SOME THINK SHIP LOADING CANNOT BE CUSTOMISED.
WE THINK DIFFERENT.
The industry has been on an automation journey for many years now, there is no doubt about that. However, the effects of the COVID-19 pandemic and the resulting disruption has led many to consider how to make their container handling equipment as efficient as possible.

In this edition of the Journal, we hear from a number of PTI’s partners about how their technology is attempting to solve the issues of today’s container ports.

CEO and Founder of Aidrivers, Dr Rafiq Swash, talks about the ultimate message of port optimisation being a mix of zeroing waste and downtime in order to improve the quality of service. The only way to reduce the cost, he claims, is the effective implementation of an AI-enabled autonomous system.

“Innovative container handling is vital for the future sustainability and growth of ports, and for the rest of the supply chain that they serve,” Dr Swash says.

Meanwhile, Hyster focuses in on effective double handling of containers. Essentially, moving two containers at the same time has a number of benefits including reducing driver distance and reducing time to lift and lower containers to high positions.

As the drive for efficiency remains constant throughout the industry, solutions like double container handling are more important than ever.

We also hear contributions from LASE Industrielle Lasertechnik GmbH, which outlines how laser scanning solutions are important in the automation process.

Gantrex delves into the issue of shock in container handling equipment and explains how a solution by its own R&D team looks to solve the issue which has a profound effect on both operators and the equipment.

Finally, Vahle considers the automation approach at brownfield sites and how everything starts with electrification of container terminals.

Beth Maundrill
Head of Editorial

### CONTENTS

3. **AI-ENABLED AUTONOMY IN CONTAINER HANDLING: IT ISN'T 'ALL OR NOTHING'**
   Dr Rafiq Swash, Founder and CEO, Aidrivers Ltd

7. **IT TAKES TWO: BOOST CONTAINER HANDLING CAPACITY AND THROUGHPUT**
   Jan-Willem van den Brand, Director Global Market Development Big Trucks, Hyster Company

9. **SHOCK TREATMENT IMPROVES CRANE OPERATING EFFICIENCY**
   Dr Nicolas Dinter, Group Innovation Manager, Gantrex

13. **LASER SCANNING IN THE AUTOMATION PROCESS**
   Lars Mohr, Sales Director, LASE Industrielle Lasertechnik GmbH

15. **CONTAINER TERMINAL AUTOMATION FOR NEXT-GEN PORTS WITH VAHLE**
   Sebastian Alves, Systems Sales, Paul Vahle GmbH & Co. KG
Designing for the Future

The equipment designs and standards Liftech developed 50 years ago revolutionized global shipping. We have never stopped dedicating our curiosity and skills to structures that touch the lives of people in communities around the world.

Innovation, Experience, Integrity
If there’s one lesson to be learned from the current upheavals in shipping, ports and supply chains, it is this: we can’t simply go on the way we are.

As shipping lines, ports, hauliers, rail operators and others struggle to cope with unprecedented demand and congestion, shippers are enduring rocketing freight rates, unsustainable delays and often a complete lack of visibility. Meanwhile, the entire logistics sector is juggling the challenge of a shortage of skilled labour with the need to decarbonise operations and get up to speed with digitalisation.

Ports know they need to increase efficiency, deliver reliability and reduce carbon, but optimisation is often held back by a lack of data, knowledge creation, infrastructure or accessibility, as well as human involvement.

Effective automation certainly offers answers when it comes to ports – delivering efficiency, speed, resilience, safety and reliability, they reduce the need for humans to be in operational areas where our future generation will not want to work, play a key role in ‘smart’ systems, eliminate waste and unnecessary effort, and reduce fuel consumption and emissions. A simple term is zeroing waste and downtime for sustainable supply chain.

However, traditional automation generally requires a completely new layout or environment and infrastructure upgrades, sometimes throwing out the very considerable operational skills and excellence built up by operators – hence it is expensive and the disruption can be immense.

When operations are already close to or exceeding capacity, the very last thing a busy port needs is any sort of ‘improvement’ which requires a partial or complete stop to operations. Even for a short period, that can be devastating. So, there is the challenge – when it comes to an existing port, as the old saying goes: “If I wanted to go there (to automation), I wouldn’t start from here.”

There is, however, another way; building on what you already have. Why not optimise the operations which you know the best and that are already in place, to improve productivity and reduce operational costs? Port operators are desperate to deliver predictability of service, and that is what Aidrivers is focusing on – building on the existing system, focusing on existing fleets and making automation more accessible and affordable.

Why wait for new vehicles or an infrastructure upgrade, why lose the knowhow of your mechanics, when it is perfectly possible to switch the manually driven vehicles you have now to be driven by machines, connecting them without expensive new infrastructure, to
provide optimisation and enable in-time operations. We call it non-destructive AI-enabled autonomous deployment. We understand that current terminal operators cannot stop operating, so we design our AI-enabled autonomous solution, V2X-enabled Fleet Operator and our digital twin solution to enable zero downtime deployment, without any environment or infrastructure upgrades, by simply upgrading the existing fleets.

