The path to automation in an RTG terminal

Converting to AutoRTG – the next step towards improving performance

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Automation: The next step towards improving performance

This white paper describes the possibilities and processes of converting a rubber-tyred gantry crane (RTG) terminal to automated operation (Kalmar AutoRTG). Increasing the automation level of a terminal with products that automate a single part of the operation or the whole process is recognised as the next step towards improving performance at today's container terminals. The benefits of automation include lower operational costs as well as improved terminal productivity, capacity, safety and security.

Automating an existing RTG terminal is a large-scale project that requires deep expertise, careful planning, a capacity for wide-ranging systems integration and the ability to consider numerous factors beyond the technical implementation. Besides the actual automated system, there is also extensive change management within the entire organisation of the terminal, as operating an automated terminal requires a thorough change of business processes as well as new skillsets for the people operating the terminal. One way to successfully address these issues is a stepwise approach in converting the terminal from traditional manual operation to automation.

In this paper, we examine several of these topics, ranging from the financial impact of automation to terminal and infrastructure design as well as organisational considerations.

1. Why AutoRTG?

1.1 RTG BENEFITS

Rubber-tyred gantry cranes (RTGs) are the most popular equipment choice for container stacking at terminals around the world, especially where high-capacity stacking and good manoeuvrability are key requirements. With a global installation base of some 8,000 machines, approximately 60% of the world's container terminals use RTGs.

Automated RTGs are suitable for the same types of terminals as manually operated rubber-tyred gantry cranes. The main reasons to choose an RTG setup compared to other terminal concepts include simplicity as well as relatively low capital expenditures and infrastructure costs for deployment. RTGs are also highly flexible; by contrast with rail-mounted automatic stacking cranes (ASCs), the rubber-tyred cranes can be moved to a different area of the terminal if, for example, additional handling capacity is needed at another stack.

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RTGs also offer high stacking density and an easy automation upgrade path that is compatible with older equipment. As RTGs are able to interact with both road trucks and terminal tractors, the RTG concept is equally suited to maritime container terminal operations and inland container terminals. When considering the choice of automation solution and terminal concept, it is important to remember that the question is not an either/or choice. Hybrid terminal layouts utilising multiple horizontal transportation and/or crane technologies are also possible.

Due to large existing RTG fleets, the stepwise automation of current cranes is a commercially viable option for many terminal operators, since it enables the terminal to gain the maximum benefit from current equipment without the need for large additional capital expenditures.

1.2 BENEFITS OF AUTOMATED OPERATION

An automated RTG terminal offers several clear advantages over a traditional manually operated terminal. The most immediate and most easily quantified gains are significant savings in terminal operating expenses such as labour and maintenance costs. Other direct benefits include increased efficiency and flexibility, more predictable operations, higher availability, significantly improved occupational safety, better site security, longer equipment life spans, as well as time saved from eliminating the need for drivers to commute to the cranes during shift changes.

An automated RTG terminal can utilise various options for horizontal transportation equipment. These can range from traditional terminal tractors and manual shuttle carriers to automated guided vehicles, fully automated shuttle carriers, and in the future, automated terminal tractors. When automating an existing RTG terminal with an AutoRTG solution, a major benefit is that the full horizontal transportation system does not necessarily need to be revamped, but the existing terminal tractors can remain in operation.

Automation brings benefits to terminals of any size. In RTG terminals, the benefits typically become most apparent when operating half a dozen or more RTGs. However, even a very small terminal can realise performance gains from the first level of automation (remote-controlled operation). Automation can be implemented in steps from remote controlled operation to fully automated operations. Even a small initial investment will reap immediate benefits, and more can always be added later.

RTG automation is relatively new in the industry; however, proven technologies from ASCs are increasingly being deployed in this field. An often-heard remark from people seeing an automated terminal for the first time is how smooth the operation seems. No aggressive driving is seen, no containers are banging on the ground, and everything

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> Automated equipment conserves resources and contributes to the sustainability of operations.

proceeds in a steady, systematic fashion. In an automated terminal, equipment is always handled optimally. Unplanned repair tasks and collisions due to human error are eliminated.equipment is always handled optimally. Collisions due to human error and unplanned repair tasks are eliminated.

