Japan, South Korea, Taiwan, the Philippines, Vietnam, Singapore, Australia and New Zealand.

To meet the growing demand for urea, Asean Bintulu had to increase the capacity of its export facilities. BEUMER Group was awarded with the contract as a general contractor, and in a consortium with the PBJV Group Sdn Bhd from Malaysia, who took over the assembly of the system. The service provider from Malaysia is responsible for the transport

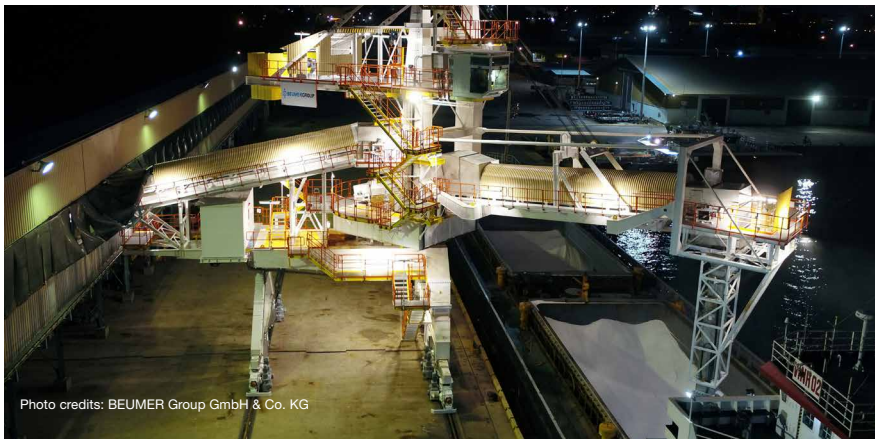


Photo credits: BEUMER Group GmbH & Co. KG

It is in operation 24/7 hours at the port.

Shiploader before starting into operation

“BEUMER GROUP HAD TO INTEGRATE THE NEW SYSTEMS INTO THE EXISTING ONES IN A WAY THAT ENSURED THAT THE MATERIAL FLOW TO THE SHIP WAS NOT INTERRUPTED”

and installation of onshore and offshore pipelines, in addition to other activities. The company also equips ships for their respective jobs in the oil and gas industries.

COMPELLING ENGINEERING AND TIME MANAGEMENT

This order was a brownfield project. This means that BEUMER Group had to integrate the new systems into the existing ones in a way that ensured that the material flow from the longitudinal stockyard to the ship was not interrupted. Another requirement was that the already available hardware and software components from third-party suppliers needed to be updated to match the increased performance. The maintenance of the entire system will become a lot easier thanks to this modernisation, because all components are on the same technical standard. BEUMER Group, in cooperation with PBJV Group, developed a technical solution which they presented to ABF together with a schedule that met all the required milestones. Asean Bintulu Fertilizer was convinced by the system provider’s hard work over the course of the proposal phase.

ABF's production location is running 24/7. To minimise the downtime, BEUMER Group had only 55 days scheduled to complete the entire integration, which was quite a challenge. BEUMER Group took over project management and engineering, supplied all the systems and supervised installation and commissioning.

The scope of supply included a portal reclaimer for 600 tonnes per hour (t/h), the ship loader for 1,000 t/h, a fully automatic tripper conveyor for filling the longitudinal stockpile, a mimic panel to comfortably monitor and control the system, the adjustment of the motor control units, a substation, a transfer station with a capacity of 1,000 t/h and a screening station, the most critical element in the schedule. The system supplier installed a solution with a capacity of 2 x 500 t/h. BEUMER Group had to disassemble the existing screening station down to the main supports of the building and provide it with entirely new technology.

The transfer station divides the material flow towards ship loading and truck loading. This allows the customer to load either ships or trucks or both at the same time. The assembly of the portal reclaimer and ship loader was less time-critical, because the team could start working on it already prior to the 55-day shutdown, before the production plant was closed down. The assembly of the portal reclaimer in the longitudinal stockpile offered an entirely different challenge. The low ceiling height made it impossible to assemble the reclaimer on the floor and then set it up. The system supplier had to find another solution: here they had to assemble segment by segment. Challenging and time consuming.

BEUMER and PBJV were up for the challenge, and, in close cooperation, developed installation drawings and procedures for each work package, in compliance with the strict safety requirements of all parties involved.

The portal reclaimer removes the bulk material in layers from the side slopes and transports it through a primary crusher to a belt conveyor at a capacity of 600 t/h.

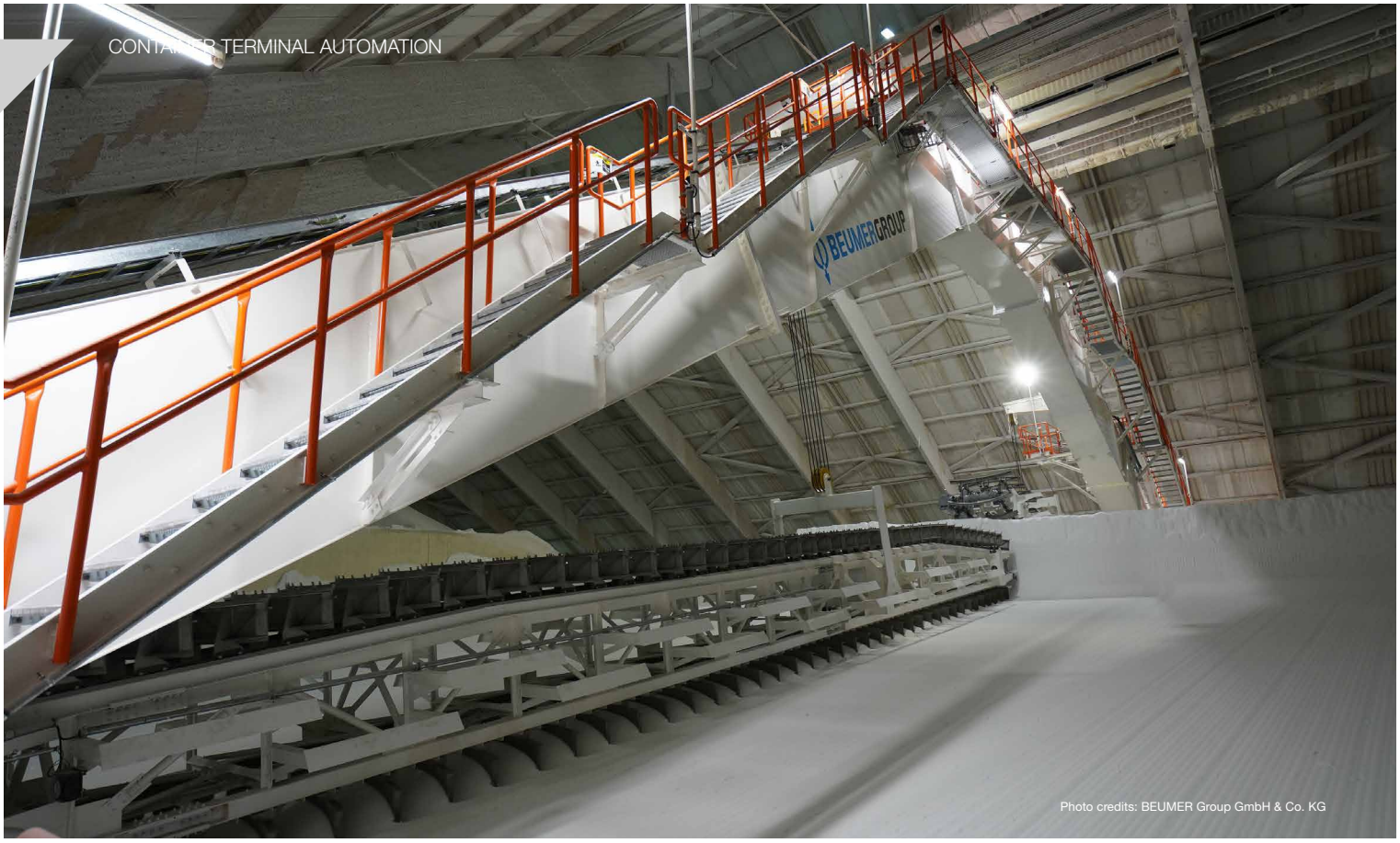


Photo credits: BEUMER Group GmbH & Co. KG

The portal reclaimer is fully automated.

"BEUMER CONTINUOUSLY DEVELOPS NOT ONLY ITS OWN PRODUCTS FURTHER, BUT ITS CUSTOMER SUPPORT TAKES CARE OF UPGRADING MECHANICAL AND CONTROL TECHNOLOGY MANUFACTURED BY THIRD-PARTIES."

ADAPTED TO THE PERFORMANCE REQUIREMENTS

The portal reclaimer traverses the longitudinal stockpile with the urea fertiliser, removes the bulk material in layers from the side slopes and transports it through a primary crusher to a belt conveyor at a capacity of 600 t/h. The portal reclaimer is fully automated. An existing side reclaimer adds another 400 t/h from a second longitudinal stockpile into the system.

The existing belt conveyor systems were not designed for the higher performance of the new portal reclaimer. Which meant that the system provider had to upgrade the drive stations already in place. No problem for the system supplier: all systems used by the customer should seamlessly interlock.