Trade automation, new infrastructure, new systems, new environments – all of this, unsurprisingly, can make people nervous. Let’s say you have been operating a port for 20 years and know exactly how it works. Changing the whole thing – cranes, trucks, layouts – is like changing languages.

Building on the existing system keeps the stress to a minimum – it’s a more affordable, more accessible and more scalable approach.

Aidrivers’ autonomous technology is helping ports and other industrial fleet operators to improve safety and efficiency, reduce costs and ensure consistent quality of service, while at the same time delivering greener, more sustainable operations.

Our autonomous intelligent retrofitting system (AIRS) features a drive-by-wire manager for a precision drive control system, with a fail-safe mechanism. The system includes precision 3D mapping and localisation, AI-enabled perception with situation cognisance and responsive autonomous drive control of articulated vehicles, for natural navigation in a dynamic, constantly changing port environment.

Our AI-enabled Fleet Operator (AIFO) technology provides a connected environment and self-ware V2X-enabled operations for any equipment – trucks, cranes, traffic lights, gates, etc. – so that they all work together with a common goal of consistency and in-time operations, but without the need for infrastructure upgrades, by having network resilient self-managed autonomous systems.

AIOs provides the edge autonomy to the truck, crane or other piece of equipment for a self-managed operation – in which the kit has full knowledge and cognitive awareness of the area, shares what needs to be done, and does it.

AI-enabled autonomous systems use cognitive AI to reason the situation and decide on the appropriate response – delivering a far more robust and reliable outcome compared to that of humans faced with boring, repetitive work. An autonomous system offers precision and intelligence – which in turn lowers emissions by reducing waste and delivers a high quality of service.

As for the port, by taking the “conversion” route, it can capitalise on its existing assets – and there is no such thing as “all or nothing”. It’s entirely possible to do this in small steps. Change one, two or three vehicles at a time and roll them out in stages, without the need for huge investment. Convert the current operating burn rates into long-

“THE ULTIMATE MESSAGE OF PORT OPTIMISATION IS ONE OF ZEROING WASTE AND DOWNTIME TO IMPROVE QUALITY OF SERVICE AND DELIVER CONSISTENCY.”
term investment; for example, a manual truck might require the employment of four drivers, but that outlay could instead be invested in automating the truck and creating higher-paid jobs. The retrofitted autonomous vehicles and cranes can work alongside and in the same way as the existing manual vehicles (except, of course, the autonomous machines won’t take a break for the toilet or spend 15 minutes on a phone call, instead working entirely predictably so multiple jobs can be assigned).

At present, conventional equipment in ports is thought to be running for 50% more than it needs, because of waiting and inefficiency.

Another major challenge for the port operator is not being able to optimise the TOS as any change can bring the perceived risk (or at least the fear) of a small-scale disaster on launch day.

The only way you can assess how a TOS works is to try it out with different configurations. The problems that the Port of Felixstowe faced after introducing its new TOS in 2018 have been documented. Who wants that level of risk? That problem can be resolved by Aidrivers’ digital twin, which provides the digital infrastructure in which to test TOS operations and reprocess or rescale operational data for an effective optimisation. A range of solutions and scenarios can be designed, tested, evaluated and refined in a virtual world before anything ever goes live. No risk of downtime.

There’s plenty of talk about digital twins out there, but our AISE product is different because it comes with our autonomous mobility solutions; that combination enables us to replicate a terminal with full accessibility of operations, helping us to carry out our work without disturbing existing operations. Our simulations are built based on a true physical based model in which we can incorporate the actual noises and factors of the real world, enabling genuine operations without being constrained by fixed numbers and models.

None of this is guesswork. Any exercise in optimising and automating is based on data and identifying the area of improvement – the more the better. However, data available in ports is often limited and we understand that. Again, the answer is in the digital twin – taking this route, data can be rescaled, refined and analysed, to deliver more insight in advance as well as effective AI-based predictive modelling.

Ports know they need to digitalise, but they also know that they don’t want tech that is fragmented, misaligned or vulnerable to cyberattacks. Here they can have confidence that Aidrivers is looking at the entire picture. Our complete ecosystem stretches from system diagnostics for predictive maintenance to autonomous navigation and AI-enabled Fleet operator to digital twin solutions. We offer 100% data ownership and data privacy while hosting our autonomous systems – we think that’s vital in terms of cybersecurity. We believe that Aidrivers’ ecosystem is a true enabler for ports facing the demands of global supply chains.

The ultimate message of port optimisation is one of zeroing waste and downtime to improve quality of service and deliver consistency. The only way to reduce the cost is effective implementation of AI-enabled autonomous systems. When a port handles a container, it probably has a 10-15% profit margin. Typically, almost 60-70% of the cost is in the labour or overheat due to lack of inefficiency.

