A new concept in handling mega-ships: part III

Frans Koch, *CEO, Koch Consultancy Group, Goes, Netherlands*

In the final part of this three paper series I will focus on the main differences between the current semi and fully automated container terminal and the New Generation Integrated Container Terminal.

The general objective in designing a terminal is in principle the same for each operator, namely:

- A maximal stack capacity, maintaining utmost efficiency and flexibility in order to achieve the highest performance and service level for clients against a minimum on investment and operational costs

Despite this general objective, there is a huge variety in terminals all over the world, and almost every terminal is unique. Yet there are two main principles when designing a terminal to choose from: should the stack layout be perpendicular or parallel to the quay (see Figures 1 and 2, respectively).

Present situation

At present, for newly built fully automated terminals, a layout with a stack orientation perpendicular to the quay seems to be the standard (Figure 1). Yet how this will develop in the next few years is difficult to predict because this configuration does not bring about the revolution in terminal productivity which is often called for to handle the capacities coming from mega-ships.

Depending on stack orientation, there are principle differences in the choice of equipment, as well as the level of automation. Regarding ship-to-shore cranes, it is expected that many will be fully automated with remote control technology in the near future.

For the transport of containers from STS cranes to the stack area, it seems that people either believe in AGVs (and Lift-AGVs) or in shuttle carriers in case of perpendicular stack orientation. In the case of parallel stack orientation, it seems that there is a preference for shuttle carriers, probably as a replacement for terminal tractors.

In stack operations we see RMGs and RTGs in various models and dimensions, with differences in levels of automation. Despite the very impressive improvements in respect to the handling speed of ship-to-shore cranes over the last few years, the integral handling speed over the whole terminal process neither meets the requirements of the shipping companies on the seaside, nor the requirements of the hinterland connections on the landside.

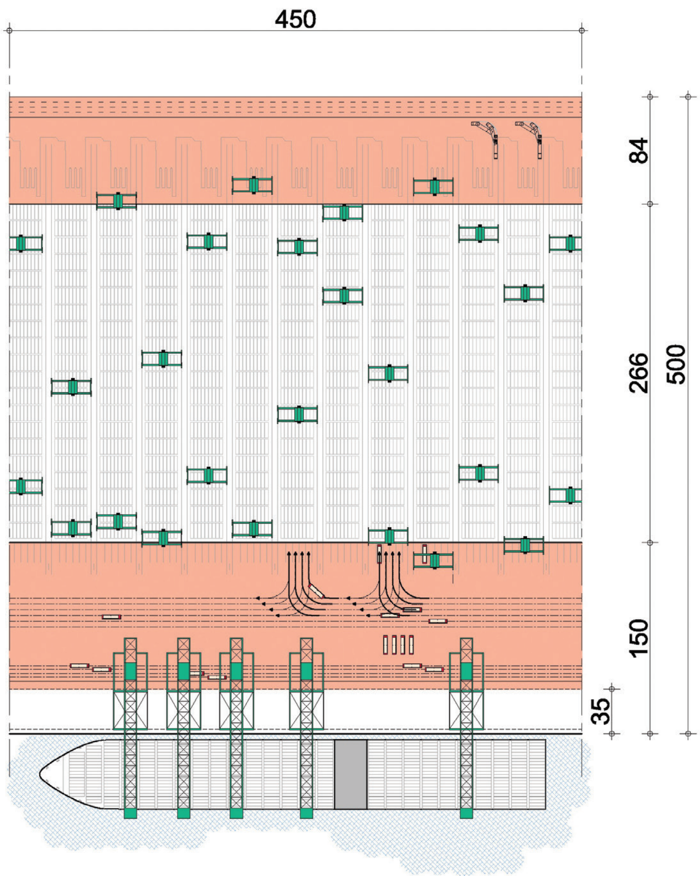

Figure 1

Terminal operators win awards if they perform 170 moves on one ship per hour during the berth-time of a ship, yet shipping companies, especially those with mega-ships, ask for 250 berth moves per hour during the total berth-time. The average berth productivity of the top ten ports in the world is approximately 108 moves per hour. There is a lot to be done.

