Breaking free of ASC cycle

Gottwald’s latest vehicle decouples the ASC and AGV cycles, writes Benedict Young in Düsseldorf.

A prototype of the first automated guided vehicle with an in-built mechanism for lifting containers has been revealed by Düsseldorf-based Gottwald Port Technology. The new technology allows the vehicle, the Lift AGV, to pick up and put down containers using a passive steel rack at the interchange area of an automated stacking crane (ASC) module.

Whereas an ASC would normally place a container directly onto the AGV, it will now be able to leave the box on the steel rack and move on to the next job. When the Lift AGV arrives at the rack to collect a load, it drives underneath the container, and a platform integrated into the AGV is raised to lift the box. The AGV then drives out of the rack, stops and lowers the container, before driving away and delivering it to the next interchange point, usually under the quay crane. When delivering a box to the ASC, the process is reversed.

The innovation decouples the cycles of the ASCs and AGVs, meaning that one piece of equipment will no longer have to wait for the other to become available, though the cycles of quay crane and AGV remain interlinked.

"In devising the Lift AGV, the performance of the whole terminal was taken into account," says Dr Armin Wieschemann, head of terminal systems. "The lack of time was always at the meeting point of the two automatic systems [ASC and AGV], rather than at the quay crane. With conventional ASCs and AGVs, one system always has to wait for the other, so the performance of the ASC improves with the Lift AGV by decoupling the interchange zone."
"Moreover, the Lift AGV generates savings in lowering/hoisting distances both at the ASC interchange and the quay crane interchange, resulting in about 3% productivity improvements for the ASC and the quay crane," he adds.

Gottwald devised the Lift AGV concept after conducting simulations that identified the ASC/AGV interchange as a point that had to be decoupled if efficiency was to be improved. "We made intensive computer simulations with TBA, our daughter company, and it came out that we had to find a solution at the ASC interchange," says Dr Mathias Dobner, Gottwald CEO. "But the point was that the solution must be based on the AGV because we wanted to make use of our extensive experience of a standardised vehicle with a simple platform with axels. Then we had the idea of adding the lift platform. We decided to do it electrically rather than hydraulically, for reliability and environmental reasons. When you have a machine that is driven for 7,000 hours a year, the reliability becomes more and more important."

The Lift AGV has two lifting platforms that can be operated independently of one another. The unit can therefore handle one or two 20ft containers or one 40ft or 45ft container at any one time.

The same electrical converters are used for the AGV’s drive and lift mechanisms. For this reason, the machine has to stop moving before the platforms can be raised or lowered. With a converter costing around €1,000-2,000 (US$1,550-3,100), the cost benefits of using only one are clear, especially when multiplied by the number of AGVs in a whole fleet. Gottwald says that simulations showed that this short stop has no influence on the overall performance.

The Lift AGV also has a load-monitoring device integrated into it as a safeguard, so the weight of every container is identified.

"While in development, we changed the electrical mechanism of the platform several times, and in the end we came up with a solution that uses a threaded spindle with a drive shaft," says Wieschemann. The drive shaft turns the spindle, which raises the platform. The lifting device has been designed with a system of bearings that prevents horizontal forces in the mechanism, and instead directs the forces downwards into the vehicle’s steel frame.

"The selected system can transfer high longitudinal forces and can realise high lifting/lowering speeds," says Wieschemann.

To maintain the same height as a conventional AGV, and to avoid raising the machine’s centre of gravity, components were sourced that would fit in the small space under the platform.

Gottwald points out that the Lift AGV does not use "a maintenance-hungry spreader", which means considerable savings in service costs. The simple construction of the machine also promises high reliability and availability, which, in turn, keeps the fleet size to a minimum.

The development of the new machine has progressed fast, with the concept originally devised in September 2006. Gottwald began constructing the prototype in February this year, and testing of the finished prototype began on the test track at the company’s Düsseldorf facility in May.
"The whole system has been tested, including the software," says Wieschemann. "Software is not a big challenge, but there are differences with the fleet-management system, such as at the waterside stack where the steel rack is used rather than the AGV waiting. The navigation system is the same as with a conventional AGV. Every system has to know where the container is – on the AGV, the ASC or the rack."

As with a conventional AGV, the Lift AGV uses transponders embedded in the ground to navigate around the terminal. Ultrasonic sensors, with an accuracy of up to 2mm, located on each corner of the AGV take over control of the vehicle motion before it drives into the rack. If required, the Lift AGV will make small adjustments to wheels in milliseconds, to ensure that the machine or the container it is carrying does not make contact with the rack. "These sensors are cheaper than laser scanners and can be used in all weathers," says Wieschemann.

The steel rack has been designed to ensure that the tolerance between it and the ground is such that the machine and the container it is carrying won’t make contact with the rack, until the container is actually put down.

"The worse-case scenario of an older AGV with spring compression, low tyre pressure and carrying two 30-tonne containers is all catered for in the rack design," says Wieschemann.

Tests with the prototype Lift AGV have shown that the docking into the steel rack can be met with a very high level of accuracy in repetitive operations.

The final rack design is likely to have a U-shaped profile for stability, with the two sides of the rack connected by a steel base plate under the yard surface. This also means that no additional reinforcements are needed outside the rack, so the racks can be placed close together. The company says that four racks per ASC module will be "more than enough" to handle the containers.

"The aim of the game is to reduce the number of machines used in each terminal," says Dobner. Whereas six conventional AGVs are required for each quay crane, half as many Lift AGVs are required. Dobner points out that this would be the same number of units required if automated shuttle carriers were used.

The Lift AGV can carry a 60-tonne payload, which Dobner points out is more than is required and is 10 tonnes more than the rated capacity of a shuttle carrier.

The similarity of design and the fact that they are almost the same height will allow the Lift AGV and conventional AGV to operate in the same fleet if necessary. As well as new production models, the lifting mechanism can also be fitted to older, conventional AGVs.

Gottwald does not yet have a customer committed to the Lift AGV, nor an agreement to trial it in one of the existing AGV terminals. But the company has developed the equipment in consultation with its terminal partners.
"There is big interest and we are expecting many potential and existing customers to come and see the prototype," says Dobner. "I expect the first customer for the Lift AGV to be an operator developing a greenfield site, who believes that Gottwald is able to build up a reliable, proven operation."

Although the development of the first Lift AGV is a landmark, Dobner says it will not be the last evolution of the AGV.

"We asked ourselves how we could improve after the first three big [AGV] terminals," he says. "After the Lift AGV, the next steps will come, such as new drive concepts. I personally believe that we have to carefully watch the developments around environmental requirements in ports.

"I believe we have to look for other drive concepts – and that is exactly what we are doing now. I’m sure that in the near future we will see the AGV with another drive system, such as a pure electrical vehicle with batteries that can be refuelled with the quick exchange of battery packages. We know that we can do it, and now we have to do investigations to decide how to proceed." cs

To see an exclusive CS video of the Lift AGV, visit the media centre at www.cargosystems.net

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