Innovative container handling is vital for the future sustainability and growth of ports, and for the rest of the supply chain that they serve.

ABOUT THE AUTHOR

Aidrivers’ founder Dr Rafiq Swash of Brunel University London contributes to international research in AI, visual information search and retrieval, computer vision, 3D sensors, predictive data analytics and automation. Professionally this has expanded into further international leading collaborations in connected robotics, AI-enabled automation, sensor intelligence and fusion, digitisation and behaviour and pattern modelling.

ABOUT THE ORGANISATION

Aidrivers provide specialised AI-enabled autonomous mobility solutions for port terminal automation that meet the needs of port operators. The company is working passionately to address industrial mobility challenges by optimising industrial operations and improving the quality of service towards a sustainable future.
Severe congestion in container yards can wreak havoc on port terminal operations and subsequent stages of the supply chain. Disarray opens the door for excess container movements, and inefficient use of container handlers can in turn lead to longer queues and waiting times for inbound ships and outbound lorries alike.

But as supply chains adapt to ongoing disruption in the wake of the pandemic and container volumes continue to reach record-breaking levels, the threat of logjams is only intensifying. Add to that the global imbalance in the geographic distribution of shipping containers that has produced gluts of empty containers at some ports and shortages at others, and charting a course for efficient container management comes against a backdrop of uncertainty.

Under these conditions, port terminal operations face pressure to squeeze the most efficiency possible out of their container handling operations, while lowering the cost per container moved. This paper examines how double container handling can enable process and storage strategies that increase productivity and capacity, and ultimately boost throughput by up to 30%.

**DOUBLE CONTAINER HANDLING UNLOCKS PRODUCTIVITY, CAPACITY FOR PORTS**

While the pressure to move more containers remains constant, ports are also grappling with the challenge of improving ground slot usage to mitigate rising real estate costs and space limitations. In fact, the *Global Port Trends 2030* report by Deloitte found that increased focus on spatial strategy will be a key focus for ports over the next decade, due to space scarcity in existing urban ports and increasing complexity of port operations.

But what does the workflow – and the equipment – for double container handling look like in practice? Just as the name suggests, double container handling allows operations to move more empty containers at the same time with less equipment. In addition to the productivity advantage, some heavy-duty double-handling equipment built for high lifting can stack containers higher, bolstering TEU capacity, allowing port terminals to make greater use of vertical space. For example, empty container handlers that enable operators to build stacks up to nine containers high can significantly increase capacity and optimise yard space. Even if weather conditions, local policies or other constraints prevent operations from stacking nine high, increasing stacks from five to six containers can still boost capacity by up to 20%.

Double handling empty containers is well-suited to dedicated empty container
yards and can also be deployed in straddle carrier ports. In a dedicated empty yard, double handling can allow operations to reduce the amount of equipment required to service lorries, helping reduce traffic congestion. Traffic flow and safety can also be supported by separating pedestrian, lorry and container handling equipment traffic, with each having designated areas that do not overlap. While separating traffic could also be done with single empty container handling, prohibiting lorries from driving into the container stack area means longer driving distances for equipment to deliver containers to lorries. As a result, this workflow is far more economical with double handling. The increased volume of containers handled simultaneously can actually lower the cost per container. Moving two containers at the same time can also:

- Reduce driving distance – which in turn lowers fuel usage, tire wear and handling time per container, and increases equipment productivity
- Reduce time to lift and lower containers to high positions – which also reduces fuel usage, limits handling time per container and increases equipment productivity

**Versatility**

The standard 20- and 40-foot steel containers are not the only types that equipment must handle. New, specialised container options are becoming more popular, resulting in a wide variety of weights and handling requirements. Urbanisation is also driving growth in the “fresh chain” – shipments of foods and other goods that require cooling – resulting in more refrigerated containers, or reefers. Because different container fittings require different spreader configurations for optimal handling, operations should check that their manufacturer can provide the variety of spreader options to accommodate their changing needs.

**Strength and stability**

While 20-foot steel standard containers typically weigh approximately 5,000lbs (2,300 kg), gas containers or standard reefers with watertight floors can often exceed 11,000lbs (5,000kg) each. In addition to capacity, handling two reefers requires orienting them in the same direction so that their cooling units can connect to power outlets in the yard, so equipment must be capable of dealing with an eccentric load.

**Security**

Oftentimes, containers being loaded or unloaded are not completely level with the ground, so a spreader feature designed to articulate several degrees to match the angle of the surface or load helps the attachment lock securely into the container pockets while reducing stress on the spreader, mast and truck.

Lifting and stacking two containers simultaneously requires high performance from operators, especially when working in tight configurations. But labour turnover in the industry is high, making it tough for ports to find and retain enough skilled operators. To reap the productivity and capacity gains of double handling, ports must be thoughtful about using technology and design to set operators up for success.

