DEVELOPING A CONTAINER VESSEL 'DOCKING' SYSTEM

by Gordon RANKINE

ABSTRACT

With larger vessels now being introduced on major container shipping routes around the world, attention is being focused on increasing efficiency at ports of call. One technique that is being looked at by a number of port operators is to berth the container vessels in a 'Dock' that will enable ship-to-shore gantry cranes to work both sides of the vessel. Although this is innovative to the container shipping industry, berthing vessels for double sided working is not altogether new as it has been used successfully for handling many other types of cargo over the years.

'Docking' container vessels to enable double sided handling is well suited to automation. It can readily be linked in with the use of Automatic Guided Vehicles and the Automatic Container Terminal Warehouse. This creates an opportunity to make more efficient use of available port land and to speed ship turnaround. The container vessel 'Docking' system provides a vision for the next generation of container handling at ports.

INTRODUCTION

With a significant increase in the size of the largest container vessels over the last couple of years and the prospect of even larger 'Mega' carriers before very long, the next move in increasing container handling efficiency will have to come from the port operators. The jump in container vessels from 13 boxes wide to 17 boxes wide has set a lot of people thinking about the future for containerised shipping. Over the next few years it is likely that the major terminals will be competing with one another to take the 'gateway' traffic either to keep or maintain 'hub' status. Some of the more farsighted ports are already looking into new techniques to keep up-to-date with the demands of both customers and shipping lines.

A number of interesting concepts have recently been put forward with the aim of increasing efficiency at container terminals. As with any developing technology some of these thoughts are more practical than others. It is, however, encouraging to see the increased awareness of this subject and the greater level of debate will help to refine the better solutions.

One such method is to arrange the ship berths so that the container vessels can 'Dock' with a working quay on both sides (see Figure 1). Containers will then be transferred to and from an automated storage system for onward distribution or shipment. Technical feasibility of the 'Docking' concept has already been established following studies at a number of ports, with a terminal likely to come to fruition shortly in Amsterdam. The next step is now for individual ports to work out the overall economics of introducing this system at their own container terminals. The vital issues that will have to be considered include:

- Availability of suitable land;
- Speed of ship turnaround;
- Capital and Operating costs.

The vessel 'Docking' system used in combination with the Automated Container Warehouse is part of a visionary way forward for container terminals to keep abreast of the improvements to container vessels as we move into the next millennium.

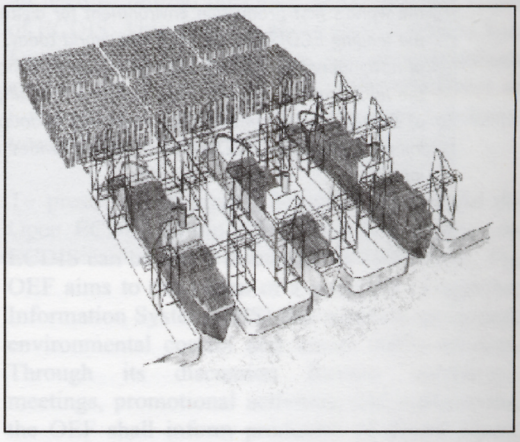

Figure 1. The Container Vessel 'Docking' System together with the Automated Container Warehouse

Land Use

Many of the traditional ports around the world have become a victim of their own success with industrial and urban developments surrounding the port and preventing it from expanding to keep pace with the needs of a modern day terminal. In cases where there is some land available around a port it can be very expensive and more suited to

commercial development. This has led to the total demise of some ports and in other places ports have had to struggle with a considerable handicap compared with competitors that have developed from 'green field' sites.

Today's port planner has to be aware that land is not as freely available as it has been in the past and ports do not necessarily get priority treatment when it comes to allocation of coastline. In fact, with environmental pressures and leisure pursuits in the ascendancy, both in developed and undeveloped nations, new land for port use is hard to come by and there is now increasing pressure to make more efficient use of land at existing ports.

Construction of a new port at a new location is not necessarily straightforward anyway because of the scale of infrastructure required, including linkages to the hinterland. Obtaining environmental clearances has also become more difficult and is another important factor when considering a major expansion.