An easily overlooked benefit of automation is that it enables the terminal to keep the full fleet in operation 24 hours a day without significant cost increases or the need to carefully optimise manning levels. As the cranes operate without drivers, and operator idle time is reduced by handling multiple RTGs from one remote control desk in the sequence of work orders, they are available to execute container moves at any time. This enables terminal operators to extend their operating hours and provide the best possible service to customers. During quiet times, it may require only one or two operators to keep the entire fleet in operation, ready to serve vessels. Automation also helps reduce truck congestion during peak hours, while eliminating the need for challenging ”hot change” procedures if crane operators need to move to and from the cranes mid-shift.

Additionally, automated equipment conserves resources and contributes to the sustainability of operations. Significant fuel and energy savings are realised through optimal driving patterns as well as the reduced need for air-conditioning and yard lighting. The latest-generation hybrid and full-electric Zero Emission RTGs provide even greater benefits in energy efficiency and sustainability.

2. Terminal implications

2.1 TIMEFRAMES FOR CONVERSION

The time required for the conversion of a manual RTG terminal to automatic operation depends greatly on the specific design, needs, operational environment and business goals of the terminal, in addition to the target automation level, desired phasing of the project and the amount of equipment. A typical timeframe for an automation conversion might be 12 to 18 months, though this is contingent on numerous factors including the need for possible electrification or Terminal Operating System (TOS) upgrades.

In an automation conversion of an existing terminal, minimum disruption to ongoing operations is crucial. System emulation and careful planning will significantly reduce the time needed on-site, and tasks such as software system integration can be carried out off-site before any activities start at the actual terminal. Pre-integration by the automation system vendor also significantly reduces the time required to ramp up automated operation.

When planning the conversion timeframe, a key consideration is whether to optimise for maximal testing of new systems or for the swift adoption of the new processes and organisational culture required by automated operations. A slower transition will enable more thorough technical testing and training of operational personnel, but a quicker transition may be preferable for organisational reasons. However, a significant part of the preparations and training of personnel can be done in advance with training simulators and emulation.

2.2. MANAGING THE TRANSITION PERIOD

In any brownfield automation project, a key priority is carrying out the conversion with minimal disruption to the existing operations of the terminal. This requires careful advance planning. Prior to the actual automation deployment, the terminal can start by implementing process automation features that they can benefit from when eventually extending the automation level of the RTGs.

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An RTG terminal can be automated in several steps, each increasing the level of automation. Automating an RTG terminal does not necessarily require any changes to the terminal layout, but an automation-optimised layout may improve efficiency.

An alternative way of implementing automation in a brownfield terminal is one stack block at a time. This method enables the adoption of the desired automation level in one go, and may be the most efficient way to deploy automation at an existing terminal. It should also be noted that all cranes do not need to be equipped with the same level of automation. This allows the reuse of existing cranes and enables scenarios such as having some older RTGs retrofitted only for remote control, while newer cranes are equipped to a higher automation level.

Automation implementation is not just a technology project, but involves changes to all areas of the terminal. Therefore the change management of the entire operation has to be planned carefully from the very beginning. The professional profile of the people operating and managing automated equipment will be markedly different from the staff running a manual terminal. Completely new skillsets are needed, and maintenance standards will need to be revised thoroughly. A well-planned automation project will encompass training of the workforce as well as further development of the skills of equipment operators by utilising simulation tools.

3. Infrastructure

3.1 THE BIG PICTURE

When automating rubber-tyred gantry cranes, the existing terminal infrastructure can in most cases be kept as it is. However, the productivity of the automation deployment will be higher if the terminal layout is adjusted for automated operation.

An RTG automation conversion project can also be a natural point at which to carry out forward-looking upgrades on terminal equipment. For example, diesel-electric RTGs can be upgraded to cable reel powered electric RTGs that will be easier to automate in the future, since the cabling for fiber-optic connectivity is already in place. Other potential modifications include the installation of additional cameras that improve operator visibility and ergonomics, as well as power unit upgrades and general crane overhauls. Crane electrification also contributes to improved sustainability of operations by significantly reducing on-site emissions from the equipment.

3.2 SEPARATING PEOPLE AND MACHINES

The number one priority in an automated terminal is maintaining strict separation between automated operations and areas in which people work, and designing safe yet practical interfaces between the two. In an AutoRTG terminal, particular attention needs to be devoted to truck lane operations in which road vehicles and their drivers need to enter the container handling area.