**Visibility**

Operators need a clear vantage point with excellent visibility through the mast. Options for raised and tip-up cabins can provide operators visibility to the top of a container while positioned on a chassis and a more comfortable view when stacking containers more than four high. Radar and smart camera options can also allow operators to check that containers are seated and secured correctly.

**Ergonomics**

With labour in short supply, ports need operators performing at their peak. A spacious, comfortable operator environment with ergonomic controls can help fend off fatigue and support performance throughout the course of a busy shift. The cabin should provide comfort and help enhance productivity by positioning all truck controls and information in easy reach, including spreader status and first and second container detection. The joystick should be intuitive and designed for easy, precise operation of the mast and spreader.

**DOUBLING DOWN ON PRODUCTIVITY**

While the industry grapples with disruption and continued evolution, the drive for efficiency and doing more with less remains constant. Innovative handling strategies, enabled by double-container handling equipment, will have an increasingly important role to play for operations in need of raw productivity gains and more efficient use of increasingly scarce space and labour. But don’t take it from me, the Deloitte Global Port Trends 2030 report predicts, “Successful ports will be the ones that increase their spatial productivity. Unsuccessful ports will have lost their reason to exist and be swallowed by their respective city.”

---

**ABOUT THE AUTHOR**

Jan-Willem is responsible for leading global product strategy and market development focusing on solutions in Ports and Terminals. Such solutions from Hyster include high-capacity lift trucks, a range of dedicated container handlers and ReachStackers and the service, parts and rental support of Hyster’s nationwide dealer network.

**ABOUT THE ORGANISATION**

Hyster Company is a leading lift truck designer and manufacturer offering 130 models with one of the widest capacity ranges in the industry. Supported by one of the industry’s largest and most experienced dealer networks, Hyster trucks offer high productivity, low cost of ownership and easy serviceability to customers globally.
A crane at rest is a costly crane. A crane that is not moving as fast as it safely can, for as long as it safely can, is costly too: it’s not making as much return on the capital used to build it as it could. Port operators know that anything that keeps cranes moving contributes to the throughput of their terminals and hence their profitability. Anything that slows or stops cranes moving does the opposite: throughput falls while capital equipment lies idle, depreciating as operators watch.

The challenge for port operators is two-fold. The first is that the nature of their business is to move large masses quickly in a challenging operating environment. The second is that some of the equipment used in such environments has intrinsic features that make it vulnerable to the effects of rough handling. The combination of these challenges can lead to unscheduled stoppages for repairs, as well as requiring the implementation of scheduled maintenance programs. And that’s costly.

For example, a modern crane mounts its lifting mechanism on a trolley that runs on rails fixed to a gantry mounted up to 60m above ground level. The gantry has a hinged boom that can be swung up, out of the way, when ships are docking and undocking. When the boom is level, it can extend more than 60m beyond its hinge point to reach containers stacked on the far side of the biggest ships. The crane’s operator sits in a cabin that is mounted to the trolley.

**THE ISSUE WITH SHOCK**

The intrinsic issue with this set-up is that the crane trolley must traverse a discontinuity in the rail at the hinge, where two so-called ‘short rails’ meet, moving at speed while carrying loads of 30 tonnes or more. The resultant shock, as the trolley crosses the gap, can cause accelerations of up to 3g (or three times the force of gravity). This turns the 30-tonne static load of the container into an impulse of 90 tonnes, which must be absorbed by the short rails used on either side of the boom hinge. And if the short rails are not aligned with each other horizontally, the trolley’s transition from one to the other will create large lateral forces as well.

These vertical and horizontal forces can chip the short rail or cause it to deform temporarily. If a lot of material is lost or the deformation is permanent, then the next time a trolley crosses the hinge joint it will experience even greater forces, leading to more chipping and deformation in a feedback loop that can end in rail failure.

The regular shocks created by the trolley crossing the gap at the hinge joint and the subsequent vibrations can affect the rail
welds, crane structure and any embedded electronics on both the crane and the trolley. The same shocks and vibrations also cause rail clips and hold-down bolts to loosen over time. This creates a health and safety issue if such fixings fall off the gantry the next time the boom is lifted.

The short rails bear the direct impact of the trolley’s passing, but that impulse is then dissipated in the rest of the crane’s structure as small elastic deformations, as well as vibration and noise. Each of these has its own effects, on everything from the tightness of bolts and the position of sensors to the operating lifetime of any electronic equipment mounted in the operator’s cabin.

Such regular shocks also have a profound effect on operators, who may be expected to move up to 30 containers per hour during shifts of up to 12 hours. Each time the trolley crosses the discontinuity in the trolley rails at the gantry’s hinge joint, they are subject to shock, vibration, and noise. This can cause operators to suffer health issues such as back pain.

The cumulative effect of these repetitive shocks may also undermine operators’ confidence in their safety and hence break their concentration. This can reduce their performance, especially on long shifts, as they slow the movement of the crane to reduce the number and magnitude of the shocks. And as we said at the start, slow cranes are costly.