Challenges

Present efforts, such as:

- Improving the use of automation through specific training
- Better communication and collaboration in the logistical chain
- Optimising stow and quay planning

These may be important in the long-run but are not sufficient for now. Due to the real-time information tools online customers are getting used to, receiving a parcel within 24 hours after ordering it is becoming the norm. Distribution centres which have more than 470,000 pick locations in storage are able to deliver a particular article from the warehouse to an expedition department within 30 minutes after receiving the order. Because container terminals play an important role in the supply of these distribution centres, they should be prepared to stay in line with these higher future demands.

The actual challenge should not be just

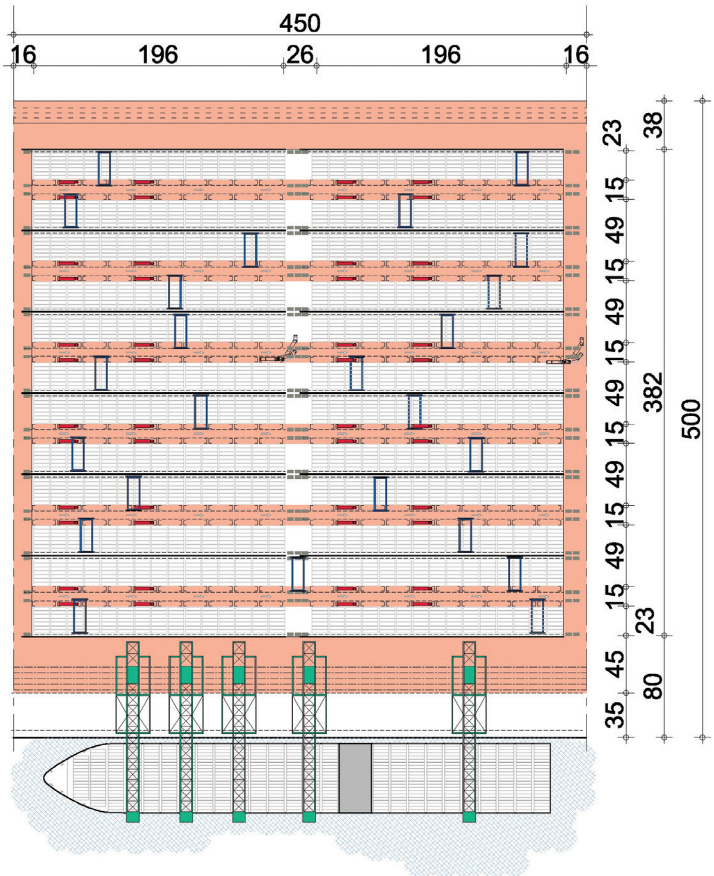

Figure 2

improving current processes by 10 or 20%, but aiming to deal with the rising demands for longer than a few years. A performance of 10,000 moves in 24 hours could become reality within a decade.

Funding

As always, the customer will pay, provided that the price is in conformity with the market and the costs due to transport and handling are in a reasonable ratio to the total price of the article in the manufacturer's opinion. Herein lies further challenges, yet this article only focuses on the differences between the current modern terminals and the NGICT-system.

Game changers

History teaches that revolution in this very capital intensive sector is often a bridge too far. This is why we put off the STS side of the NGICT-concept for a future article. To be able to profit from the current, very fast automated STS cranes, it is inevitable to realise an important change in the way containers are being transported over the yard. This is not only important for handling mega-ships because shortening the berth time for smaller vessels saves money as well, and it will place the benefits of mega-ships along the whole transport chain in a new light.

Firstly, 5 to 7 AGVs per STS crane (see Figure 1) is too many to make it possible for 5 or 6 STS cranes to perform efficiently while working adjacent to each other on one ship. The most effective solution for that problem is reducing the travel distance of the AGVs substantially.

Searching for dead-lock free zones, finding optimal sequences regarding entering, waiting, passing and leaving strategies for about 30 AGVs driving in the usual routings as shown in Figure 1 will always be a very complex and space-taxing exercise.

Using simulations, I have discovered that by using two-directional AGVs which are capable of driving in two perpendicular directions terminals could cut down on travel distances and therefore travel time by up to 50% (see Figure 4). Even using current AGVs, which could change between driving tracks in the transfer zone underneath the overhead bridge cranes (OHBCs) by parallel steering mode, this method could save a substantial amount of time.

