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Lowering the risk of semi-automation

APM Terminals' new facility in Portsmouth is not only something new for the US, it is likely the first "greenfield" automation project to be delivered on time and on budget

APM Terminals (APMT) officially opened its new US$450M terminal in Portsmouth, Virginia on September 7. While the opening ceremony was mainly devoted to recognising those that contributed politically to the project, those involved in the terminal at the operational level emphasised the achievement of getting a terminal featuring a new and advanced operating system and automated container handling equipment integrated and up and running so smoothly.

As is well known the terminal features shuttle carriers serving semi-automated remote controlled RMGs. The RMGs run perpendicular to the quay in 15 blocks with two RMGs per block. Each block is approximately 60 TEU long by eight rows wide and the cranes stack 1 over 5 high. The road trucks are served in a special zone at the landside end with five truck lanes under each crane.

The RMGs, built by Konecranes, have no cantilevers and, in appearance at least, look like "RTGs on rails." The automated crane control system supplied by TM GE Automation Systems brings the cranes into position over the trucks and a remote control operator then takes control of the crane for the last stage of positioning the container or the spreader.

As a safety feature the RMG cannot operate over the truck zone until the truck driver has left the cab and is standing on a pressurised mat placed inside a cubicle outwith the crane rail. Other safety systems prevent cranes operating over zones where a person has been detected.

While the semi-automated RMGs are the most notable feature of the yard, the terminal features other systems and operating methods that are unique in a 1M TEU capacity/year container terminal. The quay to yard transfer is made by low height (1 over 1) Kalmar shuttle carriers that can also buffer containers between the quay and the yard. The rail yard is located on one side of the terminal and this area is served by yard tractors with a cassette system supplied by TTS Liftec Oy. Most of the reefer cargo is also placed on cassettes and moved to a separate area behind the main ASC stacks.

Up and running

Automation is still regarded as a high risk option for container terminals. The technology to guide an RMG and land a spreader automatically is well established, but the process of integrating automation into terminal operations is much more difficult. Most automation projects in Europe featured long periods for commissioning and testing to overcome problems that arose as the equipment was installed and/or difficulties getting systems properly integrated.

In contrast, the new Virginia terminal began receiving equipment (and the RMGs had to be erected on-site) at the start of this year and handled its first vessel at the end of July. The project schedule also survived the collapse of Consens Transport Systeme, the original contractor for the 1 over 1 shuttle carriers.

A key difference between this and European automation projects is that APMT is not involved in developing any of the operational software itself. The first RFP was for the terminal operation system (TOS) and this was put out in late 2004. Navis was selected and developed versions 3.6 of SPARCS and 2.9 of EXPRESS to meet the needs of the terminal operation. Navis also supplied Web Access 3.14 and SPARCS Analytics, a real time monitoring tool.

Track record

It is safe to assume that TM GE Automation Systems was selected to supply the crane control and semi-automation system based on its experience with overhead bridge cranes at Singapore and overhead cranes at the Ilva Steel Mill in Italy, both sets in operation for some years now.

The company now offers crane automation with its Maxview automation system and TM 10 drive system. Typically the crane's long travel position is calculated through incremental encoders that are automatically calibrated via transponders, and at Virginia passive transponders (supplied by Götting in Germany) can be seen embedded in each rail tie. The trolley position is calculated via an incremental encoder on the trolley drive calibrated with a laser range finder while the hoist encoder is calibrated with a limit switch.

To detect container position (stack profiling), avoid collisions and land the spreader/load the Maxview uses a laser scanner system, which at Virginia is based on SICK laser scanners. A key difference between Maxview and other automated landing systems is that Maxview uses the same scanners to detect the position of the target and the load. Position information from three sensors is sufficient to get the position of the spreader with 6 deg of freedom.

Using a single set of sensors enables the software directly to compare position without having to calibrate between two sets of sensors. Performance of the automation system at Virginia is helped by the relatively stiff crane structure and delivers a stacking accuracy of within half the width of a corner casting. The rows under the cranes are stacked tightly with 400mm between containers.