**RESPONDING TO THE PROBLEM**

The obvious response to this issue is to mount short rails, made of high-grade steel, on a damping material, so that the impulse created by the trolley passing over the hinge can be absorbed and dissipated. Unfortunately, we’ve not been able to find an elastomeric material with the combination of shock absorbance and operating lifetime characteristics necessary to be a practical solution. The material just will not stay in place under the rail when subject to repetitive shock.

Our response, formulated by the Gantrex R&D team, has been to develop a patented technique in which we constrain a shock-absorbing elastomeric material within a U-shaped channel along the length of the short rail. This stops the material migrating under load and so retains its integrity over its designed operating lifetime of two million container moves. The Gantrex HingeGuard™ short rails have been trialled by early adopters in the field, and the insights gained from those trials have already been incorporated in a second generation of the design (see above).

Does this approach work? We’ve invested in an extensive design effort, including multiple prototypes cyclic testing under severe loading conditions, and many FEA simulations. What this has shown is that, compared to using a standard short rail, the Gantrex HingeGuard™ short rail reduces the impulse caused by a trolley crossing a hinge gap by 80%, and reduces the subsequent vibration by 30%. You can see why it works in the figures below.
In the first figure, a trolley wheel crossing a standard short rail creates concentrated local stress (indicated in red and as $\sigma_1$) that is close to the rail material’s elastic limit of 1080MPa. This explains why standard short rails can so easily be damaged during regular operation.

The second figure shows that elastomeric material incorporated within the Gantrex HingeGuard™ short rail spreads the stresses caused by the trolley wheel’s passing across a much greater distance. This reduces the stress on the top of the rail ($\sigma_1$) fourfold and halves the stress on the foot of the rail ($\sigma_2$). This reduces the maximum stress experienced within the short rail considerably, making it much less likely to approach its material limits. This helps reduce wear on the rail, hence extending its lifetime.

The Gantrex HingeGuard™ short rail is one of a set of components that make up the overall impulse and vibration reduction system. Others include clamps that exert a powerful vertical force clamping the base block to the structure, shear blocks that stop the rail moving longitudinally, and clips that can be adjusted in situ to keep short rails in alignment with each other across the hinge gap. This reduces the likelihood of large lateral forces being exerted on the rail.

The technology may be impressive, but what value does it offer terminal operators? Reaching for the back of a virtual envelope, if we say that it costs $100 to move a container, a good crane operator moves 30 containers an hour, and assuming cranes run at 70% utilisation over 24 hours, then a crane can earn, or give up, $50,000 of revenue per day. Currently, a crane may need one or two short-rail replacements during the approximate ten-year lifetime of the long rails that forms the rest of the trolley track on the gantry. If each replacement takes five days, then the cost of short-rail wear is $250,000 to $500,000 per long-rail lifetime. Across a terminal with 20 cranes, that’s between $500,000 and $1m per year in lost revenue.

If the extended lifetime of the Gantrex HingeGuard™ short rails enables operators to replace them at the same service intervals as the long rails, all that revenue can be recouped. The reduction in shock, vibration and noise should also improve operators’ health and safety, giving them the confidence to sustain their throughput and hence the terminal’s profitability. In the end, it all goes back to efficient capital utilisation and the fact that a crane at rest is a costly crane.

ABOUT THE AUTHOR

Dr Nicolas Dinter, Group Innovation Manager, Gantrex, is an experienced R&D professional and start-up facilitator. He began his career studying material properties, and later launched an incubator for mobility businesses. He was the driving force behind the Gantrex HingeGuard™ short rail development and testing. Nicolas has an engineering degree, a PhD and an MBA.

ABOUT THE ORGANISATION

Gantrex is the global market leader in the production, distribution, installation and maintenance of high-quality crane rail solutions. Gantrex’ products are used in many different applications and end-markets including ports, shipyards, steel mills, aluminium smelters, railway depots and heavy industries.

Gantrex is an international company with sales and service centres in 20 countries on 5 continents.
NOVEMBER 16-17
2021

Live Streaming Event
SMARTPORTS.TV

A joint initiative by...
Port automation has become increasingly important in recent years. The COVID-19 pandemic showed that supply chains can be sensitively affected and is one challenge port operators are facing today as part of the global supply chain and why the demand toward automated port equipment continues to rise.

Technological solutions like the Internet of Things (IoT), computers, robots, and artificial intelligence (AI) are some of the first things that come to mind when we talk about automation in ports and there is no doubt that they can improve the operations at a container port as well as enhancing the container port equipment. These technologies, correctly implemented, create notable advantages. However, the question remains what do global container businesses gain from adopting technology to automate port operations?

One answer to such a question is to be more independent and thus to automate cranes. These so-called automated yard cranes (ASC) which could be either rubber tyred gantry cranes (RTG) or rail mounted gantry cranes (RMG) are equipped with state-of-the-art laser measurement systems which will positively affect the container crane business.

