Improving the operational performance of STS cranes

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As global trade continues to increase there is a steadliy growing worldwide demand for container handling capability at the lowest possible price. Competition is sharpening as new container terminals are being built using the latest technology and existing terminals consider ways to increase their capacity while decreasing their cost. Not only is the total volume of annually shipped containers growing but so is also vessel sizes and the number of containers handled in a single port of call. Whether a large new terminal with massive automated yard handling capacity or a smaller terminal trying to keep up with competition, they all have the same strong incentives to improve the operational performance of the STS cranes in their terminals. To meet the increased demand in quay crane capacity, different strategies can be adopted using a larger number of cranes or more complex crane designs such as dual trolley or dual hoist cranes. For all types of mechanical crane designs automation features can be implemented to increase a crane's productivity and decrease its operational cost further.

Even though there are evidently strong incentives for improved STS crane productivity and automation concepts can be used to achieve these goals, there has been widespread resistance against fully adopting the concept of automation in the crane business. Automation features have been perceived by some as too complex and by others as resisted among the crane operators since there is something in the notion of automation inherently conflicting with their professional pride.

However, as STS automation has been around for quite some time by now and as terminals adopting automated rail mounted gantry cranes as their choice for yard container handling bear witness of the proven large scale productivity gains due to automation, the general view is changing. Confidence in crane automation is growing as the concept is gaining a more widespread understanding and acceptance.

Terminals actually using their STS automation features indicate that with the implementation of proper operational policies and providing the right incentives for operators and maintenance personnel STS automation can successfully be implemented to increase the overall operational performance of a terminal. The rapid development in areas such as sensor technology promise that the future will see a continuing development in crane automation systems.

Automation technology

Over the years ABB has been pushing the frontier of container crane automation in terminals worldwide and has developed a wide range of products and systems for the automation of both STS and yard handling RMG cranes. By choosing to combine these products and systems in different ways, an STS crane can be equipped to a varying degree with automatic features to aid the crane operator in achieving productivity benefits while still maintaining control and responsibility over the crane in every situation. The automation of STS cranes is sometimes referred to as semi-automatic since a crane operator is always present to supervise the automatic motion and to handle the parts of the job sequence requiring manual operation such as for example pick up and set down on the vessel. Over the world ABB crane automation has been applied to regular STS cranes as well as dual trolley cranes and soon the world's first automated dual hoist STS cranes will be in production. The ABB STS automation product portfolio includes a series of optional products that can be combined freely to create a suitable automation solution for any needs:

Electronic Load Control (ELC)

The ELC system provide sway free manual operation of the load by means of Sway Control and automated travel cycles between any selected positions on vessel and quay following an optimal safe path and accurate positioning at the target by means of Position Control.

Ship Profile System (SPS)

A laser based ship scanning system generating a height profile of a vessel for use in providing the optimum safe path for the ELC. By enabling main hoist smart slowdowns and trolley obstacle avoidance over the ship, the SPS guarantees fast and safe container handling over the vessel.

Skew Control

By minimising the skew motion of the load and controlling the skew angle to a given reference, Skew Control speeds up the landing sequence on both vessel and quay. Skew pendulum is usually induced by unevenly distributed load, the wind or by mistakes during landing.

Chassis Alignment System (CAS)

The CAS system guides the terminal chassis to stop in a proper position aligned to the crane enabling faster loading and unloading cycles. The chassis driver is guided by means of traffic lights mounted on the crane. The chassis position is measured by laser and CAS can be used with ELC and Skew Control to provide an accurate target reference for automatic positioning to speed up landings even further.

Automated Container Landing System (ACLAS)

ACLAS allows the crane to perform fully automatic cycles from ship to quay by performing fast and safe automatic landings independent of the crane operator skill. ACLAS use ELC, CAS and Skew Control.

Terminal Logictics Control Interface (TLC)

When provided with a TLC interface the crane is connected to the terminal logistics control system and thus further integrated into the terminal. Scheduling of work can be sent directly to the crane by giving the control system direct work orders to pick up or set down a container in a given position. Such work orders are then executed by the crane operator either manually or by starting and supervising the automatic job cycle.