BEUMER continuously develops not only its own products further, but its Customer Support takes care of upgrading mechanical and control technology manufactured by third-parties. The client is very satisfied with the conversion concept, as the aim is to preserve already existing structures as far as possible. This helps companies to reduce their costs, by reducing the number of necessary components and ensuring fast return on investment. Adding shorter installation and handover times was also particularly important with this project.

EFFICIENT SHIP LOADING

Belt conveyors transport the urea over the screening and transfer stations to the new ship loader, also supplied by BEUMER Group. The mobile and swivel-mounted ship loader has a telescopic chute and a throw-off belt conveyor to make loading as efficient and flexible as possible. With this system, the customer can now load ships with 1,000 t/h.

Petronas and Asean Bintulu Fertilizer are completely satisfied with the solutions, the progression of the project and the work of the BEUMER and PBJV consortium. The commissioning for the ship loader took less than three weeks, the entire system was completely commissioned after eight weeks and handed over to the operator.

ABOUT THE AUTHOR

Heinrich Beintmann has been with the BEUMER Group since July 2011. As a Project Engineer, he took over the sales of curved overland conveyor systems. Afterwards he became Project Manager for conveying and loading systems. Since June 2017 he is Senior Project Manager.

ABOUT THE ORGANISATION

BEUMER Group is an international leader in the manufacture of intralogistics systems for conveying, loading, palletising, packaging, sortation, and distribution. With 4,500 employees worldwide, BEUMER Group has annual sales of about €950 million. BEUMER Group and its group companies and sales agencies provide their customers with high-quality system solutions and an extensive customer support network.

PORT OF TALLINN
The Port of Good News

AUTOMATION IN TALLINN - FROM MOORING OF PASSENGER SHIPS TO CONTAINER HANDLING

Port of Tallinn featuring comment from Valdo Kalm, Chief Executive, Port of Tallinn, and Riia Sillave, Chief Executive, HHLA TK Estonia AS

Automation, cost, energy and human labour saving are the keywords in today's logistics, to achieve both efficiency as well as move towards an environmentally more sustainable logistics value chain. In late 2021, Port of Tallinn and HHLA TK Estonia container terminal introduced two new automation processes, that follow exactly these principles. Namely – the ships sailing on the Tallinn-Helsinki route are served by automooring equipment in the Old City Harbour and all truck traffic to and from Port of Muuga's container terminal is operated by an automated gate system respectively.

AUTOMOORING OF PASSENGER SHIPS

Tallinn-Helsinki shipping route is one of the busiest in Europe between two capitals, with annual passenger levels on pre-Covid times reaching over 8.8 million. Three shipping companies with five vessels serve passengers with 11 departures a day.

"Port of Tallinn's ambition is to be the most innovative sea gate on the Baltic Sea," commented Chief Executive of the Port of Tallinn, Valdo Kalm. "We have set in our strategy a clear goal of establishing environmentally sustainable solutions for ships, passengers and buildings and installing an automooring system follows that goal exactly."

Previously at Port of Tallinn's Old City harbour the traditional way was used. Linemen with mooring lines and bollards helped the ship moor at the quay – a process of at least 10 or more minutes. With the vacuum automooring equipment installed in December of last year, the same process takes less than two minutes, and the time when the ship is released is measured in seconds.

The direct benefits of automooring are twofold. First is the time saved on each mooring. But as important is the

FACTBOX:

AUTOMOORING

- Quays 5, 12 and 13 in the Old City harbour. Quays 5&12 were equipped with the equipment of Cavotec, Quay 13 with Trelleborg equipment.
- Similar pieces of automooring equipment are installed in the Helsinki West Harbour, the Åland ports in Marienhamn and Langnas.
- Mooring systems were installed in the framework of TWIN-PORT 3 project and are being co-financed by the EU Connecting Europe Facility (CEF). It is a collaboration project between ferry operators (Tallink, Viking Line and Eckerö Line), the ports of Tallinn and Helsinki and the City of Helsinki for the years 2018-2023.

Automooring speeds up the ship mooring and reduces emissions at the port area.

fact that the whole system is remotely controlled and can be operated by one person, the captain.

"Given that with automooring a ship spends less time manoeuvring at the quay, it contributes to cleaner air at the port area and the vessel can sail a little bit slower," Kalm added. "Even five minutes of saved travel time for each travel reduces the ship's fuel consumption and thus also CO2 and other emissions.

"Given there are more than 10 journeys daily, our investment towards better efficiency and automation has also a considerable positive environmental effect."

By estimates, Tallinn's city center will have lower levels of harmful emissions that equal to some 10,000 diesel cars thanks to less time spent manoeuvring at the port. Slower cruising to Helsinki, 80 kilometres from Tallinn, helps to reduce up to 12,000 tonnes of carbon emissions per year.

The new vacuum automooring equipment was installed on the quays serving the Tallinn-Helsinki route. Automated mooring devices can be used in practically all weather conditions- only when the wind is blowing over 17 metres/ second, the mooring lines of the vessel are used for ensured safety.

AUTOMATED TRUCK TRAFFIC AT MUUGA CONTAINER TERMINAL

In addition to an automation solution installed for passenger ships, a new automated gate system was introduced in the HHLA TK Estonia's container terminal located at the cargo port in Muuga, east of Tallinn. The system, which increases the efficiency for terminal operations as well as logistics companies is a first-of-its-kind in the whole HHLA Group.

"Being part of Europe's leading port and transport logistics companies HHLA Group, we are always looking for ways to offer our customers solutions that facilitate smooth and swift trade," said HHLA TK Estonia's Chief Executive, Riia Sillave.

"Our terminal is the largest multimodal container, RoRo and general cargo terminal in Estonia and we are a gateway for East-West and North-South trade corridors. The new system is fully automated from the entry gate to container scanning, load on/load off and departing from the terminal area."

The terminal's system offers an opportunity for logistics companies for better planning by scheduling their visit beforehand, also enabling to plan higher number of visits to the terminal, shortening the trucks' turntime.

"Once inside the terminal area, the turntime in the terminal can be shortened to as little as 10 to 15 minutes," Sillave added.

Given the container traffic volumes – in 2021 HHLA TK Estonia's container

"REDUCING TIME SPENT IN TERMINAL GIVES BETTER TIME MANAGEMENT FOR THE COMPANIES AND DRIVERS ALIKE, AS WELL AS REDUCES THE EMISSIONS OF THE TRUCKS WAITING IDLE"

Once the lorry is checked in, the RTG-operator is automatically notified to start the dispatch process.

FACTBOX:

HHLA TK ESTONIA'S AUTOMATED GATE SYSTEM

- All trucks entering the HHLA TK Estonia terminal will at first drive through an OCR (Optical Character Recognition) gate for container registration.
- After OCR-gate trucks arrive at a terminal gate's self-service kiosk from where the lorry driver sees from a display all relevant information regarding the terminal visit. The truck is checked in at the gate automatically and directed to designated lanes.
- When the lorry is checked in, a notification is automatically sent to the RTG-operator and dispatch process can start.
- Upon departing, the trucks again pass through OCR-gate for container registration, after which the truck is directed to exit the terminal.

terminal handled over 225,000 TEU, with the terminal's capacity reaching 600,000 TEU – shortening the transit time of trucks considerably increases the efficiency of logistics value chain.

"Reducing time spent in terminal gives better time management for the companies and drivers alike, as well as reduces the emissions of the trucks waiting idle," noted Sillave.