Wherever it is possible to make use of traditional ports there is clearly a considerable benefit in doing so and, if greater efficiency can be extracted from the use of existing land, these traditional ports should remain in the vanguard of new developments. Furthermore in some countries, such as in the UK, legislation is increasingly demanding that wherever possible 'brown field' sites are re-developed into industrial areas (including ports) rather than the creation of new facilities on 'green field' sites.

Speed

The major shippers are more likely to use ports that can turn around ships quickly. The number of cranes deployed and the cycle time are two of the main factors that can influence the speed of turning around a ship at a container terminal.

The container 'Docking' system provides an excellent opportunity to increase the number of hooks over the berthed ship by enabling cranes to work from both sides. If sufficient cranes were to be procured, there could even be double the number of container movements compared with conventional berths.

There are also benefits in terms of the speed of lift. Assuming that the same velocities and accelerations are adopted on respective cranes the container 'Docking' system will have the edge over conventional berths because of the shorter cantilever distance that containers will have to travel along the crane.

Costs

The terminal of the future must address all the technical issues together in order to produce an integrated concept and simultaneously improve the efficiency of ship turnaround and container storage. Port designers must keep up with [illegible] developments and this can present consid challenges both in terms of advancing techn and financial engineering.

Obviously the costs for development construction of a new ship berthing layout w in the forefront of any commercial via assessment made by a port operator b embarking on such a project. The detail of this be absolutely site specific, depending on the pr port layout and underlying soil conditions etc.

For many sites a greater length of quay will ha be constructed for the 'Docking' system, but the cranes will be much smaller and therefore cheaper than those required for a conventional berth. This also means that a lighter, and therefore cheaper, form of construction can be used for the quays.

Although the cost of the automated warehouse per square metre will clearly be more than the cost of open storage areas, the area will be considerably less and the efficiency will be far greater. Land values and the cost of environmental requirements will also have to be included in the equation.

HISTORICAL CONTEXT

A berth of this nature is not entirely a new idea.

In the London Docks it was commonplace until the 1970's to find ocean going vessels transferring cargo over both sides; perhaps using quayside cranes to link with the shore and ship's gear to load and discharge lighters on the other side.

Double-sided work could also have been seen in Hong Kong even more recently. Right through its development as one of the top container ports, vessels in Victoria Harbour were still having containers transhipped using simple barges with their own gear. This process was most effective when handling on both sides of the ship at once.

This practice is even used today inside ports to speed up handling operations. For example some bulk carriers are unloaded at conventional deep-

water berths with gantry cranes working on the quayside and floating unloaders discharging the vessels on the outer side into barges.

Some other forms of shipping have also progressed rapidly in recent years to meet the needs of the modern user. For example in the offshore oil industry both speed and efficiency are required to supply drilling materials and other provisions to offshore platforms. To meet this demand a 'Docking Shed' has been constructed in southeast USA with nine indented berths each 50m long and 25m wide. Each bay is serviced by overhead gantry cranes within the building that covers the entire dock area.

Introduction of the new fast ferries in the UK coastal waters has halved the time for many of the short sea crossings. This has inevitably called for an equivalent speeding up of turnaround time in the destination ports. As a result the 'HSS' vessels latch onto their purpose-built stern docking system in port rather than a conventional mooring arrangement. This makes it possible to unload and load a full compliment of cars, trucks, passengers and provisional within a 30-minute port stop.

CONTAINER VESSEL 'DOCKING'

The container 'Docking' terminal can be developed by berthing any number of vessels in rows with cranes able to work both sides of the vessel. Containers would be transferred to and from the AGV system moving directly into the designated slot within the Automated Container Warehouse, which takes up considerably less land than conventional container storage.

For example, a container 'Docking' terminal might have three bays to serve the warehouse with jetties constructed between vessels to support the ship-to-shore gantry cranes and AGV tracks as shown in Figure 2.

Getting a ship into a double-sided berth isn't very difficult – it really is just as simple as entering a dry dock or a lock.