For automated horizontal transport, processes must be developed for all activities that involve people moving in the same space as the transport equipment. These include, for example, the handling of exceptions. All non-standard cargo that requires manual handling also needs to be kept out of the automated operating area. Furthermore, outside the actual container yard, the terminal must implement process automation solutions to carry out some of the tasks that have previously been handled manually, for example job selection based on the visual detection of arriving trucks in the truck lane.

High terminal productivity can be expected only when the amount of exceptions in the process is minimised, and the handling of the remaining exceptions is as efficient as possible. Human error is by far the most typical source of exceptions; i.e. unexpected behaviour of the people in the area causes the crane to stop the operation. At many terminals, this issue has been resolved by introducing compulsory induction procedures for all people that are present in the container terminal. Even truck drivers are expected to attend the induction sessions before they are granted access to the terminal. This minimises human errors, reducing the amount of exceptions in the process while also improving occupational safety.

3.3 SOFTWARE INTEGRATION

Automated equipment is only as good as the software controlling it. To obtain the desired performance from automated container handling equipment, the terminal's ERP (Enterprise Resource Planning), TOS and other systems must be up to the task, and designed to seamlessly fulfil the required business processes while providing efficient ways to handle exceptions.

An efficient automated terminal requires that business processes are mapped carefully, and that the systems are designed to follow these processes. Software integration needs to take place at all levels, from yard equipment to process automation. The complete system design, including all subsystems, has to be implemented according to a single set of business processes and exception scenarios, where the roles and interfaces between the subsystems and users are clearly specified. An important area of managing the automated terminal is providing intuitive user interfaces that not only present the right information about the operation in a usable format, but also give fast and easy-to-use means to handle exceptions.

Smooth and efficient deployment of new technology in an automation project requires thorough testing to ensure that all subsystems form a solution that complies with planned business processes. The execution of all business processes has to be confirmed first in a lab environment where all subsystems are present and end-to-end scenarios have to be verified with simulation and emulation before testing in a live environment. Testing should not focus only on routine 'happy day' scenarios that present few major problems, but on exception situations that typically cause the most significant disturbances in the real operation.

Kalmar offers a comprehensive emulation environment that runs an authentic terminal logistic system with simulated vehicles and cranes. Complex deployments can include a number of different software versions and releases from multiple vendors, which can all be tested beforehand with actual terminal data. Operational improvements can be verified with emulation to identify and solve potential bottlenecks with new software versions.

For successful software and system integration, substantial benefits can be gained by delivering the automation system and TOS as a pre-integrated package that guarantees that the products are designed to work together. Since the software has to be kept up-to-date over the entire lifetime of the automation solution, this model can also help ensure the crucial long-term compatibility between future versions of the products.

3.4 INTEGRATION SERVICES

Integrating an automated container terminal is a significant task that demands seamless interfaces between numerous systems and subsystems. The task can be simplified greatly by professional services delivered by a trusted systems provider. In addition to testing, such services can include, for example, integration management that involves coordinating multiple sub-projects to deliver a single solution to the customer, or operational consulting that identifies ways the terminal can improve its processes.

4. Automation conversion

4.1 DEGREES OF AUTOMATION IN AN AUTORTG TERMINAL

RTG terminals can be set up with several levels of automation, from basic crane remote control all the way to fully automated operation. The desired automation level can be selected based on the existing systems, operating environment and business goals of the terminal. Typically, process automation is deployed prior to – and alongside – automated equipment as the first step in gaining the benefits of terminal automation.