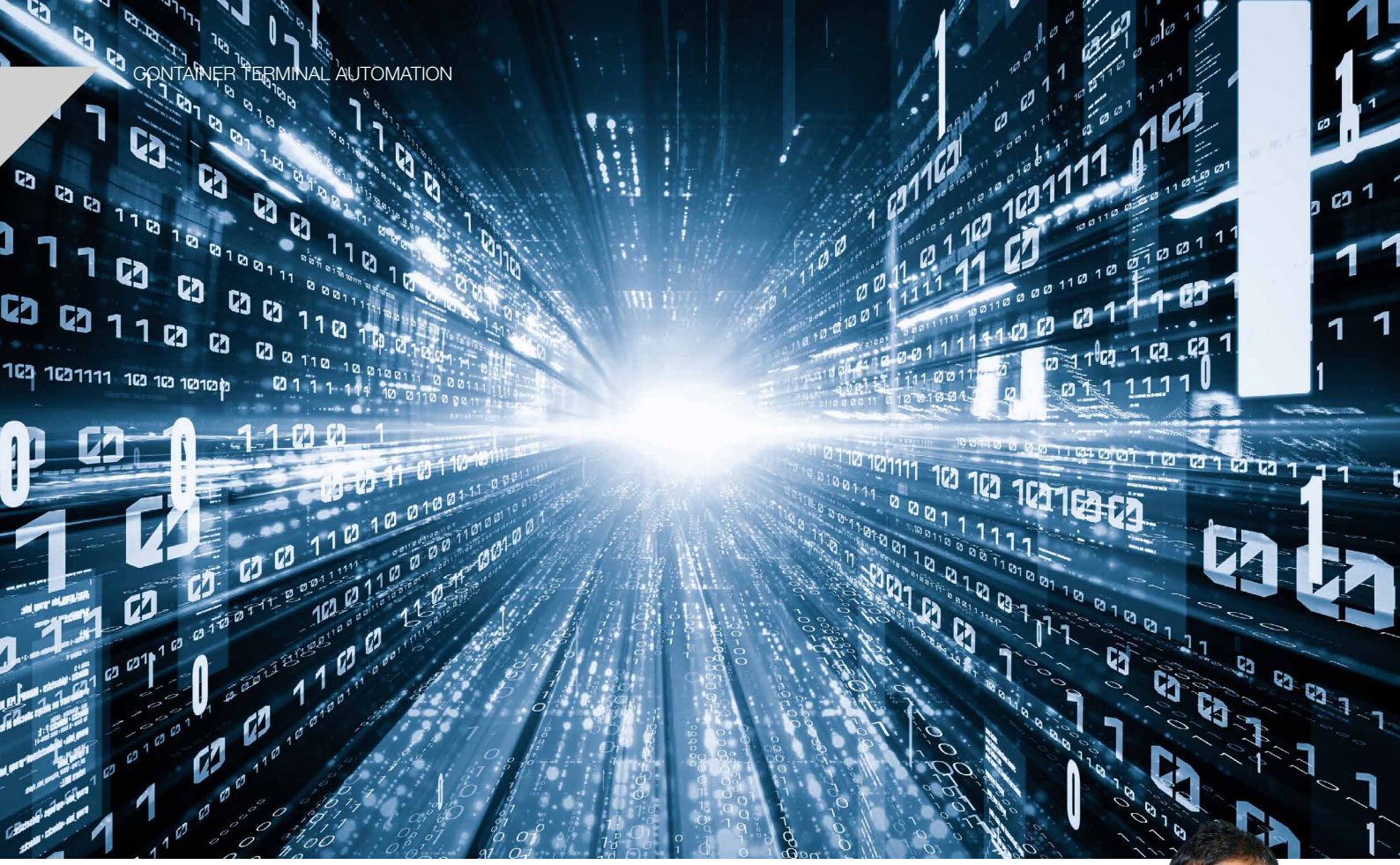
"Noteworthy to add is that full automation reduces the number of direct human contacts required for completing a process – a necessity too familiar to everyone of us those past two years."

"ONCE INSIDE THE TERMINAL AREA, THE TURNTIME IN THE TERMINAL CAN BE SHORTENED TO AS LITTLE AS 10 TO 15 MINUTES"

ABOUT THE ORGANISATION

Port of Tallinn is an intermodal port handling multiple types of cargo as well as passengers, which makes it the biggest port authority in Estonia. Port of Tallinn aims to become the most innovative port on the shores of the Baltic Sea by offering its customers the best environment and sustainable development opportunities.

HHLA TK Estonia is located at the heart of the nodal point of Europe and Asia, ideally positioned on the trade routes between East and West as well as North and South. The terminal services a wide range of vessels in Muuga Harbour, one of the few virtually ice-free harbours in Northern Europe.



THREE WAYS TO MINIMISE CONGESTION AMID INCREASED BERTH WAIT TIMES

Ajay Bharadwaj, Senior Director of Product Management, Navis

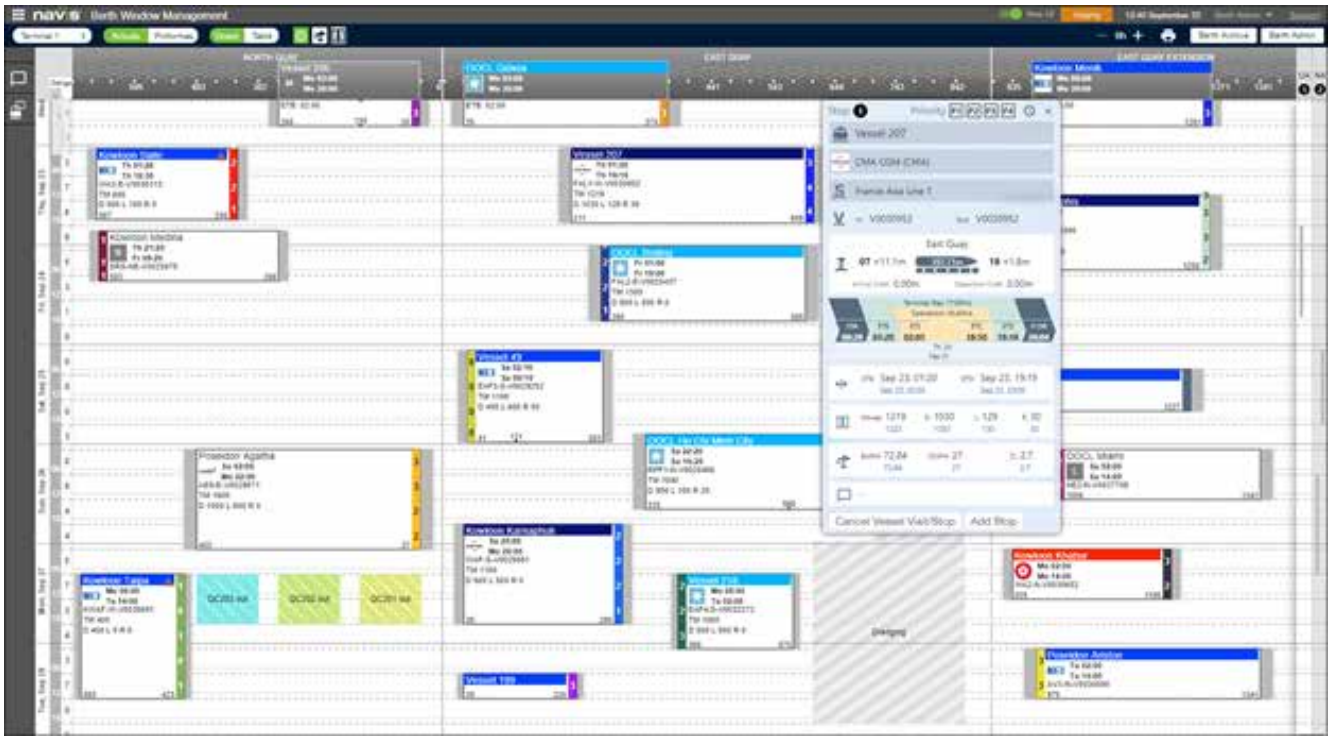
Imagine an airport that tries to operate without a control tower. Planes want to take off and land without any streamlined communication about which gate might be available or what traffic looks like on the runway, and control operators don't know why a plane might be late or even how far away it might be.

It seems unfathomable because, even in the midst of the COVID-19 pandemic, there were nearly 565,000 domestic flights in the US in June 2021. If there weren't strong communication, there would be endless wait times and far fewer flights because demand is so high.

That's essentially how many ports all over the globe are still operating. Consumption of goods has increased worldwide. Yet some port operators are still using archaic planning tools like whiteboards, spreadsheets, or even pen and paper. Berth wait times in North America have roughly quadrupled since May 2019, from approximately eight hours to 32 hours that a vessel anchors waiting for a berth to clear. This has become a worldwide issue that forecasters see continuing for more than a year. Reasons for these wait times are many and complex.

One big pain point is a lack of communication. Unless a port has real-time data and communication tools, vessel crews, carriers, and agents often don't have visibility into berth allocation or when a certain position in a port becomes available for them to dock, unload and load. It is up to the terminal to make those schedules based on their operations. Likewise, terminal operators often don't have visibility on when a vessel will arrive. With today's tools, it is possible to know where the vessel is, but more complicated to have an accurate ETA that allows the terminal to plan its berth space more efficiently. These issues and poor planning often result in wasted time and increased costs.

There are other factors that can cause congestion, as well. The Suez Canal, which was infamously blocked in March 2021, saw another ship get stuck in early September. When the canal that sees 10 per cent of the world's trade flow through it ends up with a traffic jam, there are huge consequences. Even once vessels get to port, terminal operations have seen a pandemic effect,



like many other industries. There are fewer people available to operate the cranes that load and unload cargo, which also leads to hefty delays.

Amid all the delays and interruptions, there are solutions that can help. Let's look at three ways that you can help decrease berth wait times and minimise congestion at ports.

DIGITISE VESSEL BERTH PLANNING AND MANAGEMENT

The marine terminal industry is one of the last industries to adopt new technology. Most vessel planning and operation management today is still done manually. Relying on emails, phone calls, and spreadsheets doesn't allow for real-time changes and can lead to costly mistakes. When there is no way to see data in real-time, there is no possibility of vessel arrival optimisation or preparing for a delay in berth arrivals.

Digitising the vessel planning process allows terminals to eliminate manual tasks associated with scheduling and gain visibility into real-time information to make smarter decisions. That allows vessel crews to manage planning activities like delayed arrivals, shift priorities, and prepare appropriate resources.