In the road truck area operators at remote control stations in the central office building take over when the spreader reaches around 12ft above the ground. The crane speed is governed to slow speed automatically and the Bromma spreaders are fitted with electrically-actuated flippers on the end beams to assist positioning.

The challenges

Developing SPARCS and EXPRESS to support semi-automation and shuttle carriers was a considerable task for Navis, requiring 25,000 man hours of development in 12 months. Navis had developed SPARCS to support automation at ECT and was able to leverage some of that work, but other aspects of the project such as the shuttle carrier system had to be developed from scratch.

On the crane side TM GE Automation Systems could benefit from PSA's bridge crane experience, but even from a visual comparison between the two terminals it is apparent there are some key differences in the crane operating system. For one thing the RMGs at Virginia long travel significantly faster (AMPT staff confirmed the travel speed is 300 m/min) and position the spreader much quicker, with the crane automation system appearing to lower the spreader at full speed.

In addition, the final positioning of the containers is much faster. TM GE Automation Systems could not comment on cycle times but noted that the clearly faster performance at Virginia could not be attributed just to differences in sensor systems, which vary with project requirements and site conditions in any case.

Right balance

The key challenge with stacking crane automation is not actually achieving the accuracy for automation but striking the right balance between accuracy and cycle time. This project gained where others struggled because APMT avoided the trap of specifying excessive, overcomplex equipment control parameters and performance criteria at the component, system and integration level.

Instead it charged TM GE Automation Systems with delivering a working semi-automated system and, at the equipment level in particular, left it with enough scope to leverage previous experience and work through potential conflict areas.

Perhaps the biggest challenge was bringing the crane control and operational software together. This was a long and difficult process at ECT where Navis and equipment suppliers had to send beta copies of software back and forth and meet regularly.

Fast worker

The schedule in Virginia did not permit this and at APMT's request Navis developed a new ODBC (open database connection) that allows a much simpler way of connecting the two systems. Instead of mapping SPARCS work instructions from its database to another used for the crane control system, the ODBC connects the Maxview Crane Director software to the SPARCS database.

SPARCS sends work instructions to the Crane Director that individual cranes scan for work orders. Maintenance and commissioning moves are managed through maintenance staff requesting jobs through the remote control station, which generates work orders in SPARCS.

To allow Navis and TM GE Automation Systems to develop the terminal operating and crane control and software simultaneously, APMT developed an emulation tool that each could use to test and audit different systems at different locations. When the RMGs and the TOS software actually came together on the terminal, Navis was able to control the RMGs remotely from tually came together on the terminal, Navis was able to control the RMGs remotely from Oakland within two hours and the complete system passed integration tests within two weeks.

APM Terminals has steered a careful path both technically and in terms of industrial relations to bring its new Portsmouth facility to fruition

Off the shelf

Although AMPT Virginia is not a fully automated terminal with AGVs or autostrads, it should be a significant step in demonstrating to terminal operators that an automation project at least can be brought in on time and on budget. More than anything this project demonstrates that the challenge of automation is not about hardware any more, but about how to integrate all the components. APMT understood this from the beginning and tightly managed the key aspects and risk areas.

From a software perspective Navis has developed the automation and shuttle carrier functionality within SPARCS and is now working on transferring it to SPARCS N4. There will always be customising required for automation, but with its work at ECT and now this project much more of the functionality is available off the shelf.

For Navis' CEO John Dillon one of the biggest successes to come out of Virginia is proof that Navis can deliver in a way it could not 4-5 years ago. One of Dillon's goals as the first Navis CEO has been to grow Navis as a service organisation and develop the rigour to define accurately and manage large projects.

The wider IT industry has a poor track record in this regard, says Dillon, but he believes that project management is a strength for Navis. The company is currently involved in four projects of a similar scope. ❑