4.1.1 REMOTE CONTROL

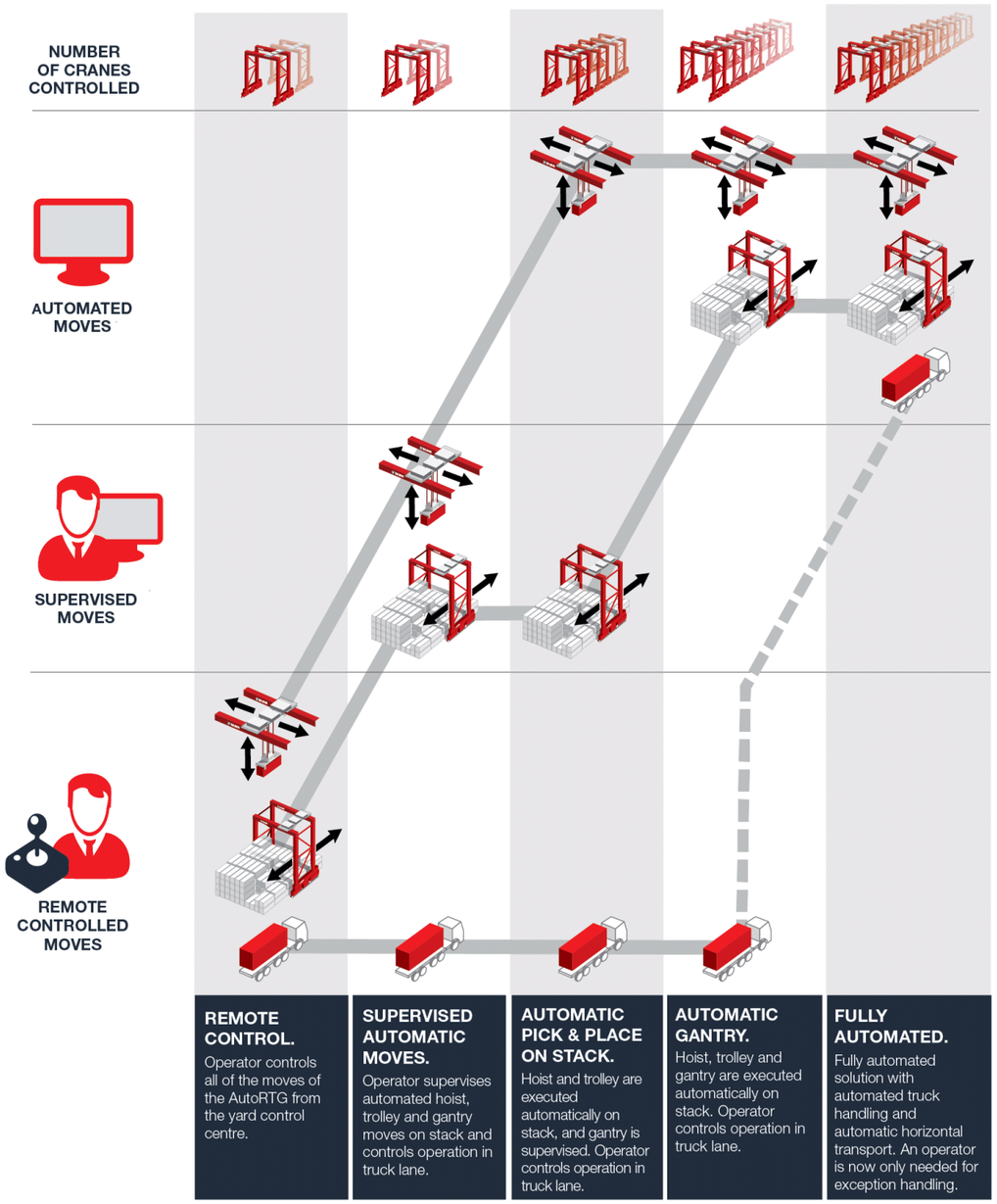
The most basic level of terminal equipment automation is remote control, which already enables a single operator to control multiple cranes. For manual RTGs, crane idle time is usually up to approximately 50% of crane operating hours. In a typical situation, a terminal might need to keep 10 RTGs manned at night even with only a few road trucks arriving, because the required containers are located in different stacks around the yard. In this kind of situation, remote control provides the biggest advantage, since the fleet of 10 RTGs can be kept fully operational with only one or two crane operators during quiet times, whereas with manually driven cranes one person per RTG would be required.

Remote control provides the possibility of optimising the manning level of the terminal based on the true amount of moves needed, instead of the number of operational cranes, as the operators are located in an office environment at remote control desks, able to take control of any crane in the terminal. Typically, a single operator can manage up to three RTGs remotely, and during quiet hours this ratio can be much higher. Remote control also offers other benefits such as eliminating the time needed for crane operators to commute to and from the RTGs in the yard.

4.1.2 SUPERVISED AUTOMATIC MOVES

At the next level of automation, RTG operation is fully integrated with the TOS, so jobs are handled in an integrated solution and not in a separate equipment-specific system. Connection of the control desk to the crane is automatic once the job arrives. At this level of automation, the crane executes automatic gantry and trolley moves to the target location, as well as automatic hoisting in the stacking area, all under the operator's supervision.

Supervised operation saves valuable seconds on each move, as the crane automatically positions itself accurately over the target container. In addition to providing significant incremental time savings, the automated moves are smoother, resulting in less wear and tear on equipment and containers. Upon completion, jobs are automatically reported to the TOS, which reduces human errors.