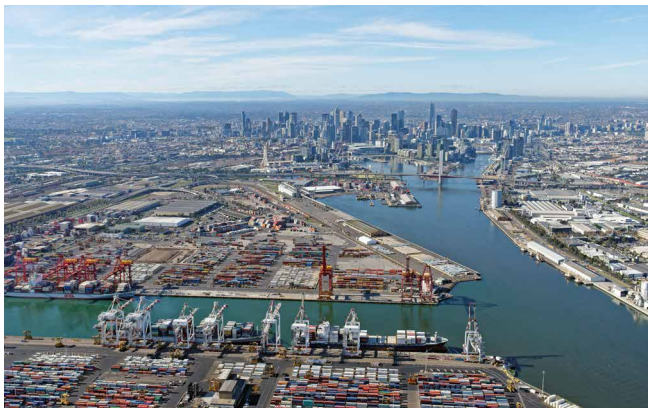
MAKE DATA AVAILABLE FOR VENDORS AND CUSTOMERS

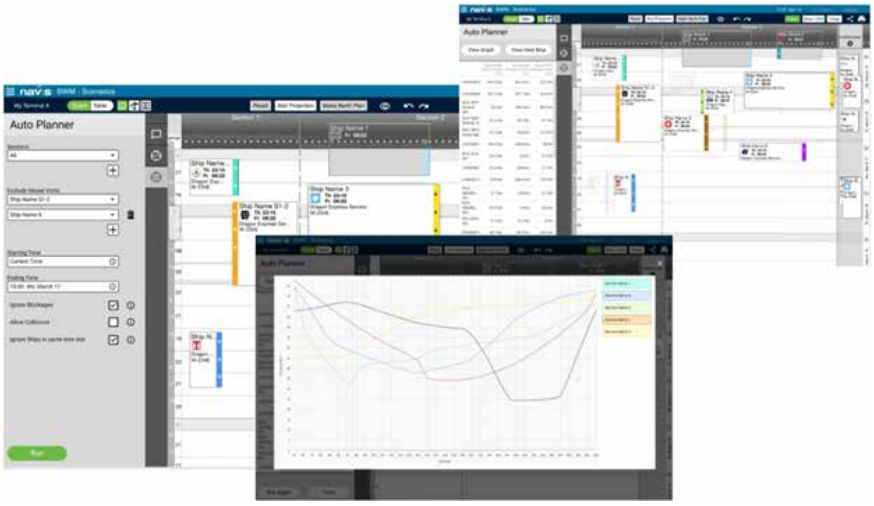
Strong communication isn't enough to solve all potential problems at port. Evolving toward real-time data exchange will allow for true collaboration among all the stakeholders involved in moving cargo. If one side has visibility into the other with real-time data, it reduces last-minute calls and emails.

If the terminal knows in real time that a particular vessel is delayed or ahead of schedule, it can either accommodate the vessel in a slot that fits its arrival time, or communicate with the agent so the vessel adjusts its speed to the corresponding schedule.

The same is true for departure. Greater visibility of a vessel's estimated completion time of operations enables agents to close tasks, allows the port's technical-nautical resources to be available at the appointed time, and

"WITH WAIT TIMES CONTINUING TO DRAG ON LONGER AND LONGER, AND FORECASTERS PREDICTING THESE LAGS WILL PERSIST, NOW IS THE TIME TO TAKE ACTION."





"AS ML CONTINUOUSLY LEARNS, YOUR SYSTEM MAY BE ABLE TO AUTOMATE RESOLUTIONS TO PARTICULAR ISSUES."

makes it easier for the next port to optimise its operations.

One of Australia's biggest port and supply chain operators with multiple terminals solved this problem with a cloud-based, multi-terminal management system. After implementation, the port has real-time visibility of the consequence of a late- or early-arriving vessel and any delay in terminal. Management, maintenance, and monitoring are all centralised and communicated digitally, which reduces manual tasks.

Terminals can make use of idle time on their quays by preparing for upcoming vessels and housekeeping their yards. With enough notice, they can even rebook their labour, providing cost savings for the end customers. If terminals have a better sense of what cargo will make cutoffs, they can improve their yards to avoid future unproductive moves and better utilise their space.

Data sharing offers a more complete picture when optimising operations, reducing the distances traveled by the cargo handling equipment (CHE), optimising the number of gangs, and maximising berth occupancy. Cloud-based tools enable real-time visibility between terminals and vessels, which makes that technology among the most valuable pieces of the puzzle for a terminal as it streamlines operations.

LEVERAGE AI AND ML

In addition to digitising operations, it's essential to leverage artificial intelligence (AI) and machine learning (ML) with Terminal Operating System (TOS) data. The connection between vessel planning and the TOS is the first key to managing the operations. To take it a step further, terminals can leverage AI and ML algorithms to learn past behaviors, trends, and recurring issues and predict and prevent possible future issues. As ML continuously learns, your system may be able to automate resolutions to particular issues if there has been a consistent way of resolving that same issue.

There are many solutions out there leveraging AI and ML. An example would be relying on an optimisation engine that takes into account new data points and comes up with a suggestion on where to berth your vessel in a big terminal with long quay miles. Using ML, a large terminal can save up to 20 per cent in CHE driving distances, lower fuel consumption, and reduce operational costs.

With wait times continuing to drag on longer and longer, and forecasters predicting these lags will persist, now is the time to take action. These proven solutions can help reduce the chaos and bring organisation to terminals that are busier than ever.

ABOUT THE AUTHOR

Ajay Bharadwaj is Senior Director, Product Management at Navis. He's responsible for Navis's cloud initiatives, SaaS application offerings and Carrier and Vessel Solutions. Ajay brings 15+ years of experience in building and launching products, cloud, security, pricing and licensing models. Ajay has degrees in Computer Science and a MBA from the University of California, Los Angeles.

ABOUT THE ORGANISATION

Navis is a provider of operational technologies and services that unlock greater performance and efficiency for the world's leading organisations across the cargo supply chain. Navis combines industry best practices with innovative technology and world-class services, to provide comprehensive management of the supply chain for safer, smarter and more efficient cargo operations. Navis Rail offers a SaaS suite for the planning and optimisation of freight railroads including the network, schedule, traffic cars, locomotives and crew. www.navis.com

"EVOLVING TOWARD REAL-TIME DATA EXCHANGE WILL ALLOW FOR TRUE COLLABORATION AMONG ALL THE STAKEHOLDERS INVOLVED IN MOVING CARGO."

APM Terminals Pacific Ltd.



OPTIMISING APM TERMINALS

Jack Donnelly, Editor, PTI, featuring interviews with Gavin Laybourne, Global CIO, APM Terminals, Alan Stott, Senior Director of Industrial Cloud of Infrastructure & Automation, Maersk, and Jack Craig, Global Head of Technical, APM Terminals

Operating 76 terminals in its global network, APM Terminals (APMT) moved over 35 million containers in 2020.

APMT operates terminals with varying degrees of maturities in its supply chains, ranging from APM Terminals Pacific Ltd at the Port of Los Angeles, to the Suez Canal Container Terminal at Port Said, Egypt.

Automated solutions are already in operation in many forms at APMT. An automated gate process uses a Optical Character Recognition (OCR) portal at APM Terminals Gothenburg, recognising container numbers, seals, and dangerous cargo classifications – all without human interaction. The result is faster cargo release to the terminal, reducing the numbers of trucks in a yard and time waiting on entry.

Of course, the pandemic-driven growth on demand in container cargo has resulted in an even higher demand for efficiency and optimisation from ports and terminals.

Automation can take many forms, however. After moving through automated gate systems, cargo can be collected from a vessel by an automated crane system, reducing wasted movements and allowing one controller to optimise Ship-to-Shore (STS) container transfers with multiple cranes. In digital operations, automation implemented to Terminal Operating Software (TOS) can result in box stacking efficiencies, reducing straddle carrier workload and driving down emissions.

"Automation is not just about efficiency," Gavin Laybourne, Global CIO at APMT told PTI.

APMT is taking a modular, individual approach to introducing automation to its terminals. Automated processes, whilst boosting efficiencies, have raised well-documented concerns through its impact on reducing job availability and increased installation and maintenance cost.

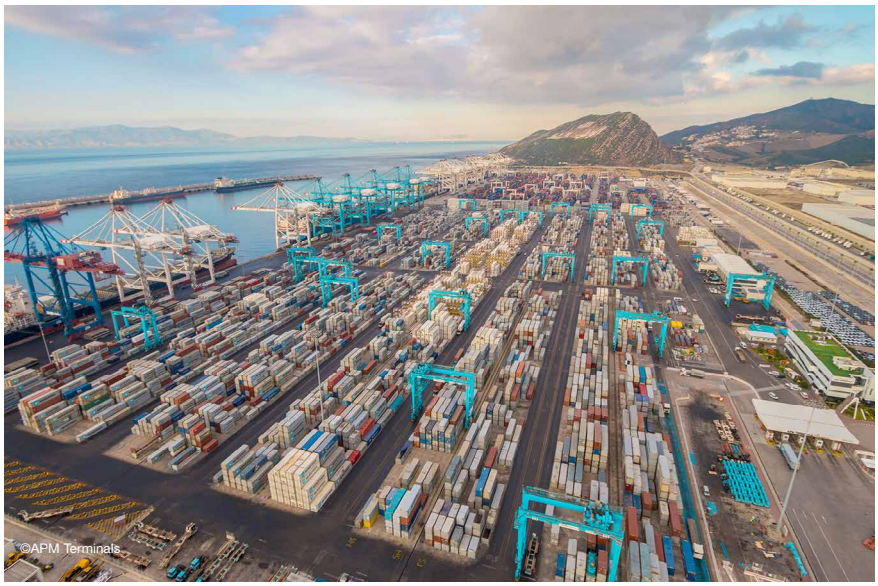
"We play a role in society. For example if you think about some countries where it's okay to [prefer] manual labour in a terminal, going in with automation to replace labour is not our approach," Laybourne continued.