Secondly, it is interesting to see that due to a higher stack density, the travel distance in the stack area itself will be reduced as well (see Figures 3 and 4). Thirdly, we should realise that ASCs must be faster and more flexible in job assignments than in the current configurations. The solution for this is special OHBCs which have

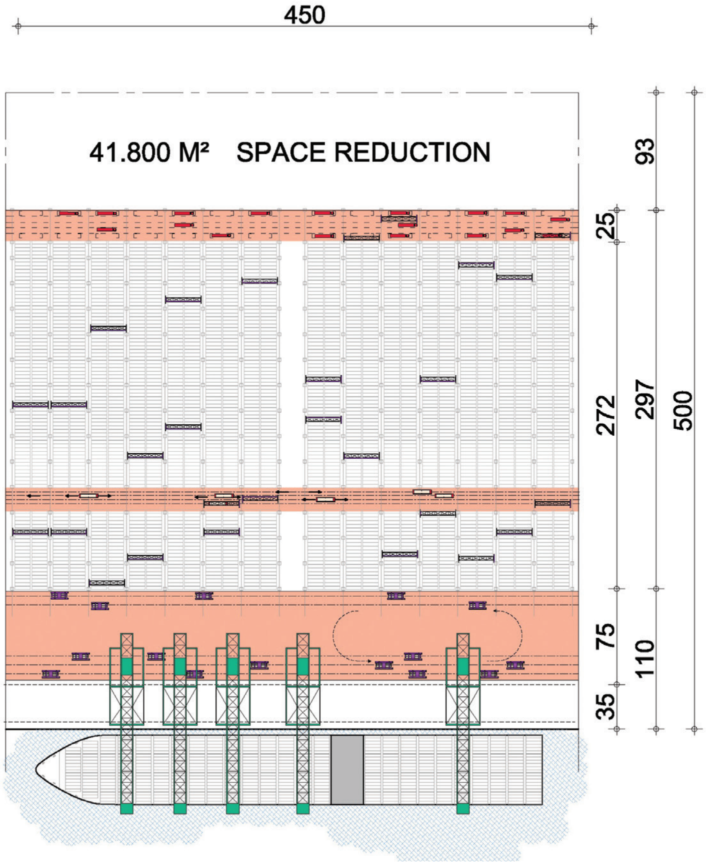

Figure 3

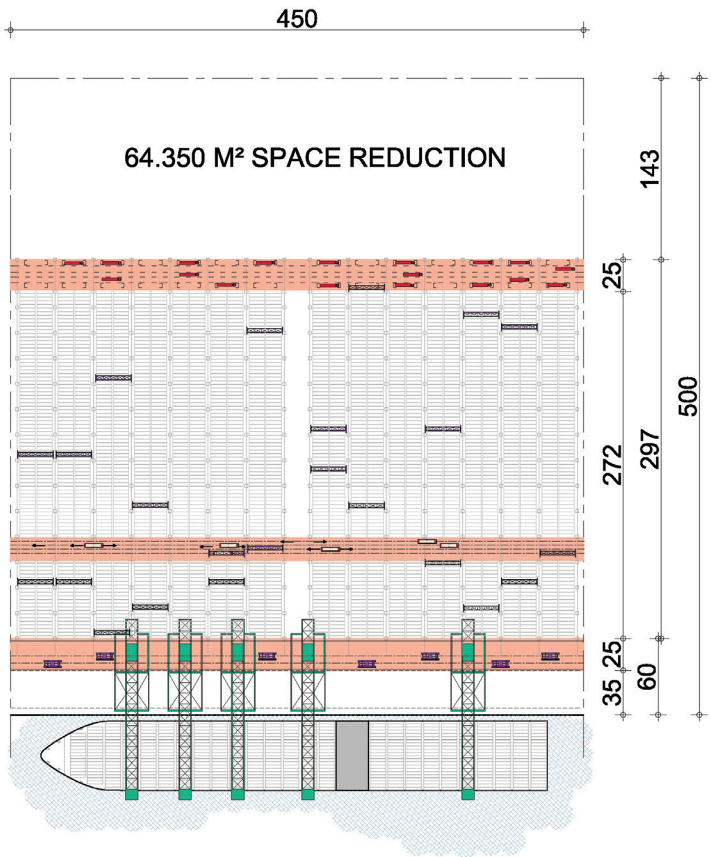

Figure 4

higher travelling speeds and pass each other in the same stack lane, making it possible to increase the number of OHBCs in one stack lane.

Depending on the length of the stack lanes, three (or even four) OHBCs in the same lane can work simultaneously without hindering each other. So it becomes possible to handle two transfer points for trucks within each stack lane at the same time (see Figure 3 and 4).