In the view of the authors of this paper, the most practical way to automate an RTG terminal is a phased, incremental conversion following the automation levels outlined above.

This level of automation (supervised operation with automatic gantry steering) is the current norm in new RTG installations. Other automated solutions that are rapidly gaining ground include container location systems as well as stack profiling which increases safety through improved collision avoidance.

4.1.3 AUTOMATIC PICK & PLACE ON STACK

More advanced automation features can be added for even higher efficiency and performance. In semi-automated RTG operations, the crane executes automated trolley movements in addition to automated container pickup and ground placing in the stack area. With all hoist movements automated in the stacking area, this level of automation significantly decreases the required operator time per container move. Gantry movement takes place under operator supervision, while truck lane operations and exception handling are accomplished by remote control.

4.1.4 AUTOMATIC GANTRY

The level of automation can be taken even further by automating gantry moves. At this level of automation, trolley, hoist and gantry movements are all executed automatically in the stacking area. The operator controls the crane by remote control only in the truck lane. If desired, stack housekeeping can also be automated.

4.1.5 FULLY AUTOMATED

Finally, in a fully automated RTG setup, all crane functions including hoist operation, container picking and placing, gantry moves and truck lane operation are automated. If needed, an operator can still step in to manage exceptions remotely. With an automated RTG system, operator time per crane move is minimised, and stack housekeeping can be fully automatic.

4.2 STEP-BY-STEP AUTOMATION APPROACH

In any terminal automation project, the key consideration is maintaining maximum throughput during the conversion. Many terminals have containers moving 24/7 at the quay and roadside, so operations cannot be shut down completely for automation deployment.

In the view of the authors of this paper, the most practical way to automate an RTG terminal is a phased, incremental conversion following the automation levels outlined above. However, this is not the only option, as areas of the terminal can also be automated in one go, for example on a block-by-block basis. The optimum choice will always depend on the business needs of the terminal.

Whether automating the terminal with a step-by-step or block-by-block approach, the cost savings can immediately be measured and evaluated as the conversion progresses. A well-planned automation project will also involve adding readiness for future automation levels that may be needed at a later date.

4.3 PROCESS AUTOMATION

Irrespective of the automation level and conversion type chosen for the RTGs and other terminal equipment, an additional way to realise significant performance gains in any terminal is through software-based process automation. Small incremental productivity gains from keeping track of containers, eliminating manual input of information, and optimising crane, container and equipment moves add up to significant savings per year. Process automation is an easy way to begin automating a terminal and will continue to deliver increased value as more of the equipment is automated.

Process automation contributes to the performance of an automated terminal in two ways. Firstly, continuous tracking of containers and horizontal transportation equipment enables fleet usage and container moves to be optimised on the level of the entire system. Secondly, process automation radically reduces the amount of human errors due to factors such as incorrect data entry or manually completed work steps.

Converting an existing RTG terminal to automation does not necessarily require redesigning all of the existing processes at the terminal; however, it is crucial that these processes are well understood and documented in order to reap the full benefits of automation.

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5. Safety and security

Safety is always paramount in any terminal operation. Automated terminals provide significant improvements in occupational safety by keeping people out of the operating area of moving heavy machinery. As an example from automated straddle carrier terminals, the Patrick container terminal in Brisbane has become one of the safest in the world since the adoption of the Kalmar AutoStrad™ system. At the time of writing, the terminal has operated for nine years with zero accidents.

An automated RTG terminal requires safety ”by the book”, but the deployment of appropriate safety solutions is complicated by the fact that automated container handling is still a relatively new development. To comply with existing industrial safety standards and legislation, a significant amount of work is required to ensure that automated crane solutions are certifiably safe in a production environment, and not all manufacturers may be willing to voluntarily undertake the necessary effort. However, once a baseline safety analysis of the operating concept has been completed, it can be used as the foundation for the safety design of future automation deployments.

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As part of the AutoRTG development process, Kalmar has undertaken an extensive OHA (Operational Hazard Analysis) that comprehensively identifies and classifies the potential occupational safety risks associated with automated RTG operation, and enumerates the solutions required to mitigate these risks. These solutions may involve hardware or software features of the automated system, or operating procedures at the terminal.