"We take many different lenses on how we are going to automate: is it on safety? Does it link with decarbonisation and the energy transition we are going through? We're asking the question of how automation plays a role in that economy, because there are some countries where we are the only gateway for import and export."

In October 2021, APMT formed an alliance with Chinese equipment giant Shanghai Zhenhua Heavy Industries Company (ZPMC).

The Memorandum of Understanding (MoU) aims to take the relationship from merely transactional to a long-term strategic alliance. Included in the deal is an order for 18 STS and 9 Yard cranes across

"STANDARDISATION GIVES THE WHOLE INDUSTRY A LOWER BARRIER TO ENTRY."



APM Terminals Tangier S.A

6 of APMT's facilities. ZPMC equipment is already present in terminals such as Vado Ligure in Italy and TM2 in Morocco.

Automated processes at APMT's terminals have improved safety through more predictable processes, in addition to reducing emissions through electrified and hybrid yard cranes, adds Jack Craig, Global Head of Operations at APMT.

For the APMT deal with ZPMC, the agreement is an important evolution. Craig explained: "It is our view that the traditional equipment procurement approach in an automated environment is not optimal.

"Automated equipment is part of a system and purchasing it (especially at the project start) is not about buying steel. What this means is that we need less definition of technical specifications that define the approach and more definition of expected outcomes and performances in the overall system.

"We should acknowledge that ports are a challenging operating environment, but progress remains slow and the level of automation remains relatively immature," he said.

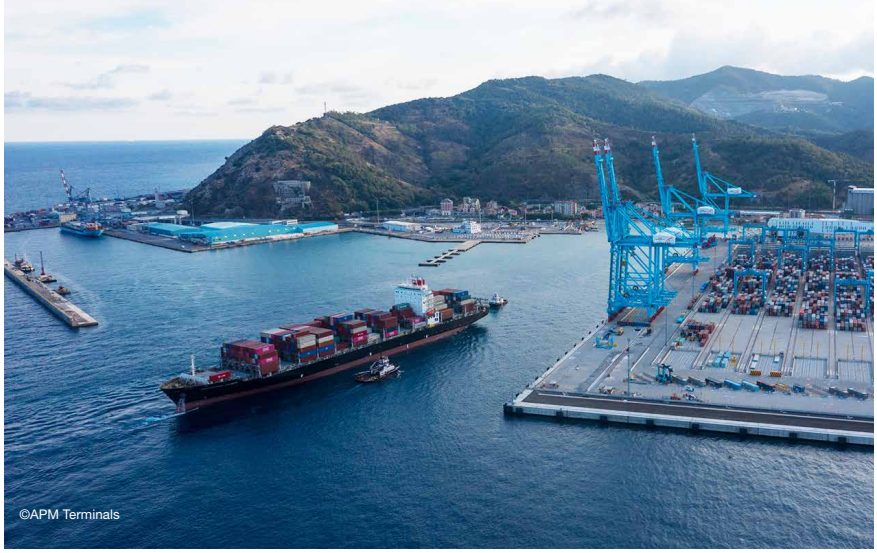
Comparing the automation journey to what can be seen in other industrial sectors, terminals are "playing catch up," continues Craig.

"At the same time, we remain convinced this will continue to improve. I think there is significant opportunity to leverage the thinking and learnings from other sectors to increase the speed of improvement, but this means suppliers and operators need to be humble enough to learn and bold enough to engage."

Taking regional variances into account, a supply chain's capabilities in one nation or region may differ to another: making that modular mindset to implementing automation, piece by piece, critical.

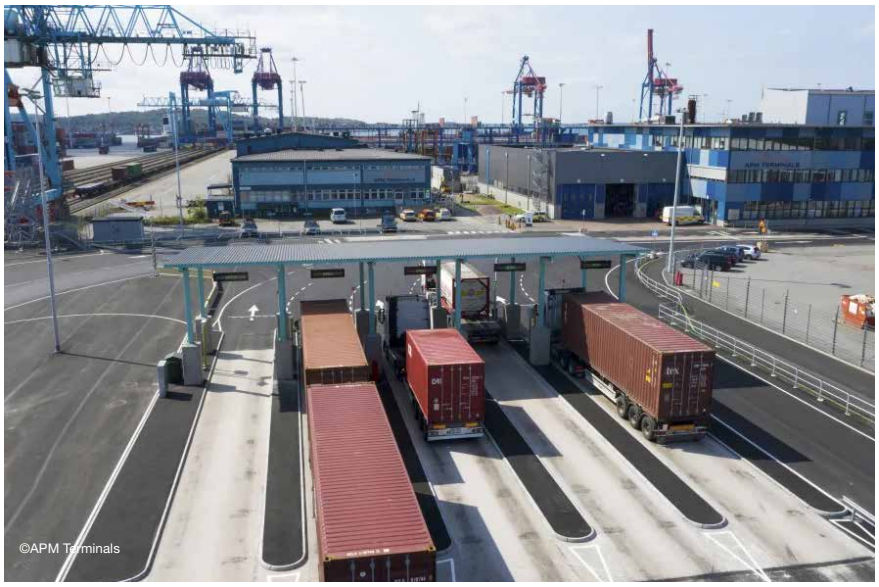
"Comparing Latin America to North America, processes might be standardised across a whole country, for example. Whereas for another country, each port may have differing levels of control for what they can do and what they require you to do," explained Alan Stott, Senior Director of Industrial Cloud of Infrastructure & Automation at Maersk.

"This investment in modularity at an automation level and at a digital level above that allows us to plug into a more standardised market – but also have that agility to dynamically integrate into specific ports with their challenges and requirements."



APM Terminals Vado Ligure Spa

"AUTOMATED EQUIPMENT IS PART OF A SYSTEM AND PURCHASING IT … IS NOT ABOUT BUYING STEEL."



APM Terminals Gothenburg AB

"OUR ATTACK SURFACES HAVE BECOME SO MUCH WIDER AND EXPOSED ON THE OPERATIONAL TECHNOLOGY SIDE."

THE STANDARDS LANDSCAPE

Industry standards in ports and maritime have matured significantly in recent times. The work from the Digital Container Shipping Association (DCSA), for example, to create common frameworks for optimising Just in Time (JIT) arrivals for vessels, is just one example of collaboration to reduce differences in understanding in port and shipping processes.

In terminal automation – particularly in cargo handling equipment – creating a standardised communication framework is a more complex task.

APMT has a vast suite of cargo handling equipment from varying manufacturers including STS and Rubber-Tyred Gantry (RTG) cranes from ZPMC and Liebherr, to straddle carriers from Kalmar.

What this means is that without a basic understanding of each other's processes, utilising IoT connected devices in exchanging data, communication and automating processes of box stacking, vehicle location, and predicting cargo flows between these devices becomes all the more difficult.

"We still have a lack of industry standards," Laybourne said. "Modular automation is something we are taking on, but it needs the industry aligned.

"Standardisation gives the whole industry a lower barrier to entry. Standardisation can put the customer central in a global supply chain, where data can be exchanged on common platforms."

Not only this, but standardising green handling equipment – Kalmar's hybrid shuttle carriers in use at APM Terminals Vado, for example – can open the door for optimisation. Stott adds: "We are partnering with our data gathering and visibility teams to focus on not only how can we electrify, but then how can we use connectivity around data to optimise that newly electrified equipment."

Head of Technical Craig continued: "The lack of industry standards is a significant source of cost, inefficiency and pain for us and our end customers. There are almost no agreed standards around interfaces and other elements and this means every project is unique.

"Plainly speaking, this is a waste of everyone's time and talent. There have been efforts to address this in the past but we have not seen much progress. We need to solve this issue."

AUTOMATED, CONNECTED, AND THE INCREASED CYBER RISK

Enhanced connectivity in a smart port – including in a TOS, a Port Community System (PCS), a suite of STS and RTG cranes and connected terminal operatives – increases the risk of a cyber attack for a terminal operator and the wider supply chain.

In 2022 already we have seen the major Northern European Ports including Rotterdam and Hamburg suffer a cyber attack on its oil terminals. With greater connectivity, an entire supply chain risks paralysis at the hands of criminal or nation-state actors.

"Our attack surfaces have become so much wider and exposed on the Operational Technology side. That keeps me awake at night," Laybourne explained.

For APMT's approach, cyber-defence is now embedded into its way of thinking. Maersk suffered a $300 million loss from a NotPetya malware cyber-attack in 2017. APMT, since that point, has been taking learnings to invest in cybersecurity.

"Cyber-defence is looking at operational technologies and considering how to protect not just the perimeter: it's protection once an actor gets inside a perimeter as well," Laybourne said.

"The investment APMT is putting into cyber-defence is unprecedented compared to five years ago. It has to be embedded with our automation and digitalisation agenda."

Stott reaffirmed the message of his IoT team seeing security as a culture: "We eat, live, and breathe security. It's investment into not just Development Operations – DevOps – but now Development Security Operations (DevSecOps), a continuous investment in security every release cycle.

"The concept of DevSecOps is secure by design. We have it from the first outset of any product or offering, and then it's continuous security with every release cycle from that point onwards."