**LASE A SOLUTION PROVIDER**

LASE, a laser measurement system manufacturer and supplier from Germany, has a solution in our product portfolio to help customers with their demands to either equip new cranes or retrofit existing cranes with systems to automate. LASE delivers “the eyes of the machine” through its system called LaseAYC-2 – Automated Yard Crane.

This system is already in use with several port customers worldwide. LASE also offers this solution as an Original Equipment Manufacturer (OEM) system for different cranes manufacturers. This means the system can be directly installed on brand new cranes.

**LASEAYC-2 FOR AUTOMATED YARD CRANES**

The LASE solution is a measurement system working with two 3D laser scanners, mounted under the trolley of an RMG or RTG as well as a software application package which handles all information and interaction with the cranes Programmable Logic Controller (PLC).

Measured data from the 3D scanners will be handed over to the application which creates a 3D-image of the container yard for pick up and drop off actions and it will also measure railcars and/ or chassis for pick up and drop off of containers.

The LASE measurement application sends results via Ethernet, ProFilter or ProFinNet interfaces to the crane PLC. The crane PLC can handle the processes data from the LASE system and then manoeuvres the crane with the load to the desired positions.

**FUNCTIONALITIES OF LASEAYC-2**

By using the LaseAYC-2 system customers can have several functions of operation.

The main functions of the system are automatic pick and drop in the yard,
automatic pick and drop on the railcars, automatic and semi-automatic pick and drop on road chassis, collision prevention between load and stacks in trolley drive direction, soft-landing and spreader tracking in drop down phase.

Alongside the key functions described above the system also has further optional functionalities available like placement verification on railcars, railcar lifting prevention, double box lifting prevention, indirect container height measurement, train profiling, truck movement detection, container slot surveillance.

BENEFITS OF HAVING AUTOMATED EQUIPMENT/LASE SYSTEMS ON SITE

Some of the benefits companies have by using the LaseAYC-2 systems on RTG or RMG cranes are, for example, faster and plannable availability of automated equipment with a potential for lower resources and operation costs. LaseAYC-2 also ushers in efficiency and productivity in many ways as this technology can help companies automate repetitive tasks that do not require sophisticated one person decision-making. This can result in greater productivity and efficiency. Another benefit is cost reduction and profit boost as increased efficiency and productivity from technology can result in a decrease in operating costs and a corresponding increase in profits.

CONCLUSION

The LaseAYC-2 system has already been deployed to port operators in a number of nations including, but not limited to, Australia, Ireland, Italy, the US and the UK. It has been proven by three crane manufacturers as an OEM part and was also installed on several cranes already in service.

If you as a customer want to unleash the potential of container cranes a LaseAYC-2 system could relieve the burden of manual operations.

THE LASEAYC-2 SYSTEM HAS ALREADY BEEN DEPLOYED TO PORT OPERATORS IN A NUMBER OF NATIONS INCLUDING, BUT NOT LIMITED TO, AUSTRALIA, IRELAND, ITALY, THE US AND THE UK.

ABOUT THE AUTHOR

Lars Mohr is the Sales Director – LASE Industrielle Lasertechnik GmbH and holds a Masters and Bachelors degree in environmental engineering with a major in process engineering and process simulation. He has 20 years of global experience in engineering and sales roles in the energy, mining and port industry. Lars knows what truly drives companies towards technology with a clear, logical mind with a practical approach to problem-solving and a drive to see things through to completion.

ABOUT THE ORGANISATION

Efficient handling and safety in nearly all port operation sites become more important and due to the permanently competitive markets our laser-based products help to enhance the productivity and reducing claim costs. The modular design, plus the use of standard, highest quality components, allows maximum utilisation of our customers’ existing infrastructure and technology, minimising up-front expenses.

Due to the trust of the most prestigious manufacturers and automation companies in the world, which rely on the innovations and quality of the laser measurement systems by LASE, we are able to offer customised products and system solutions since the beginning. After over 25 years of our existence we can proudly look back to our achieved goals, but nevertheless we also analyse permanent changes and industry needs simultaneously.

Convince yourselves of our broad portfolio of innovative products and solutions for efficient container handling and safety at nearly all kinds of port operations – either at the gate, truck lane, back reach, yard or vessel.
Container traffic has increased continuously over the last few years with only the COVID-19 pandemic giving container throughput at ports worldwide a slight setback in 2020. However, the forecast for 2022 and beyond shows growth is set to carry on with an increase of 3% from 2019 compared to 2021.

With the pandemic in mind and the possibility of even a port like in Yantian, China, closing because of the effects of COVID-19 it has made it mandatory to adjust the way of daily work in container terminals accordingly [Figure 1].