The most crucial safety element in any automated terminal is maintaining strict separation between automated areas and those with people working in them. In an RTG terminal, the key area to consider is the truck lane, which must be engineered to provide a safe yet practical interface for loading and unloading road trucks. Particular attention must be paid to the driver interface and the driver waiting areas. To maintain adequate throughput with roadside operations, road trucks must also be able to drive safely in and out of the truck lane at designated places along the length of the truck lane.

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For RTG operations, a key safety consideration is container handling, both in the stack and during loading/unloading. Essential safety features in the truck lane include two-way audio capability that enables the truck driver to communicate with the remote operator in exceptional situations. For the operator, clear visibility to the truck lane via multiple camera views is crucially important.

Safety can be further improved with automated gantry steering; truck lift prevention, which prevents a locked chassis from being accidentally lifted; and stack profiling, which eliminates the risk of containers being knocked off the stack due to collision.

As automated RTGs can accommodate any type of automated or manual horizontal transport equipment depending on the needs and existing infrastructure of the terminal, the required safety solutions will need to be adapted based on the type of horizontal transportation solution chosen.

In addition to infrastructure and terminal layout considerations, a new safety mindset will need to be instilled throughout the workforce. Adoption of safe working procedures for accessing the automated area is required, and employees will also need to be trained locally – a safety handbook in English is not enough.

An automated terminal will bring about a major change in the overall working conditions of operating staff. By transitioning to indoor desk work, employees will no longer need to work outdoors exposed to noise and other emissions, cold and heat, bad ergonomics or vibrations.

Automated terminals also improve the security of both cargo and personnel thanks to automated container handling and location tracking of all containers. Containers are not accessible in the automated zone and cannot be set down in unauthorised areas. Increased security contributes to customer trust and terminal competitiveness while reducing financial losses.

6. Maintenance

Manual crane systems will work even if the equipment is not in perfect condition, since human operators can often compensate for the quirks and deficiencies of each individual piece of equipment. By contrast, automated equipment always needs to be in 100% working condition to deliver its full potential.

> With automatic operations, the emphasis shifts to more frequent preventive maintenance.

This requires a major change in practices and attitudes for maintenance operations. With automatic operations, the emphasis shifts to more frequent preventive maintenance. However, as this maintenance is usually done at planned intervals, the caused impact to the operation is minimal. As collisions and other accidents due to human error are eliminated, the need for ad hoc repairs is reduced dramatically, bringing cost savings in the long term. Automated equipment can also provide continuous updates on its status and send alerts when any faults are detected.

7. Automating existing equipment

The actual automation of most RTGs of recent model years is relatively straightforward. Steering and driving is controlled by onboard automation systems instead of from the cabin, while sensors and data links are added for control, monitoring and system diagnostics.

Electric RTGs with cable-reel power and existing fiber-optic connections are the easiest to automate, as the same cabling can be used for remote control signals and zero-latency video feeds. Diesel-electric RTGs can also be converted to fully electric operation, which will reduce emissions and can cut fuel costs by as much as 95%. The return on investment can be less than two years. A turnkey project includes the design and supply of power grid connections, substations, a conductor-bar system or cable-reel integration, taking into account the full chain of interacting components.

Kalmar's automation solution is suitable for use with any brand of RTG together with Kalmar equipment. However, there are limits due to the age and type of cranes that may not be practical and/or economical to automate, potentially leading to less than optimal performance. In older RTG models, sensor installation may not be feasible, but it is likely that they can still be remote controlled. A terminal can also successfully run different models and generations of RTGs at various automation levels.

The best automation solution will always be based on the needs of the terminal. Working with a fully integrated system from a single vendor – and upgrading equipment when necessary – is often the lowest-risk and most cost-effective solution in the long run, when considering the lifetime maintenance of the solution in the rapidly changing world of new technology.

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> An automated terminal requires a different profile of employee.

8. Human resources

The largest and most immediate cost savings from automation are due to the significantly fewer operators required. Typically, a single operator can handle two to three AutoRTGs remotely, and in quiet periods even up to six machines.

8.1 CHANGING SKILL SETS

Automation is where IT meets engineering. In a traditional manual terminal, these are typically two separate teams that have little contact with each other. With an automation rollout, they need to start co-operating and form a joint team in which the skills and responsibilities of the people match each other and mutual responsibilities are clearly defined.

