Investment vs. operating costs: a comparison of automatic stacking cranes and RTGs

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Introduction

Automatic stacking cranes are breaking ground in all parts of the world. For medium-size as well as large terminals, even in areas with low labor cost, automation is often both economically and operationally the best alternative.

ABB has been active in supplying cranes and equipment for over 100 years and to this day has supplied electrical and automation equipment to more than 1,200 cranes of all types and in all parts of the world.

To date, ABB has commissioned over 300 automatic stacking cranes (ASC), with another 50+ scheduled for delivery in 2010-2011, representing the majority of all ASCs in the world. The state-of-the-art technology used by ABB Crane Systems facilitates safe, cost effective and highly productive handling of containers for terminal operators.

This article will discuss the differences between ASCs, RTGs and electrical RTGs (ERTGs) and compare investment and operating costs.

Crane type overview

ASCs, RTGs and Electrical RTGs are all crane types that can be employed when the available yard area is limited and high stacking is beneficial. Automation is being introduced all over the world to ensure low operating cost, high availability and high utilization of the yard capacity. Another parameter that is becoming more and more important is the reduction of emissions from diesel engines.

The Automatic Stacking Crane, ASC

There are two types of ASCs: cantilever (side-loaded) cranes, where container transfer in and out of the stack is made alongside the gantry; and end-loaded ASCs, where the containers are loaded in and out of the stack from the short side of the container blocks.

Both crane types can be made with very large spans and stacking heights. The cantilever cranes can be moved along the rails over several stacks, but cannot be moved from one row of stacks to the next. A cantilever crane is larger than an RTG

Figure 1. A cantilever automatic stacking crane in operation.

TABLE 1: A COMPARISON OF RTG, ERTG AND C-ASC CRANES

	RTG	ERTG	C-ASC	Comment
Investment	(+)	(-)	(-)	Depending upon crane price
Operating costs	-	-	+	Large reduction in labor
Cycle time	-	-	+	Higher trolley and gantry speeds
Yard utilization	-	-	+	More advanced stacking, more compact
Flexibility	+	0	-	Movement on rails for the CRMG
Civil works	+	0	-	Rails vs. concrete track
Infrastructure	+	0	-	HV – lines, remote, net-work
Maintenance	-	0	+	No tire changes, no diesel engine etc.
Environment	-	+	+	Electrically fed, no emissions, no rubber tire
TOS	+	0	-	More advanced
Service level LS/WS	-	-	+	Faster repositioning of cranes
Productivity	-	-	+	Better house-keeping, less dependence upon driver skills

because the containers are typically lifted between its legs. The automatic stacking cranes are fully electrical and supplied by a high voltage cable on a cable reel.

All movements within the yard area and above a certain height over the travel lanes are performed fully automatically. When loading or unloading manned vehicles, the last part of the operation is conducted with supervision from a remote office. Typically, one supervisor can handle four to six cranes.

As the terminal layout and way of operation are generally very similar for cantilever cranes and RTGs, the following comparisons will concentrate on these rather than the end-loaded ASC.

The Rubber Tire Gantry crane, RTG

The RTG is one of the most common crane types for yard stacking and needs no further introduction. Each vehicle is manned with a driver; housekeeping is limited since the ability to move a loaded container in the gantry direction is limited. Shuffling is made within the bay being operated, which limits block occupancy.

Due to the diesel engine and rubber tires, the RTG is flexible and can be moved between different stacks in the terminal. The investment cost is relatively low; however, modern RTGs are equipped with positioning systems (for example, DGPS), auto-steering and cameras to facilitate driving and improve operation.

The maintenance cost for an RTG is substantial, mainly related to the diesel engine.

Electrical RTG

An electrical RTG (ERTG) is in many ways a combination of the ASC and the RTG.

Because of the minimized or in most cases totally removed diesel engine, maintenance and emissions can be greatly reduced. However, even though the cranes can be shifted between the blocks, flexibility is reduced, resulting in a way of operation more similar to that of an ASC. An upgraded terminal operating system (TOS) is typically required, allowing containers and workload to be better distributed over the yard.

The additional investment cost is around US$200,000 for a bus bar ERTG, compared with a traditional RTG. The ERTG has low emissions and requires less maintenance than a traditional RTG, but on the other hand the bus bars require more ground space than a traditional RTG or ASC, thus reducing the yard utilization even further.

Compared to a cantilever ASC, the energy cost for the ERTG is higher because more cranes are needed. In addition, especially in hot climates, rubber tires require maintenance.

Comparison

Due to the restrictions in gantry travel for the RTG, containers of the same attribute set are concentrated, whereas an automatic cantilever ASC can employ controlled 'random' stacking. Together with the easily performed housekeeping moves that can be done continuously and fully automatically with an ASC, the maximum block occupancy at peak levels is high, at around 80 to 85 percent. The same figure for an RTG stays at 65 to 70 percent.

For waterside operation, RTG cranes follow the cargo flow and are moved to the stacks presently used for operation to and from the ship. This impacts the landside productivity, where the arrival of external trucks is not coordinated and hence requires that the entire import area be covered.

Low gantry and trolley speeds leads to low RTG productivity. All together, the overall crane productivity for an RTG is typically less than 40 percent of its technical capability.