ABOUT THE ORGANISATION

APM Terminals operates one of the world's most comprehensive port networks. The 76 terminals in its global network are operated exclusively by APM Terminals or together with a joint venture partner. This equates to handling around 250 vessel calls per day and 12.8 million moves per year.

APM Terminals is part of A.P. Moller -Maersk.

FUTURE OF
PORT AUTOMATION

Enhanced with automation technology, our fully electric Automated Guided Vehicles are built for improved environmental sustainability and port productivity.

With a strong track record in engineering excellence, ST Engineering provides a complete suite of automation solutions to enhance port and logistics operations – from AI to IoT, platforms and infrastructure to mega scale project management.

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Credit: T. Indra




DRONE-AS-A-SERVICE FOR PORT OF HAMBURG

AN INNOVATION COOPERATION FOR PORT OF THE FUTURE

Dr. Phanthian Zuesongdham, Head of Division Port Process Solution, Hamburg Port Authority, Christian Bahr, Product and Business Manager – Unmanned Systems, Hamburg Port Authority, Matthias Gronstedt, Managing Director, HHLA Sky, Dieter Küsel, Business Solutions Expert, HHLA Sky

The usages of industrial drones – or UAV or Unmanned Aircraft Systems (UAS) or Remotely Piloted Aircraft (RPA) – have been explored, prototyped, and developed in many industrial segments over the past five years. The technology is vastly advanced at every step and release of its development. According to the recent report in Feb 2022 from Insider Intelligence, the global drones services market size is expecting to grow to $3.6 billion by 2025. Goldman Sachs forecasts the total drone market size to be worth about $100 billion as there is growing demand for drones from the commercial and government sectors. In Europe, Statista has published a prediction of drone commercial revenue in Europe to grow from $837.8 Million in 2021 to $3 Billion in 2025. This results in a potential annual growth of 40 per cent and implies also possibly massive investment in this segment in the coming years.

Port of Hamburg firstly initiated the drone projects in 2019 where we investigated various port-related industrial use cases within this ideal technological playground of an 8,000-hectare port area under a controlled and realistic conditions. The results turned out very promising.

The Hamburg Port Authority (HPA) and HHLA Sky have taken up the leading role in the explorational process of drone use in the Port of Hamburg. While the HPA concentrated on the use cases of how the drone technology could be integrated in the port operation and build up the required drone operation in general, HHLA Sky focused on the highly secured drone operational control platform. The use cases of the HPA in deploying tele-operated drone services primarily

"LICENSING OF OPERATION IN THE ENTIRE PORT AREA IS EXTREMELY SOPHISTICATED AND CHALLENGING DUE TO ITS COMPLEX REQUIREMENTS THROUGHOUT THE AREA."


Credit: T. Indra

included prevention and management of special events like flood or catastrophic scenarios and water area control. These could increase safety and efficiency of the existing processes. The solution of the HHLA Sky provides a highly secured control and management platform for drone services which can be deployed for semi-automated or automated operation.

INTELLIGENT PORT INFRASTRUCTURE

As port infrastructure manager of the Port of Hamburg, the HPA has been implementing new technologies and digitally transforming the port management. Supporting the smartPORT philosophy and the vision to become zero-emission port by 2040, the HPA envisions the usage of 'mobile sensors' enabled by the drone technology as crucial complementary services for the future port operation.

In the field of intelligent port infrastructure management, sensor data derived from the drone services can be integrated into 'digital twin environment' additionally to existing manual inspection processes. The additional sensor data allows real-time evaluation which leads to reduced lead time in follow-up maintenance tasks. Furthermore, automated acquisition routines will enable denser data sets in the future, resulting in significantly more detailed and overall updated images of facilities and objects within port. This form of automated data processing can be used in extensive and comprehensive simulations which also enable the HPA to perform predictive maintenance throughout the lifecycle in the asset management scheme. With this capability, the HPA will be able to leverage overall service levels of the port infrastructure with more smart and secure means.

In the exploration phase, the HPA quickly identified the benefits of drone services that can be integrated in the situational analysis process for various scenarios like storm surges, accidents, or incidents in ports. With these services, real-time high resolutions images, videos or other sensor data can support the operation team in assessing the situation swiftly. This information can be provided straight to control rooms or situation centres, where it will be evaluated for timely decision-making in critical situations.

HASTA

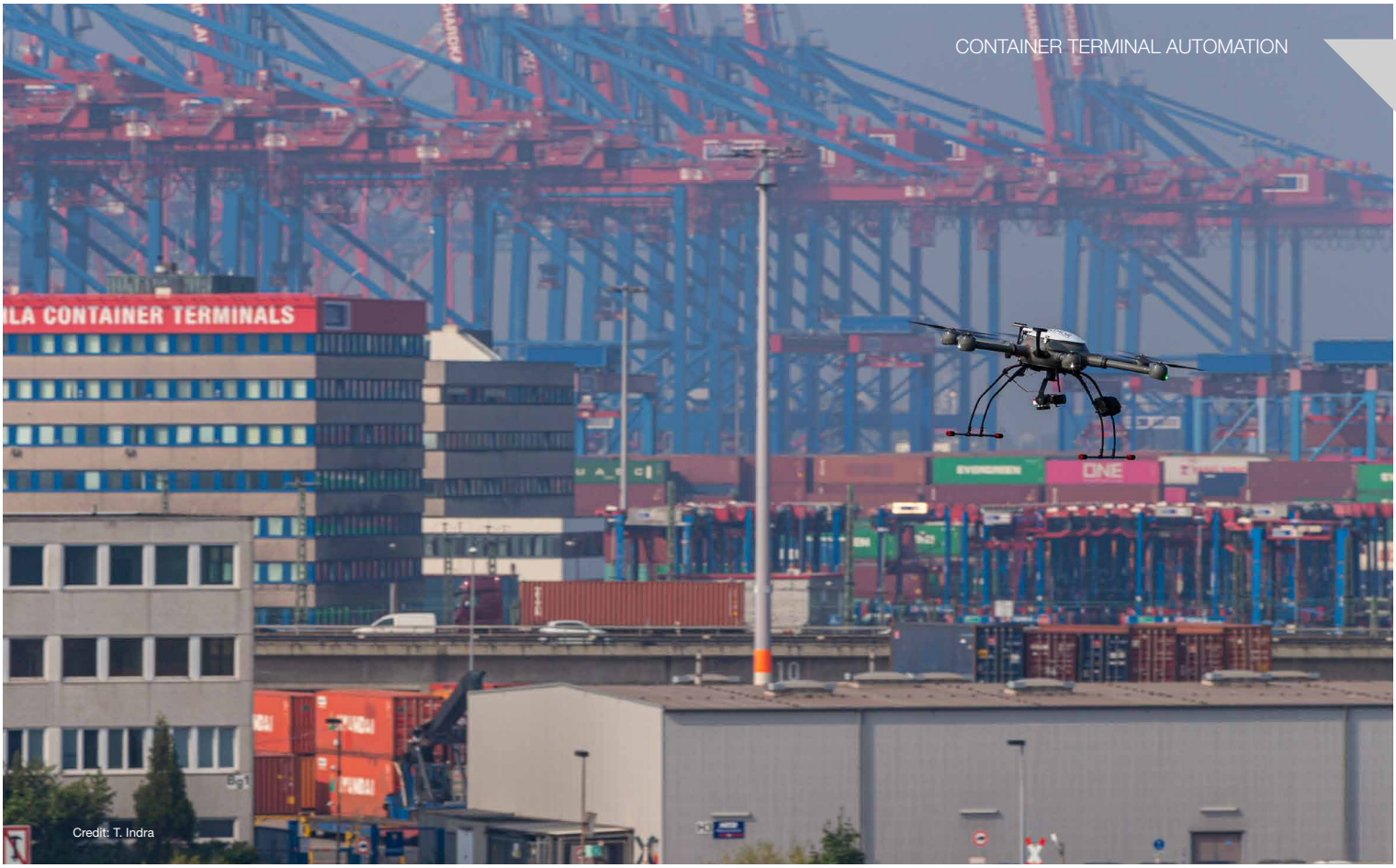
The introduction of a new drone-based situation image service in catastrophic management of the Port of Hamburg, called HASTA, represented a considerable increase in safety and allows for more efficient planning for logistical follow-up activities. The pilot test in 2020 and 2021 has shown that such a service is urgently needed, especially in the information procurement and situation analysis phase, in order to enable more efficient follow-up planning of the required situation management processes. Moreover, the use of a drone is more cost-efficient and environmental-friendly compared to the conventional service of helicopter or road troop operation. The potential of drone services are beyond just taking live images. It is perceived as a highly important risk assessment measure when it comes to rescues, evacuation, or containment of large-scaled oil spill.

During the phase of testing and piloting drone prototypes, intensive cooperation, and collaborative works across different business units within the HPA as well as technological and regulatory partners are key success factors for the introduction of drone services and operation in a complex environment like ports. The shared vision of the HPA and HHLA Sky to advance innovation of the Port of Hamburg through drone technology provides a common basis of the innovation partnership which was signed in December 2021. The ambition of both organisations as technology pioneers is to provide intelligent services for smooth port operations.