An automated terminal requires a different employee profile. A more advanced level of maintenance engineer skills is also required for the stricter maintenance standards of automated equipment. In addition, automated operations will require new, different skill sets in several other areas, including:

- Data and fact-based usage and analysis compared to operators reporting faults in equipment
- Understanding the operating principles of automated equipment and systems
- Systematic planning of operation and maintenance work

The most significant cost savings from automation are due to the drastically smaller number of operators required. Typically, a single operator can handle two to three AutoRTGs remotely, and in quiet periods even up to six machines.

New tasks that will need to be handled include automation system specialists; system optimisation engineers; IT system service and maintenance professionals; and instructors for internal staff and external parties.These competences can be built in-house or sourced from a trusted external provider.

Successful and sustainable automation also requires new key performance indicators (KPIs) for operation planning. These can include system and subsystem-level performance measurement, tracking of deviations from the normal level of performance, and operation accuracy measuring. KPI measurement is usually part of the automated system software and is monitored and reported automatically.

8.2 NEED FOR OPEN DIALOGUE

In many geographies, limited availability of personnel, even at competitive salaries, is a challenge. Automation can help mitigate this issue, but also changes the profile and structure of the terminal workforce. In general, an automated terminal will require a smaller but more highly trained staff. Automation provides new job opportunities, but also places additional demands on the workforce.

Successful change management requires an open dialogue with all relevant parties. Human resources need to be taken into account from the beginning. The significant workforce impact of automation needs to be considered and planned carefully, working in cooperation with local labour organisations and other stakeholders. Conditions, legislation and industry labour norms will differ greatly from geography to geography, so these questions can only be fully answered by the terminals themselves.

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> An often overlooked or underestimated fact is that automation implementation is foremost a major culture change in how a terminal operates.

9. Change management

An often overlooked or underestimated fact is that automation implementation is foremost a major culture change in how a terminal operates. For an automation deployment to be successful, managing this culture change is more crucial than the technical implementation.

The job profile of the workforce will be transformed, a new maintenance approach is required, IT and engineering operations will need to converge, and business processes will need to be mapped and planned more carefully than before.

Whether creating a new automated terminal or converting a manual terminal to automated operation, change management is crucial. Equipment is easily replaced, but human behaviour takes more time to adapt. Change is inevitable, so the question is how to manage it.

10. Financial impact

10.1 METRICS

Kalmar can work together with the customer to calculate the financial impact of automation in different operational scenarios and with various levels of automation. The exact numbers (OPEX, CAPEX, payback time, ROI) will vary depending on the automation approach taken. Savings in salary costs are the simple and immediately obvious benefit that is easy to calculate together with the automation vendor. For more detailed long-term projections, the terminal is the best expert in forecasting their own future volumes and operations.

Automation projects always revolve around a basic wishlist – an idealised implementation that encompasses the swiftest possible deployment, maximum performance improvement, and a totally integrated turnkey solution. Success in practice will depend on skilful optimisation of these and numerous other factors.

10.2 INTEGRATED SOLUTION

A key consideration in an automation project is implementation time. On one hand, terminals seek to minimise the cost of conversion, often by combining components from multiple vendors. On the other hand, every interface between two systems needs to be not only integrated, but also maintained through the lifetime of the solution. The simpler the overall system and the fewer interfaces that need to be integrated and tested, the faster the implementation.

Simply optimising for the cost of individual subsystem components is a short-sighted approach. A delay of just a few weeks on a major automation project can cost of millions of euros in terminal downtime as time to value is extended. If automation is built with a ”bits and pieces” approach, the terminal may save in the very short run, but these savings can be lost already at the deployment stage due to the added complexity of integration and slower ramp-up of productivity. By contrast, a vendor that can offer a completely integrated turnkey solution, based on a trusted automation platform, will be able to provide a system that is not only deployed faster, but is also more cost-effective as a whole, while providing lower lifetime maintenance and support costs. Similarly, purchasing a ”one-off” automation solution that requires additional solutions to be developed on an ad-hoc basis carries a very real risk of stranding the terminal without support for some of its subsystems in the future.

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10.3 ADDITIONAL SAVINGS

In addition to the direct benefits of lower operating expenses and improved terminal performance, automation offers indirect cost savings in numerous other areas. Automatic driving eliminates collisions and accidents in the container yard, which will decrease the insurance premiums of the terminal.

For an RTG terminal, automation can also safely enable somewhat higher stacking density, as many manual terminals currently leave the stack partially lower on the truck lane side due to safety reasons.