By comparing the four typical excisions of a modern terminal (Figures 1 to 4), the advantage of the NGICT concept becomes clear. In Figure 3, transport between STS cranes and stack cranes can also be done by AGVs or by SHCs, but the transfer direction under the OHBCs takes place parallel to the quay. In Figure 4, the STS cranes are able to transfer approximately 50% of the containers directly within the reach of the OHBCs which may save quite a lot of movements in relevant circumstances.

All four layouts have an equal number of STS cranes and more or less the same investment on the terminal operators account, yet the productivity potential and the operational costs are quite different.

Berth-productivity potential

Regarding the comparison between the four layouts, the difference in productivity potential regarding the berth-time can be estimated as shown in the following table (based on comparable kinematics per device and on average moves per hour by practical experience).

It is clear that the actual performance per layout can deviate from these productivity assumptions as expressed in the comparison berth-productivity table.

Integral productivity potential

For the productivity potential of a whole terminal, berth productivity is not the sole criterion. The expected future demands on the landside will also have an impact, on the stack operations in particular. Using the results from the table below, the conclusion must be that in the traditional stack configuration of Figures 1 and 2, neither the required berth productivity nor the future higher demands at the landside can be met.

The strongest link in the logistical terminal process (see Figures 3 and 4) is the OHBC. This is due to higher speeds and the ability to carry two 40 foot (or 4x20 foot) containers at the same time, and secondly because two OHBCs are able to work in the same part of the stack lane without hindering each other.

This implies that replacing, renewing or upgrading a number of STS cranes in front of a conventional yard configuration will not lead to a performance in line with higher future demands.

Conclusion

Even in combination with the current and modern automated STS cranes, implementing the NGICT-configuration in the yard will produce big advantages immediately. There are striking differences between the NGICT-layout and conventional systems. These are:

- Less surface occupation; therefore a lower investment and more environmentally friendly
- Shorter travel distances in the STS area, in the stack area itself, and in the truck area. This leads to a faster integral logistical process and lower energy consumption
- Fewer devices, higher redundancy level, and easier automation
- Higher flexibility in job assignment

Because the NGICT-configuration makes use of proven technology, there is little-to-no risk from the terminal operator's point of view. In the case of greenfield terminals and the extension of existing terminals, combined with the extension of quay length, the adoption of an NGICT-system saves money on investment, reduces operational cost and ecological footprint, and simultaneously improves performance.

A new concept in handling mega-ships: Part I featured in Port Technology International: Edition 65, February 2015
A new concept in handling mega-ships: Part II featured online at porttechnology.org

About the author

Frans Koch, founder of the Koch Consultancy Group (1994), forms together with his son Mathé, the general manager of the team of engineers and architects in the Netherlands who constitute Koch Consultancy Group. Both Frans and Mathé are both registered designers and hold a PMSE in structural engineering.

About the organisation

KOCH Consulting Group
Engineers & Architects

Koch Consultancy Group consists of Raadgevend Ingenieursburo F. Koch B.V., Allant Architecten B.V. and Koch Projectmanagement, a local multidisciplinary organisation of consultants, architects and engineers. Its portfolio concentrates on projects in favour of industry, harbour and marine structures, civil works, buildings, energy production plants and wind turbines.

Enquiries

Frans Koch
Koch Consultancy Group

Telephone +31 (0) 113 213030
Fax +31 (0) 113 213122
E-mail info@kochadviesgroep.nl
www.kochadviesgroep.nl
www.ngict.eu

COMPARISON BERTH-PRODUCTIVITY POTENTIAL

Configuration / Figure	STS cranes: number times average moves per hour *	Lift-AGVs: number times average moves per hour	Shuttle carriers: number times average moves per hour	RMGs: number times average moves per hour	OHBCs: number times average moves per hour	Decisive devices
1	5 x 50 = 250	30 x 7 = 210	-	12,5 x 18 = 225	-	AGVs
2	5 x 50 = 250	-	25 x 8 = 200	12 x 18 = 216	-	SHCs
3	5 x 50 = 250		12 x 20 = 240	-	(13 to 26) x 25 = 325 to 520	SHCs
4	5 x 50 = 250	-	6 x 25 = 150 plus 50% direct transfer = 125	-	(13 to 26) x 25 = 325 to 520	STS cranes

* based on 6,000 moves in 24 hours