WHAT'S NEXT

In the next 18 months from April 2022, the HPA will launch the pilot operation for Drone-as-a-Service (DaaS) within the Port of Hamburg. The initial fleet, provided by HHLA Sky, will consist of two Multirotor Drones and two VTOL (Vertical Take-Off and Landing) Aircrafts. A well-trained drone operating team will be professionally installed. The examples of services including in this pilot operation are:

- Real-time image services for planned and ad-hoc inspection activities or disaster management exercises and taskforces
- Sensor data detection for planned and ad-hoc activities
- Water area control



Credit: T. Indra

"THE POTENTIAL OF DRONE SERVICES ARE BEYOND JUST TAKING LIVE IMAGES. IT IS PERCEIVED AS A HIGHLY IMPORTANT RISK ASSESSMENT MEASURE WHEN IT COMES TO RESCUES, EVACUATION, OR CONTAINMENT OF LARGE-SCALED OIL SPILL."

During this period, a number of challenges are expected and yet to be overcome. In the regulatory aspect, commercial aviation regulators across the world are currently grappling with the leading question of how to enable commercial drones to be operated as 'Beyond Visual Line of Sight', (BVLOS). In other words, the drone pilot will not have the visual contact while steering the drone. Licensing of operation in the entire port area is extremely sophisticated and challenging due to its complex requirements throughout the area. Regarding the technical and operational aspect, all technical equipment must be manufactured according to the state-of-the-art technology and certified according to their safety and security standards applied. The capacity building of the operational team with special training is highly crucial to ensure safe flight operation, not less than for the one for human-carrying aviation.

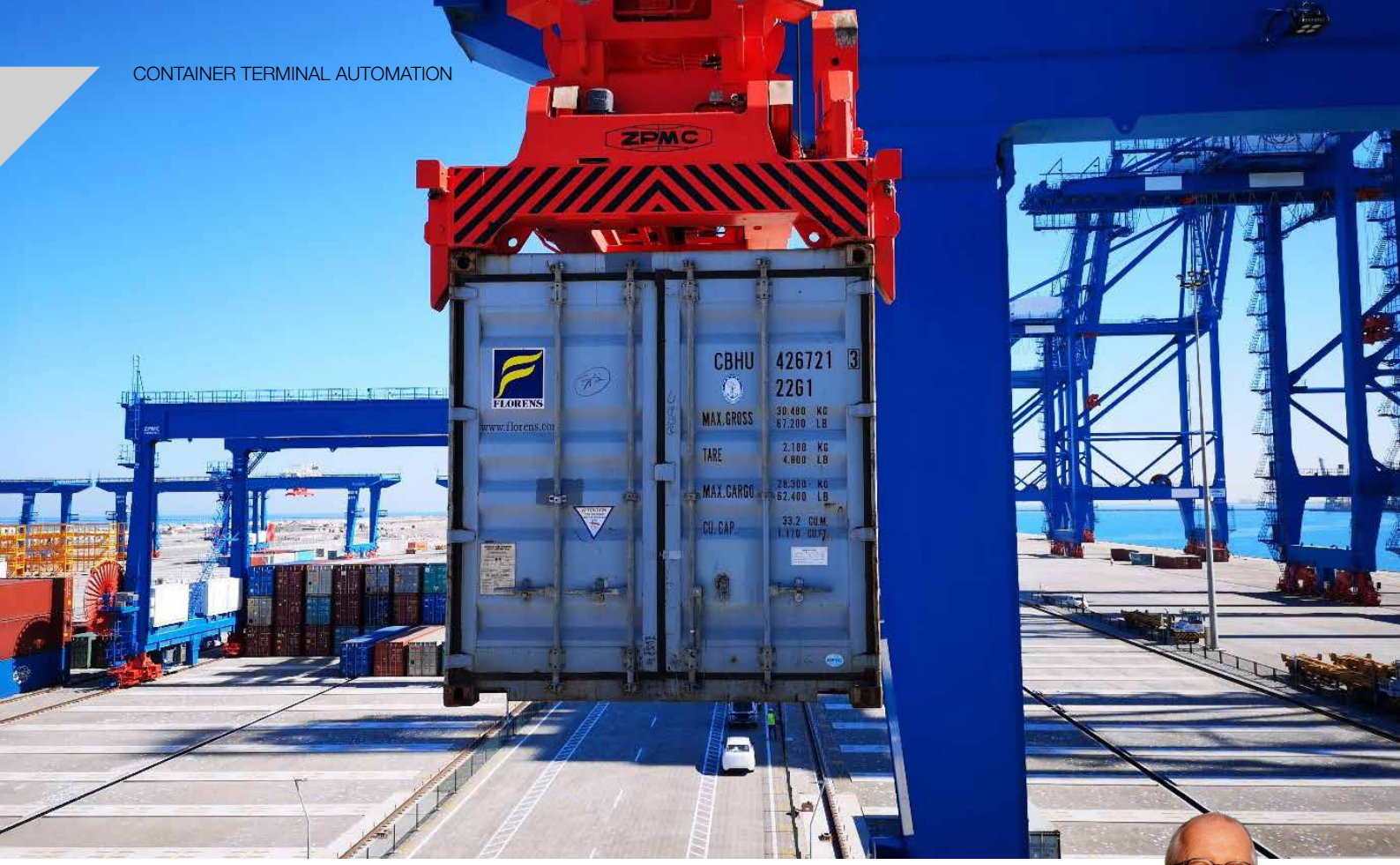
We expect from this pilot operation many eye-opening insights which will enable us to scale the services in the multifaceted environment like ports.

The regulatory framework of commercial drone operation within Europe will be effective in 2023. Therefore, this year is an exciting period where the governance issues laying out the prerequisites and frames for the drone operations by different actors from licensing operation, regulating the u-spaces, air traffic management and operation will be shaped and concreted. The technology is ready and can be deployed. The service, launch, and operations are being prepared. So, there is a high expectation that drone services for industrial use in the European sky will no longer be just a vision, but rather a scalable business. This ambitious goal could only be successful if all actors in the ecosystems will work together already today.

ABOUT THE ORGANISATION

The Hamburg Port Authority (HPA) has been providing future-oriented port management services since 2005. It is the contact point for all kinds of questions concerning the waterside and landside infrastructure, the safety of navigation for vessels, port railway facilities, port property management and business conditions in the port.


Credit: T. Indra



Container reading in RMG crane operations

TERMINAL AUTOMATION THROUGH OCR AND OFR

Anton Bernaerd, Head of Sales, Camco Technologies

When it comes to Optical Character Recognition (OCR) technology and assessing OCR or Optical Feature Recognition (OFR) systems, there is often a lot of confusion. High OCR hit rates don't guarantee less exception rates.

ASSESSING OCR/OFR SOLUTIONS FOR CONTAINER TERMINALS

Operation efficiency in the capital-intensive container terminal industry is data driven. Data sources from different systems, vendors and stakeholders drive the terminal management system, or Terminal Operating System (TOS). Intelligent cameras capturing container information throughout the container handover processes provide critical data feeding the TOS.

Data accuracy is key for limiting exception handling and labour cost. Better safe than sorry: when taking into account Return on Investment of data capturing solution, total cost of ownership is determined by system reliability. A thorough understanding of camera system KPIs are fundamental in making the right choice.

CONTAINER TERMINAL AUTOMATION

Seaports and container terminals have invested heavily in infrastructure and automation during the past decade. Traditionally a labour-intensive industry, innovation in communication, connectivity and computing power has turned the industry upside down. Advanced terminals are almost fully automated and digital twins are the next real thing. The capital-intensive industry is embracing digitisation to improve operations efficiency, better customer satisfaction and a higher return. Data capturing and terminal intelligence have moved from the operations desk to the boardroom.

AUTOMATION STARTS WITH RELIABLE DATA

It is crucial to keep track of the continuous flow of in-and-outgoing containers. Missing one container and it might be lost for weeks. Accurate registration of container flow is essential for operations organisation. One of the main data sources for the TOS comes from the intelligent camera systems at the terminal gates, in the yard or at the STS cranes loading and unloading the vessels. The intelligent cameras register trucks and containers by reading container markings (OCR) as well as features (OFR). Typical OCR readings include the truck license plate, container number, ISO code and dangerous goods labels. Typical OFR readings include seal identification and automated damage inspection.

HIGH-END VERSUS LOW-END HARDWARE

Missing data by lacking or misreading information will dramatically affect the OCR system performance. Inaccuracy will lead to handling more instead of fewer manual exceptions and a system perceived as unreliable by gate clerks. On-camera image analysis software will perform better when picture quality is at its best. High-quality lenses and high-bright lighting are key for providing easy to read images for the

“TERMINALS WANT FAST PROCESSES; TOO MANY UNNECESSARY OPERATOR JOBS SLOW DOWN THE OPERATIONS.”

Truck OCR camera portals at Puerto Angamos - Chile

AI-processor. If only a container number or license plate needs registration, a value for money solution might do the thing.

When high flows of trucks and container moves have to be processed 24/7 and in all weather conditions, or additional information is to be registered, the low-cost solution might eventually turn into replacement of the failing equipment. When information becomes critical, it is highly recommended to invest in a sustainable solution. Sometimes, one can’t afford to buy cheap. Cameras with high quality lenses, global shutter technology and remote focus capability will save a lot of trouble.