10.4 COMPETITIVE ADVANTAGE

Compared with numerous other fields, automation is still a new development for the terminal industry. Automation adoption rates vary greatly from geography to geography, and terminals will look to the automation level of other terminals on the same trade routes and/or in the same region.

Terminal demand for AutoRTG solutions has been growing markedly in the last few years. At the time of writing (early 2018), competitive advantage is still available for first movers that adopt automation sooner than their competitors. Conversely, without automation, terminals will inevitably fall behind in competition against automated terminals in the same region. In the worst case, this may even mean the end of business for the terminal. The choice of terminal automation concept can also be significant factor in whether the terminal is able to maintain its competitiveness. Selecting a deployment based on a proven, standardised platform instead of a completely tailor-made one-off solution ensures lifetime support for the system and minimises the long-term risk of the automation conversion.

For greenfield terminals, automation is already the norm rather than the exception. It is highly unlikely that any major new terminals will be built for traditional fully manual operation, at least without very careful consideration of all available automation options. For existing terminals, the benefits of automation are equally clear, and over the next few years these benefits will be reaped by forward-looking operators seeking to stay ahead in today's intensely competitive global container shipping industry.

11. Case study: Dublin Ferryport Terminals

Dublin Ferryport Terminals (DFT) serves a highly competitive market in connecting Dublin with ports and terminals predominantly in the Rotterdam and Antwerp region. Part of the container and terminal division of Irish Continental Group, DFT operates the most modern container terminal at Dublin Port, handling approximately 335,000 TEU each year. The terminal primarily serves feeder-type vessels in the 900 TEU class, but expects a volume growth of some 20% over the next five years.

With eight RTGs purchased between 1999 and 2002, now nearing the end of their service life, DFT had the ideal opportunity to move to an incrementally automated RTG solution that helped address the current business needs and operational challenges of the terminal. These include accommodating increasingly tight ship turnaround times, a shortage of available labour in Dublin, and a desire to improve the predictability and safety of operations.

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> Kalmar stood out as the ideal partner for our company.

Starting in 2017, DFT have purchased two new Kalmar AutoRTGs and are looking to replace existing manual machines with additional driver-assisted automated RTGs over the coming years. Service, maintenance and technical support will be provided by Kalmar's site-based engineering team with a permanent presence at the terminal.

The automation development will proceed step-by-step, beginning with the first two RTGs operating under remote control with supervised operations. This enables automated crane moves to the target location. At this stage, Kalmar TLS software will be introduced and integrated with the terminal's existing TOS. Ultimately, the automation deployment will encompass semi-automated and automated functionality that will allow the terminal to reap the full benefit of the AutoRTG system.

Kalmar is delivering the solution as an integrated turnkey deployment. In choosing Kalmar as the sole system provider, DFT's decision was based on Kalmar's commitment to automation, as demonstrated by the capabilities of the company's Tampere Competence Centre; its long experience in Automated Stacking Cranes (ASCs); and DFT's prior history with Kalmar, which extends back nearly two decades.

"As a trusted long-term supplier with a demonstrated ability to deliver on our expectations and their commitment to be a technology leader in this area, Kalmar stood out as the ideal partner for our company," said Alec Colvin, General Manager at Dublin Ferryport Terminals.

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Vice President, Intelligent Crane Solutions, Kalmar, is a container terminal automation professional with more than 15 years of experience in research and development, product management and sales in the international business environment. His background is in Kalmar straddle carrier and shuttle carrier automation development. He led the project of the onboard automation control system design for automated straddle carriers including software architecture design, software development, testing, commissioning and support in Patrick's AutoStrad terminal project in Brisbane during 2000–2007. Timo currently leads Kalmar's Intelligent Crane Solutions business line.

TOMMI PETTERSSON
Vice President, Automation, Kalmar, has strong experience in software and hardware development, automation project management and project sales as well as related business model development. Before joining Kalmar in May 2014, he worked as CEO in a Finnish industrial investment and development company focusing on demanding automation solutions, and, prior to that, in management positions at Elqotec, a consumer electronics contract manufacturer.

MIIKKA HAAPA-AHO
Director, Automation Retrofits, Kalmar, started his career at Kalmar in 2008, and has worked in several departments in different roles during his 10 years in the company. Currently Miikka is focusing on automation retrofits of Kalmar and third-party equipment. Miikka holds a Master's degree in industrial management and production engineering.

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

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