Simulations address issue of productivity

With many options for horizontal transport in container terminals, arriving at the right choice depends on knowing all the variables, writes Neil Madden.

Picking the right handling system depends on several criteria. There are occasions where a terminal may be considering a choice between reachstackers and straddle carriers for low density stacking operations. This choice is conventionally thought of in terms of the required storage capacity versus the space available, the design of the terminal, expected handling productivity rate and size of operation.

Straddle carriers, for example, can significantly raise productivity as the machine can twin lift 20ft containers and stack up to four high. They also have greater potential for automation – witness Kalmar’s recently launched Autoshuttle.

But in terms of horizontal transport between the quay and the yard, the options are more likely to be between tractor-trailer units, shuttle carriers (also variously branded as Runner and Sprinter) and automated guided vehicles (AGVs) – both conventional and cassette systems.

And making the right choice is critical to future competitiveness. Central to the efficient functioning of any terminal is the management of yard inflows and outflows (horizontal transport) and container stacking (vertical transport).

The function of the yard area as the central storage zone, both buffering and linking all inbound and outbound operations, means obstructions or bottlenecks in the yard can directly affect other
terminal areas – for example, waterside handling activities – with significant impact on the terminal’s overall effectiveness.

Comparing tractor-trailer units with shuttle carriers, studies have shown that with quay crane productivity of 30 moves per hour (m/hr), a straddle carrier makes around 10m/hr and a tractor-trailer around 5m/hr. It can be argued that straddle carriers and quay cranes work better together than trucks and quay cranes, as they can benefit from decoupling horizontal transport and crane operation, which likewise applies to the yard area transfer.

However, it is a moot point as to whether that advantage will be lost if the shuttle carrier is bigger. The speed that the shuttle carrier can work is related to its low centre of gravity, which enables higher safe cornering speeds. This is fine for a one-over-zero machine, but inevitably some of that advantage is lost with a one-over-one unit. On the other hand, of course, the former has to go around a container placed on the lane, whereas the latter can literally rise above that obstacle.

Increasingly, the quay/yard interface is being viewed as shuttle carriers versus AGVs, and opinions about their relative merits differ widely. In support of its Sprinter products, Noell, for example, has argued that compared with vehicles that are able to automatically pick up and set down the container, both trucks and AGVs have the disadvantage of much higher cycle times, largely as a result of different waiting times per move – again the issue of coupled/decoupled transport.

Similarly, Kalmar claims that its shuttle carrier offers the benefit of fast horizontal transfer while maintaining the high yard stacking density of the RTG/RMG operation.

"Using the shuttle carrier, there are natural buffer zones both at the end or alongside the stacks and under the ship-to-shore cranes. Since it never needs to wait for the cranes, either on the quay or at the stacks, the shuttle carrier is able to provide the required operational speed and complete a high number of cycles per hour between ship and stack," the company says.

Similarly, TBA – a subsidiary of AGV manufacturer Gottwald Port Technology, compared five alternative horizontal transport technologies: conventional AGVs; automated shuttle carriers; manual shuttle carriers; lift AGVs; and cassette AGVs.

The alternatives were compared under similar operational conditions: 10 quay cranes with single trolley and single hoist, along with 25 stacking modules, each equipped with twin automated stacking cranes (ASCs).

In general, all systems were found to deliver similar levels of productivity by deploying sufficient vehicles, and assuming adequate control software.

So TBA maintains that the perception automated systems cannot deliver the same productivity as manually driven machines is incorrect. However, the AGV option did require more vehicles.
The second conclusion was that the effect of decoupling the equipment cycles is significant. When comparing the traditional AGV with the lift AGV, a performance increase of up to 30% can be observed, or a reduction of vehicles, at comparative performance, of up to 50%, depending on the given box moves per hour.

The cassette AGV also showed an improvement compared with the AGV, but this was somewhat lower as a result of the empty cassette moves. The average driving distance per container was almost 40% higher.

The process at the quay crane was also quite long due to the necessity of lowering the cassette onto the ground to avoid impact loads on the vehicle.

So to achieve 40m/hr in this particular setting, the terminal would require 27 manned shuttle carriers (pooled), 30 automated shuttle carriers, 33 lift AGVs, 50 cassette AGVs, or 65 AGVs.

A comparison of capital expenditures and operating costs found that all automated systems are less expensive than the manned alternatives, even considering the higher capital cost. This means the additional investment for an automated system could be recouped in two years with the lift AGV or five years with an automated shuttle carrier.

Despite the automated shuttle carrier’s capability to fully decouple the lifting cycles, TBA concludes it is the least attractive automated system, mainly due to its high price and relatively high maintenance costs. In all cases where automation is being considered, the prerequisite is intelligent, flexible and robust software, and this is often where many such projects fall down.

Of course, the implication of all these hypotheses is that simulation techniques to test various equipment combinations are increasingly popular.

For the Euromax terminal, in Rotterdam, two consultants were brought in. US-based JWD was asked to assess the applicability of straddle carriers, while TBA was commissioned to look at the use of AGVs and ASCs. Although it was not entirely possible to compare like with like, Euromax ended up with two independent evaluations of radically different handling equipment combinations. The cost of hiring two consultants was a fraction of the overall project budget. Having said that, most terminals, of course, are not on the scale of Euromax and so would find it more difficult to justify that expenditure.

But even here the results are dependent on the variables entered into the simulation exercise in the first place. And several variables must be factored into the equation.

At the recent TOC Asia conference in Shanghai, Dr Juergen Boese, senior consultant at Hamburg Port Consulting, outlined these factors, broadly dividing them between internal and external influences.

Internal influences are changeable by terminal operators and comprise mainly the organisation and control of terminal processes and handling equipment, for example, terminal shift system, strategies for equipment deployment, and rules for container stacking.
External influences are given and can be adjusted on-site only to a certain degree. Typical examples are the level of wages and social security benefits of terminal employees, energy prices, cost of maintenance and repair, specific attributes of handling technologies (stacking height or available handling functions) as well as the size of the terminal, most notably the length of quay wall and the extent of the yard area.

All these factors must be considered in order to arrive at an accurate total cost of ownership for any given combination of handling systems.

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