AI AND DEEP LEARNING EXPERTISE

The Camco camera systems run AI engines for data capturing. The Camco expertise in deep learning and Convolutional Neural Networks (CNN) has been integrated in OCR camera systems with the highest accuracy available today. Convolutional Neural Networks learn by experience, Camco feeds the network with large numbers of labeled images so the network learns the features that characterise objects. Defining the best suited network architecture and tweaking the algorithms requires time and expertise. A team of eight AI engineers develop new applications and improve system performance by tweaking algorithms pushing recognition rates to a maximum. It requires a lot of resources for every percent of OCR system improvement.

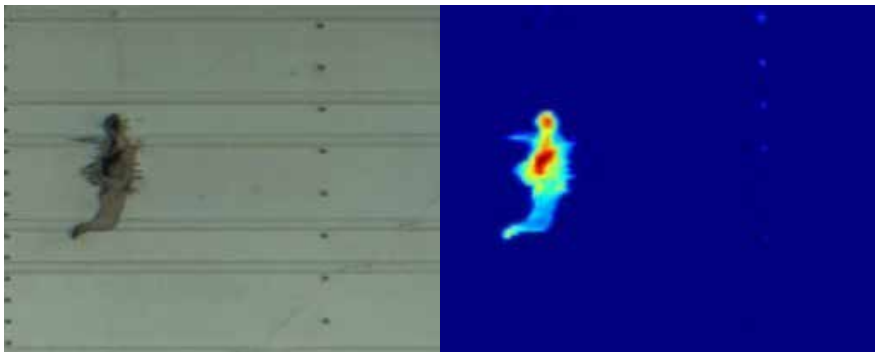
AI IMAGE RECOGNITION SOFTWARE

Accuracy and speed are the key drivers for any OCR/OFR system performance. Powerful CPUs use different algorithms for processing different images at the same time. The processors are embedded, on-camera computing instead of relying on a remote AI-server makes the information faster. All Camco cameras are equipped with a 12th generation Intel processor.

EVALUATING AN OCR SYSTEM PERFORMANCE

In order to evaluate AI vision-based system accuracy, KPIs have to be defined. Multiple KPIs can be used to measure AI vision technology performance. The main question is which KPI should be used for what purpose: a KPI in a Maintenance & Service agreement may indeed be different from KPI related to the system acceptance.

Finally, when defining AI vision KPI, it is key to take into account only data generated by the AI vision system. Indeed, exceptions can also be created by missing


Automatic Damage Inspection heat maps. AI-based container and trailer damage recognition


High-end cameras with global shutter, remote focus and embedded AI engine

BoxCatcher STS crane OCR connected with crane PLC, travelling up and down crane mounted rails

"MISSING DATA BY LACKING OR MISREADING INFORMATION WILL DRAMATICALLY AFFECT THE OCR SYSTEM PERFORMANCE."

or incorrect data from the TOS. These TOS triggered jobs are not included in the AI vision based KPI definition. In this article, we focus only on the OCR/OFR exceptions created by the AI vision system.

CONFIDENCE LEVEL: ACCURACY IS KEY

The confidence level gives an estimated probability regarding the correctness of the reading result. Its value is calculated based on intermediate results of the algorithms. The confidence is a value between 0 and 100 per cent, and influenced by quality and wear of the container markings, light conditions and so on. In an industrial process, the goal is reducing human intervention to the strict minimum and relying on only qualified data.

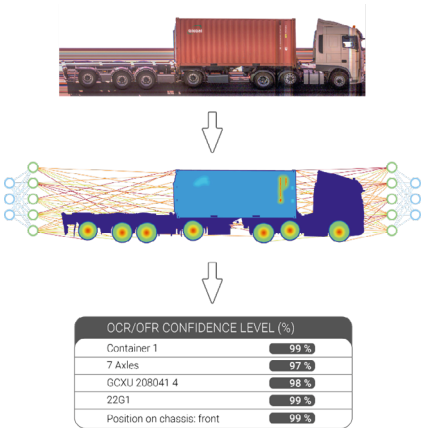
Note that TOS container vessel discharge or load data can be used by the OCR engine to increase the crane OCR hit rate. A missing digit can be recovered from the TOS system. Or truck appointment information can be used to correct missing data at the gates. At Camco, we are very careful and use this additional data only for confidence level calculation. It is key to discard the TOS autocorrection in assessing a vendor OCR result, the raw OCR result.

OCR/OFR HIT RATE KPI: SYSTEM PERFORMANCE

When measuring the performance of a stand-alone OCR/OFR system, the hit rate is the most relevant KPI. Whereas the confidence level for each reading is automatically computed by the system, the hit rate is determined through human verification, i.e. by visual check of each picture with the corresponding system read. A typical population size between 250 and 500 images is necessary for the hit rate to be statistically significant. All images in this population are used; no images are discarded, also missed pictures are taken

Optical Character Recognition (OCR): reading data strings and labels

Optical Feature Recognition (OFR): identifying seal presence and type



CNN based OCR/OFR determination and confidence level

into account. Based on this verification, the number of correct verifications, or hit rate is expressed as a percentage of the total population size. Ideally, the OCR/OFR hit rate should be near 100 per cent.

Note that the confidence level is not taken into account in computing the hit rate. The hit rate is a useful KPI to measure the performance of a stand-alone OCR/OFR system, i.e. not integrated with any industrial process such as a truck gate process or crane process.

OCR/OFR JOB RATE KPI: PROCESS PERFORMANCE

An AI vision technology system is always integrated into an industrial process such as a truck gate or crane process. Since OCR/OFR output is used as one of the inputs for a specific industrial process, accuracy is key. Wrong data leads to wrong decisions, needing human intervention for corrective action.

Since each process step requires accurate data, the registered data confidence level is used to score the accuracy of the reading result and to trigger operator verification if below a pre-set threshold. For each attribute (for example LPR, container ID, or seal), a confidence level threshold is configured. The value of this threshold depends on the specific terminal process. The higher threshold, the higher the accuracy of the read information, but at the same time it will increase the number of operator jobs for which no correction is needed. If the threshold value is set too low, then the risk to continue to work with an incorrect read result increases.

This confidence level threshold is a trade-off between a calculated risk for errors against the cost of interventions and is determined between Camco and the terminal project team.

The OCR/OFR job rate KPI can be calculated automatically by counting the number of generated operator jobs for a population of passages (after deduction of the TOS generated jobs). A passage can be a truck, spreader or train. The typical population size is between 250 and 500 passages to be statistically significant. All passages in this population are used; none are discarded, also missed pictures are taken into account. Based on this counting process, the job rate KPI equals to the number of OCR/OFR operator jobs, expressed as a percentage of the total population size.

COMBINING ATTRIBUTES LEADING TO HIGHER JOB RATE

If the OCR/OFR process output contains many (independent) attributes (LPR, container ID, IMDG, seal presence and so on), then the job rate will be higher due to the combination effect. Therefore, it is useful to only use the minimal set of OCR/OFR attributes needed for process execution. Although the job rate KPI is not an indicator for the correctness of the OCR/OFR result as such, it is a very useful operator intervention KPI measuring the performance of a business process integrated AI vision-based system.

THE RIGHT KPI FOR EVERY PROCESS

In a project context, the OCR/OFR hit rate KPI is a useful performance measure as it can be specified during project contract negotiations. It is a raw performance measurement of a standalone OCR/OFR system, independent of any customer specific industrial process. However, from an operational point of view, a terminal is more interested in the amount of generated operator work. This work determines the operator workload and the total process duration.

Terminals want fast processes; too many unnecessary operator jobs slow down the operations. In an operations context after a project is accepted, the OCR/ OFR job rate KPI is a more useful performance measure as it requires no human work to generate the KPI, and is a good indicator for operator workload. Which AI Vision performance KPI? Both KPIs can co-exist. Each KPI measures the output of a different process. The advice is to use the OCR/OFR hit rate KPI in a project context. During the lifetime of the solution, it is more useful to switch to the OCR/OFR job rate KPI. As mentioned before, TOS generated jobs are to be excluded in the AI vision performance KPI.

FACTBOX:

DEFINITIONS SUMMARY

- Confidence level: system accuracy measure: probability of reading correctness as computed by the AI vision-based system.
- OCR/OFR hit rate: raw performance measure, independent of the business process: total of correct readings related to correct data from manually inspected and corresponding images in statistic significant population.
- OCR/OFR job rate: performance measure of process integrated OCR/OFR system: total required human interventions related to all data readings, interventions being triggered by threshold confidence level and determined for a specific process step. No direct relation to OCR/OFR hit rate.

"IT IS CRUCIAL TO KEEP TRACK OF THE CONTINUOUS FLOW OF IN-AND-OUTGOING CONTAINERS. MISSING ONE CONTAINER AND IT MIGHT BE LOST FOR WEEKS."

ABOUT THE AUTHOR

Anton Bernaerd is Head of Sales and for almost 20 years has been part of the Camco Technologies team. Anton has been sharing insights on process optimisation and terminal automation in more than 250 terminals across the globe. His unique expertise in gate and crane automation makes him an authority speaker in industry events.

ABOUT THE ORGANISATION

Camco Technologies is the global leader in container terminal automation with innovative solutions for AI-based image recognition, gate automation, GNSS-based container tracking and terminal automation software. More than 250 terminals rely on Camco for container data registration and operations organisation.