Spreader Control

If the crane is connected to a terminal logistics control system and is being sent work orders that are executed by the crane operator, the information in each work order is used to automatically operate spreader telescope, flippers and twistlocks.

Benefits and doubts

Automation systems and products contribute to a consistent long term performance. Between any position and target lanes on the quay, or cells on the vessel, an automated travel cycle follows an optimum path saving energy while performing safe and fast travel and accurately positions the load without sway over the target. This is done over and over again regardless of the skill or experience of the crane operator. The consistency and safety in the operation of automated travel cycles come from the fact that the control system executes a safe and predictive behaviour according to set rules regarding path optimisation, obstacle avoidance, safe heights etc. Combined with laser based scanning of the ship and chassis an optimal path in terms of speed, energy consumption and safety is combined with fast and accurate positioning of the load over the target lane or cell enabling faster landings with fewer time consuming mistakes.

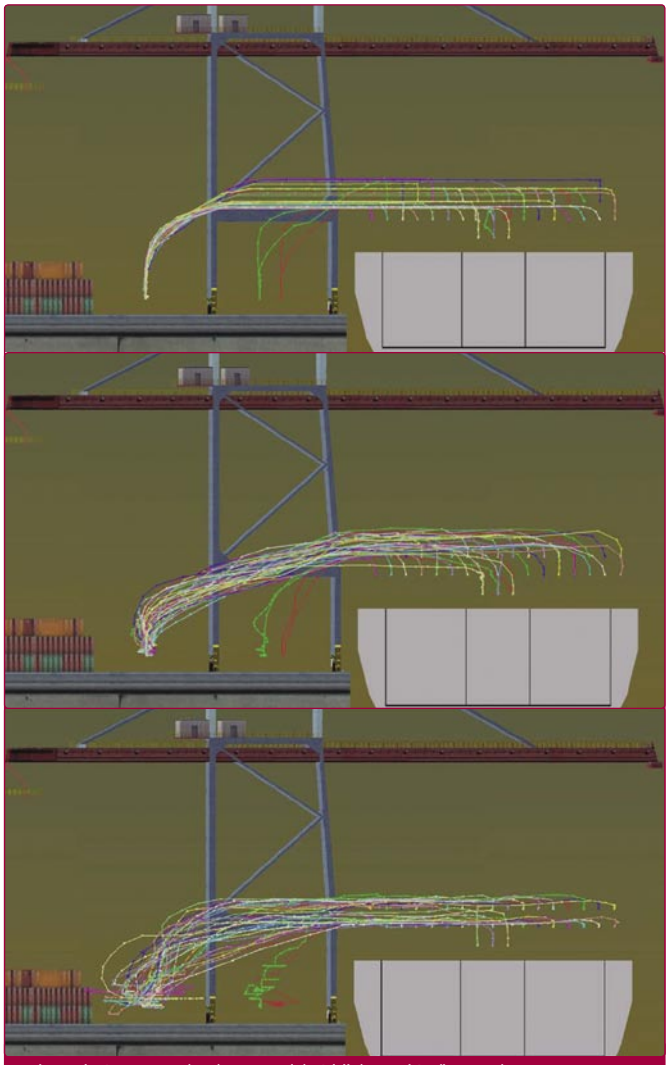
In fact, the situations where a skilled human operator loses time against automated motion are when mistakes are made, for example during landing on a chassis causing sway or skew motion on the load that the driver has to wait for, or in other ways actively dampen, before landing is possible.

Automation does not make these kind of mistakes thus performing consistently over and over again. On the other hand, this consistency comes at the price of sometimes waiting too long during landing or fine positioning over the target compared to what a human driver might have done before the system is sure of having the correct position without too much motion, in strong winds for example. These are the type of situations where a skilled driver, used to operating with the aid of automation features, can intervene and take over the motion to finish a job when opportunities arise using the superior human sense of timing.