ASC operation distributes cargo flow and work load and, with the cranes easily covering the full yard area, an overall productivity of 70 percent is achieved with cantilever ASCs.

A cantilever ASC can replace an RTG and ERTG in almost any terminal, and a comparison between the concepts can be made as in Table 1.

Economics

When comparing C-ASCs with RTGs, the most important factors are

- Crane prices
- Labor costs
- Operational differences
- Infrastructure

The price difference between the two alternatives can be assumed to range between $500,000 to $1 million per crane. For the new generation of fuel-saving RTGs, the price difference is in the lower levels. Labor cost varies from $10,000 to $100,000 per man per year and includes social cost, administration, labor planning and so on.

The flexibility of the RTG is compensated by the fact that the C-ASC can perform automatic housekeeping, has a shorter cycle time and can reposition itself quicker due to a higher gantry speed.

Furthermore, with the introduction of a modern TOS, containers can be more evenly distributed over the yard so that the cranes are not required to move between rows of stacks. For the C-ASC alternative, an additional TOS investment of $2 million has been taken into account. A cost capital of 6 percent has been assumed.

Figure 2. A modern stacking crane supervisor.

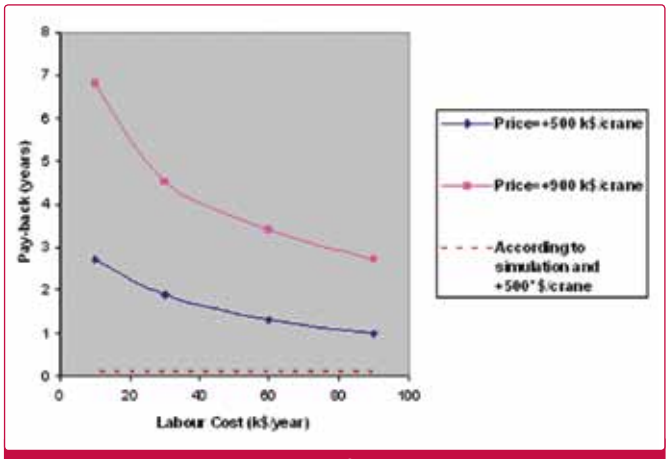

Figure 3. Conservative simulation results for automation.

Simulation

As described in edition 38 of *Port Technology International*, simulations have been performed in cooperation with TBA, Netherlands. The study compares yard operation using C-ASCs with RTGs, in a model port with the following data:

- 600,000 boxes per year
- Six quay cranes with a WS peak of 180 moves per hour
- Export and import
- ITVs between quay and C-ASC on the WS, external trucks services on the LS
- Dwell time of five days
- Empties handled by FLTs.

Results and conclusion

Due to the higher trolley and gantry speed of C-ASCs, which are more productive than RTGs, fewer cranes are required. All-important investment and operating costs have been taken into account, as have operational differences, e.g. that housekeeping and advanced stacking strategies can be more easily adapted by the automatic alternative.

The picture shows payback as a function of price difference between the C-ASC and the RTG, with labor cost as independent parameter. The picture is valid also for the ERTG.

The automated stacking crane is becoming a standard product for ABB Crane Systems and the introduction of automation is profitable, not only for large ports but also for medium-large ports (down to below 500,000 TEU per year) in countries with low labor cost.

The labor required for yard operation can be reduced to almost half – a clear advantage in many regions where the supply of skilled labor is scarce.

ASC operating experience

Automation is sometimes seen upon as complicated or sensitive to disturbances, but experience from the installed base speaks for it self. Recent figures from one of the ABB installations show:

- 10-15,000 moves per day
- Availability > 99 percent
- Operation up to 22-23m/s wind speed
- MMBF >1,000
- Cycle time as specified or better
- Stacking accuracy excellent, as everybody who has visited an automatic terminal can confirm.

Technology development – quality assured with step-by-step development

ABB delivered the first automatic stacking crane in 1997. Since then, technology has developed and what were first project-specific solutions have since become standard products.

Adaptations to fit a specific terminal are all parameterized, for example: yard configuration, transfer zone and reefer area layout, vehicle types, vehicle dimensions, number of cranes and remote desks etc. This means that changes or additional functions can be added as required.

The standardization has also had a noticeable effect on delivery times. Less than 18 months from order to first commercial vessel has been achieved in projects with different crane types, TOS suppliers and horizontal transportations.

Scope and interfaces

The complexity of design and procurement has decreased significantly as automation projects have matured and become standard ABB Crane Systems solutions. In general, suppliers are taking on larger scopes, and as a result the project complexity from the terminal operator's point of view has decreased considerably.

Maintenance and calibration

As automatic cranes have developed into a standard product for ABB Crane Systems, so too have maintenance and calibration. The cranes delivered by ABB today have automatic calibration checks and self-adaptations to ensure high production and availability, and require a minimum of staff. It can also be noted that required mechanical maintenance due to wear and tear on, for example, spreaders is smaller for an automated crane than for a manned crane.

Summary

The automated stacking crane is today a standard product for ABB Crane Systems and the investment, also in medium-sized terminals in countries with low labor cost, can be done with a

ABOUT THE COMPANY

ABB is a leader in power and automation technologies that enable utility and industry customers to improve performance while lowering environmental impact. The ABB Group of companies operates in more than 100 countries and employs about 117,000 people.

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