Most container terminals have different characteristics like size, organisation, and purpose of the container yard. When it comes to the used equipment, we are talking about Rubber Tyred Gantry Cranes (RTG), Automated Electrified Rubber Tyred Gantry Cranes (AERTG), Rail Mounted Gantry Cranes (RMG), Automated Rail Mounted Gantry Cranes or Automated Stacking Cranes (ARMG or ASC), Overhead Bridge Cranes (OHB), Straddle Carriers (SC), Automated Lifting Vehicles (ALV), Reach Stackers (RS) and so on.

RTGs and RMGs are the most popular yard machines used in container terminals. Today, many ports want to start the automation of these machines, or they...
are beginning to look into purchasing new equipment and what is needed to make these cranes most effective in operation.

Container terminals with parallel container blocks to the quay use RTGs as the main stacking equipment when container handling. RMGs or ASCs will be used in a perpendicular yard layout.

The main advantage of RTGs is the rubber tires; they allow the machine to move freely in the container yard on demand. However, the tyres limit the size and lifting capacity.

RMGs are limited to travelling on rails but can lift more weight than RTGs. RMGs with steel wheels can span approximately 90m stretching across many rail tracks, container stacking areas and even truck lanes.

However, since 2019 there has been a clear trend with increased numbers of RTGs supplied and a strong decrease of delivered RMGs, which confirms the demand for flexibility in the container terminal yard.

HOW TO CONSIDER AUTOMATION IN BROWNFIELD TERMINALS?
What is the best practice approach for electrifying and automating existing equipment of a brownfield terminal? There are a lot of different solutions available to upgrade the equipment for an automated system.

Automation can be considered from the beginning or be integrated on a step-by-step basis on the local requirements, but it makes sense to prepare the IT for yard infrastructure if possible.

EVERYTHING STARTS WITH ELECTRIFICATION
The main driver is the electrification of container terminals by converting diesel powered RTGs into E-RTGs powered by conductor rail systems or cable reels. This process allows terminal operators to significantly reduce fuel and maintenance costs (up to 90%). This brings a return of the CAPEX in a short amount of time. Today it is also important to consider the reduction of CO₂ and NOₓ emissions as well as noise pollution for ports close to dense urban environments. Electrification helps further to transform the port to a carbon emission free environment without the need to buy CO₂ certificates in addition.

Lasers and sensors for auto-steering and off-track protection assist the crane operator by allowing them to focus on the main objective of handling container as efficiently as possible. In a block change moment, a battery or small diesel genset takes over before and after an automated seamless switching process between the different power supply sources.

With the add-on of the data communication the then fully automated version of an RTG allows the operator to leave the driver cabin and to operate the RTG by remote control from an ergonomic office environment which results in improved safety and working conditions. Secondly, one operator can handle more than one crane at the same time in one block or can switch between different container yard blocks easily.

WHAT ARE THE MAIN CHALLENGES TO IMPLEMENT AUTOMATION IN A BROWNFIELD TERMINAL?
As is typical, the change management process is the most difficult part when implementing something new in an existing organisation which is focused on achieving a corporate goal.

When it comes to brownfield container terminals, change is met with ongoing operations which is the core business. That means the container yard is usually occupied with containers. Furthermore, the existing container layout can be a challenge when the available space for the required infrastructure is less. The equipment is only effective when it works and therefore not available for retrofit or conversion. Existing equipment is also often in the middle of its lifecycle, meaning that it will not necessarily support new or upgraded IT systems or Programmable Logic Controllers (PLC). It is important to check how the upcoming automation can work in the existing IT environment and take into account the remaining time and cost of the old equipment.
Terminal Operating System (TOS).

However, all these challenges can be handled by an experienced partner who can act as a general contractor to fulfil the required tasks in a turnkey project with optional first level support and preventive maintenance of the whole system.

**GUIDELINE TO AUTOMATE CONTAINER TERMINALS IN FOUR STEPS**

Process automation step-by-step can be the best and safest way for terminals to improve efficiency during daily operations. Conventional RTGs consume approximately 35-liters of diesel fuel per hour. The diesel generator is working 24 hours a day during container handling and even during idle time.

Therefore, the first step is to electrify the existing yard cranes, terminal tractors and so on by installing 1000A insulated bars with aluminium/stainless steel conductors suitable for maritime environment or motor cable reels. This immediately results in fuel savings and reduced maintenance costs. This very first step supports the financing of further automation steps because every converted RTG saves a lot of money. The return of investment depends on the yard layout (quantity of container blocks, length of container blocks), quantity of yard machines and the speed of conversion, but can be achieved within one year.

The electrification consists of a high voltage ring within the terminal with substations at the container blocks to transform the high voltage into low voltage, for example 415 V, 50 Hz on the stationary side. The substations could feed up to four container blocks depending on the number of RTG cranes operating in the block. The RTG cranes will be equipped with an automated connection system consisting of an automated telescopic arm to enter and leave the infrastructure automatically and a synchronisation unit for seamless switching of the power supply between the genset and grid. However, a fully electrified solution with batteries could be retrofitted as well, leaving the genset obsolete.

