CONTAINER TERMINAL AUTOMATION FOR NEXT-GEN PORTS WITH VAHLE

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

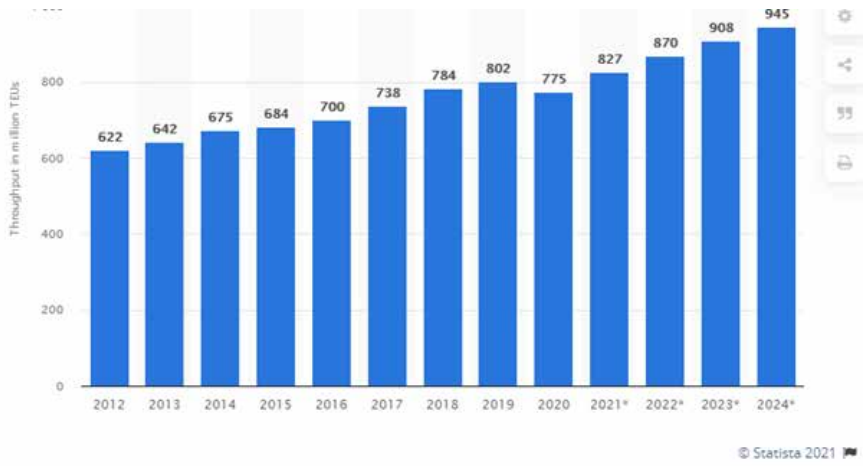


Figure 1.

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.

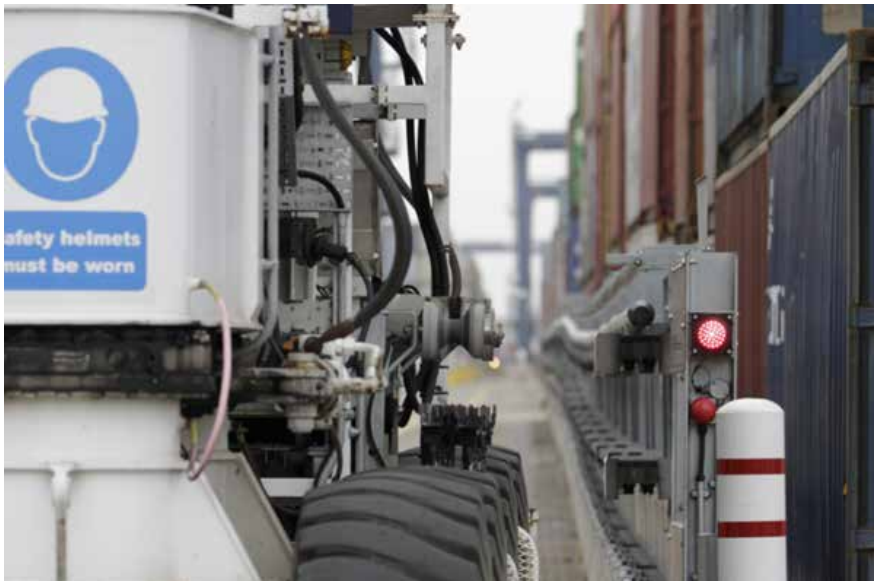
Automation can be considered from the beginning or be integrated on a step-by-step basis on the local requirements, but it makes sense to prepare the IT for yard infrastructure if possible.

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 CO^2 and NO^X 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 CO^2 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

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 substation 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