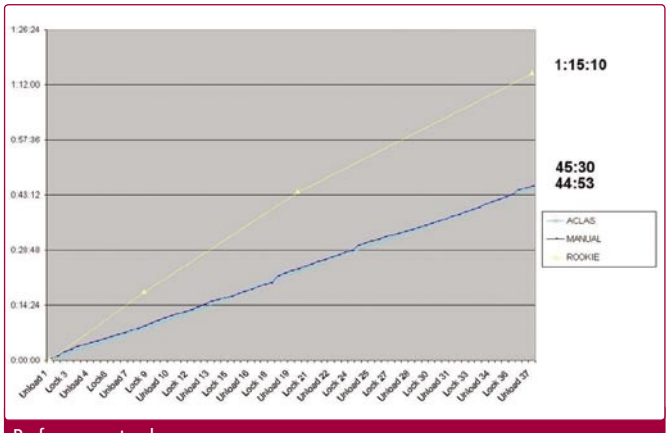
The consistent and predictive behaviour of automation make all drivers perform better as they get used to working in close cooperation with the system. This is especially true for those less experienced or skilled, thus making a fleet of STS cranes perform in a more consistent and predictive way that makes berth planning easier since it no longer matters as much who is operating which crane. Driver skill still matters, though, more in the margin of production rates. But since automation can make the driver relax for a longer part of each travel cycle, it thus makes it possible for him to focus solely on the really important sections of a move where it is really possible to save time, such as when landing on the vessel and quay (if this is not done automatically). Thus even a skilled operator will perform better in the long run using his skill and concentration where and when it matters the most.

Overall production rates are increased when the difference between skilled and less experienced operators is decreased. If the right incentive strategies are used to encourage all drivers to make full use of available automation features, without making them feel it gets in their way of possibly benefiting from professional skill, it is possible to get more out of every driver and achieve a higher and much more predictive productivity rate.

For many terminal operators as well as crane operators and maintenance personnel the concept of automatic systems aiding their work is new and might seem very complex. To the experienced crane operator automation might be looked upon as conflicting with their own professional pride and a source for concern of being marginalised into a supervisor. Other doubts concern the complexity level of a crane equipped with automation systems and products in terms of maintenance costs and the required skill of maintenance personnel and the conception that a more complex object is less reliable. But, since the skill of the operator still affects the performance level of an automated crane as well as for a completely manually operated crane, such doubt can be turned around into the optimism of gaining new tools aiding them in their profession. Perhaps such



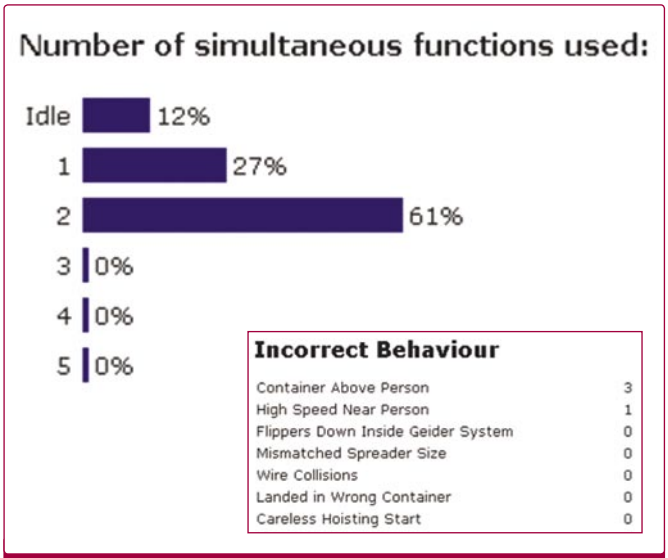
Path analysis: ACLAS (top); Manual (middle); Rookie (bottom).



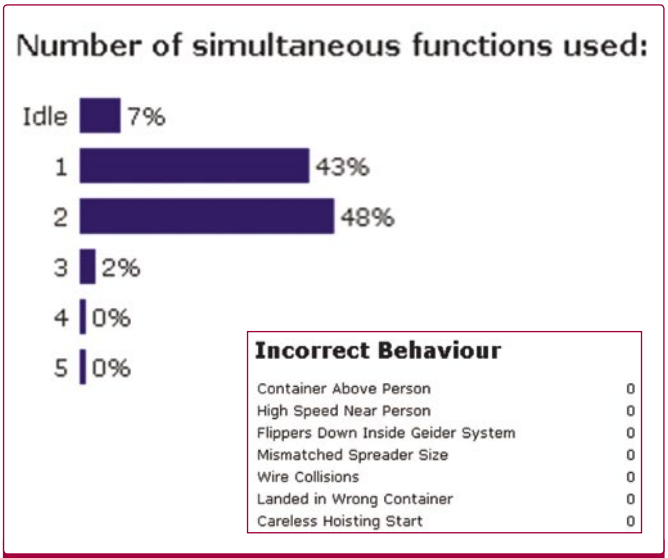
Performance track.