The second step is regarding the absolute positioning of the RTG cranes in the container block. For a maritime environment a favoured solution should ensure a high durability and lifetime. This can be achieved by use of a durable Data Matrix Code combined with an optical reading head. Through precise position feedback for process automation, the automated movement within the container block to the exact container position with one tick in the box will help to optimise the efficiency.

The third step and one of the most important is to integrate the reliable, interference-free and safe transmission of safety data, steering data and video signals. The data communication system allows all yard cranes to connect with the IT infrastructure and the TOS.

The availability of high data rates for machine-to-machine communication and human-machine-interfaces is one crucial aspect.

One possibility is to use a Slotted Microwave Guide Extreme, known at VAHLE as SMGX. The system works with its multi-node infrastructure in a frequency range of 5 Ghz, so VAHLE can upgrade bandwidth step-by-step as required by the customer. Radio frequency emissions are well within electromagnetic compatibility (EMC) regulations so more than 1Gbit/s can be made available.

All components are designed to allow more bandwidth in the future. This allows the customer to upgrade the transceivers to new software/hardware in the future at a time when everything can still be used so upgrade costs are minimised.

VAHLE is building on considerable experience with its former SMGT system on STS cranes and E-RTGs. For example, a semi-automated E-RTG set-up has been installed in cooperation with Kalmar at the Yilport Oslo container terminal, where in 2019 eight Kalmar E-RTGs were equipped with conductor rail power supply, absolute positioning, and data communication system SMGX. In 2021 the terminal operator added another three Kalmar E-One² into operation bringing the total amount to 11 cranes.
GETTING ALL ELEMENTS TOGETHER

The fourth step is to combine all elements like electrification, positioning and data communication to automate processes or even full automation which leads to a significant reduction of container handling time.

A positioning system connected to the crane PLC and TOS allows it to get permanent feedback in real-time of its actual position. In combination with a data communication system and the TOS link, it is possible to drive the crane to a certain row in the container block. This can be done in semi- or full-automatic mode.

Future developments include the VAHLE TRIMOTION System which provides electrification, positioning and data communication allowing remote operation of the RTGs from an ergonomic and safe office environment. The operator will be de-coupled from the RTG and idle time (approximately 20%) can be eliminated to increase efficiency. However, data communication is only one step to take. The main goal, using the valuable source of an efficient operator, is still valid. Therefore, more steps have to be taken. With an electrified system, such as an E-RTG, both the carbon footprint and operational costs are reduced significantly.

The first fully automated RTGs are operated in Laem Chabang, Thailand. The first phase consisting of total 20 container blocks and 20 brand-new automatic RTGs, has been in operation since 2019.

The second phase of this new terminal extension project is set to commence soon with an expected standard operating procedure (SOP) in the middle of 2022. For this the terminal operator has considered longer container blocks to increase volumes without the need to leave the stack.

The connection of all RTGs to the IT infrastructure will make the following data available:

- Crane positioning
- Crane power consumption
- Video data
- Automation control data
- CMS remote maintenance
- Weight of the container
- Consumption of the grid power in the block
- Function and errors of the crane
- Function and errors of the substation
- Measurement of the substation
- Emergency stop signals

This allows the operator to update and maintain the RTG software and ensures first level support by remote connection. VAHLE support with remote maintenance equipment is possible. This has been very helpful during the pandemic, as VAHLE has supported its customers from a distance during travel bans and flight restrictions.

The system of electrification, positioning and data communication will also be made available for STS cranes. At present STS trolley speed is limited by the need to take the crane operator into account. For new automated/semi-automated STS cranes, however, this limitation is removed, and the USMGX system will ensure high productivity as the trolley speed can be increased and downtime due to environmental conditions such as heavy rain or high speed winds, shift changes, or time-consuming maintenance of festoon systems will be minimised.

VAHLE is building on its experience of STS crane projects where the customer used its USMG (Unipole conductor rail + Slotted Microwave Guide) instead of festoons or energy chains. The USMGX system consists of four or more conductor rails up to 1000A and SMGX data communication waveguide. The trolley could be operated more than 300m/ min travel speed, which no spreader trolley currently works at. In addition, the positioning system will help automate the trolley sequence. This will be required as soon as more ultra large container vessels will approach the container terminals during the daily business.

ABOUT THE ORGANISATION

The VAHLE Group is a value-oriented family-owned business. We think and act sustainably to reach success as a strategic partner with our customers. VAHLE products are renowned for their high-quality, technological innovations and extreme reliability. All VAHLE products proudly wear the “Made in Germany” seal.

Together, the VAHLE Group exceeds sales over 140 million euros worldwide. Consisting of more than 850 employees, including over 550 employed at our German headquarters VAHLE is a truly global company. VAHLE Group includes 12 VAHLE subsidiaries and global representatives active in 52 countries. Further information about Paul Vahle GmbH & Co. KG at: www.vahle.de