a change of mindset needs to be accompanied by the proper guidance in terms of a changed view on crane operator reward programmes creating an incentive to encourage this change in opinion towards automation. And as technology improves and products have been around for a longer time, their quality, and reliability increase and the knowledge of their proper maintenance and operation increase.

When summarising the feedback from terminal operators having implemented an automated concept, it can be said that initial doubts are often dissolved over time giving way to considerable optimism. However, really taking care to implement operational directives and policies is a key factor in a successful



Manual Behaviour.



ACLAS behaviour.

implementation of automation strategies. Success of automation is all very much about the mindset of terminal managers, operators and maintenance personnel. Introducing automation on a small scale can be an opportunity to start the mindset changing process to be ready to keep up with the continuing development in crane productivity to survive in competition. Automation is changing the container handling process; it is simply a matter of how fast.

Simulator tests

In an effort to evaluate some of the above suggested benefits and the productivity of STS cranes equipped with ABB automation systems, testing has been performed in a crane operator training simulator. The ABB STS Crane Simulator is a real-time physics simulation of vessel, quay, crane, chassis, containers etc. interacting with an actual ABB crane control system running the same software as those installed on real cranes worldwide. In this very realistic simulator, the crane operator is sitting in a regular operator's chair mounted in a steel cage on hydraulics moving as a real crane would have and the operator is surrounded by large screens showing the views in all directions as they would have been seen in a real crane thus creating a simulation as close to reality as possible.

The test scenario consisted of unloading 37 containers of 40ft and twin 20ft size from a vessel to terminal chassis. Two operators with different backgrounds, skill and experience ran the same scenario while the system continuously recorded the performance and behaviour of the drivers allowing for a complete analysis of their operation. The first test subject was a professional and very skilled crane operator from the Port of Gothenburg. The second test operator was a rookie with only a few hours experience. The skilled driver had to drive the crane completely manual while the rookie used all automation systems available, such as the automatic container landing system ACLAS. The rookie also performed a manual test run to obtain an indication of the possible increase in performance for a very inexperienced operator.

The conclusions of this testing confirm that inexperienced or less skilled drivers heavily increase their productivity. A skilled driver can still outperform automation during shorter time periods by executing some very aggressive driving, on the edge of taking chances, until a mistake is made or concentration is lost. Automation brings the minimum productivity level up, while at the same time allows skilled drivers to increase their total productivity by relaxing them for the major part of a travel cycle enabling them to focus on the important tasks, where time can be lost if a mistake is made, and to keep up their good work for a longer session. Automation performs consistently over time and never gets tired. Paths are smooth saving energy compared to manual driving and an optimum and safe path is always followed.

The future

As there are strong incentives for terminal operators to consider automation for increasing their productivity while decreasing costs, crane system suppliers have an equally strong incentive to continue their development of new and improved solutions for their customers. One possible vision for the future of STS automation is that as sensor technology improves, new possibilities open up, such as performing automatic identification of containers and people working on a ship and safely performing automatic landing on the vessel.

As new large container terminals are being built in many places, yard automation is already an accepted technology with proven benefits, helping drive the change in mindsets towards increased acceptance of automation concepts. For smaller terminals automation is also an option to help manage the competition. Already today many existing STS cranes are fitted with automation systems to increase productivity. And as has been the case for the last decade ABB will continue to push the frontier for automation systems aiding terminal operators all over the world to maximise their profits through increased productivity at a lower cost.

ABOUT THE COMPANY

ABB Crane Systems' main mission is the efficient and optimised handling of containers, bulk materials and steel products in ports, power plants and steel mills. The productivity and quality of the installations are improved in a cost-effective way by applying total solutions based on knowledge of the customer's processes.

ENQUIRIES

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