This is a straightforward activity that takes place every day of the year all around the world.

The container vessels enter the 'Dock' guided by the lead-in dolphins that ensure correct alignment. The fenders along both sides of the 'Dock' are retractable to enable the ships to enter the 'Docking' bay and when the ship is berthed at the desired position the fenders are moved over from both sides, one pushing the vessel until the container ship is held centrally in the bay.

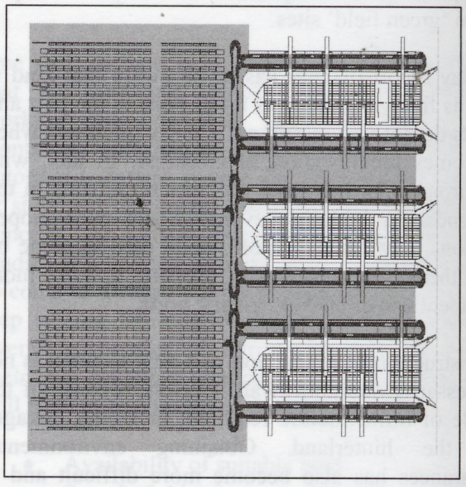

Figure 2. Plan View of a Container Vessel 'Docking System Layout.

Although three container cranes are shown on each side of each bay in Figure 2, there is no reason why there could not be more, perhaps even six. These cranes are smaller than the gigantic cranes now required to handle these larger vessels on a conventional quay because they only have to reach as far as the centre container on the ship. This means a reach of some 33 metres, rather than the 48 metres on a conventional quayside.

Crane Reach

At conventional berths, wider container vessels obviously require cranes with longer outreach to transfer containers to and from the shore. Not only are these cranes more expensive but they are also heavier and require a stronger quayside to support them. The forces that these cranes exert on the quay can be as much as 35% higher for cranes picking up the furthest box on a 17 wide container vessel compared with a 13 wide vessel. For a 'Docking' system with cranes disposed on both sides of the vessel, the forces on the quay can be reduced by 40%.

Advantages

The main advantages of introducing 'Docking' berths at a container terminal are:–

- Existing terminals can be adapted and developed to greater capacity without the need for additional land. This also means that the container handling remains at the

focal point of the existing infrastructure, therefore minimising the need for further investment on road and rail links as well as dredged channels.

- Should it be desirable to construct a new terminal this system will result in a minimum of coastal land take because of efficient land utilisation and berthing of the vessels in close proximity to one another.

- The 'Docking' concept integrates effectively and efficiently with the Automated Container Terminal warehouse because of the high level of automation that can be achieved. This enables immediate access to any single container within the six high container stores.

- The opportunity is created for reduced ship turnaround times. By working both sides of the vessel more cranes can be employed and each one has a shorter average outreach for each container movement. Craneage efficiency is therefore maximised for larger vessels.

Creating a 'Dock' Berth

Every port in the world is different and different solutions are required at each location, however it can be considered that there are two generic types of port from the point of view of berthing vessels. Firstly there is the harbour which provides still, protected water for ship berthing, which may or may not be subject to differing tidal levels. A fine example of this can be seen at Singapore and there are other similar ports in the Middle East as well as in the Mediterranean, and in the UK.

By carefully introducing some modifications to the quays at this type of port it is possible to create indented container berth bays with the capability of double-sided handling and containers being fed automatically into the warehouse at the end of the 'Dock' (see Figure 3).

The second type of port that we are considering could be described as a river port because it characteristically has a flow of water past the berths. These conditions could occur at Felixstowe, Thamesport and many others. The port may not actually be on a river but in an area where currents are present at the berths. In this case it is of course important that the berthed vessels are disposed in the most efficient way, which is most likely to be parallel to the current flows. This tends to make it difficult to construct ship 'Docking' bays perpendicular to the current and an alternative arrangement is therefore required.

In order to accommodate ship 'Docking' here it will be necessary to construct a further jetty on the seaward side of the original berth and this jetty will be able to support cranes working on the far side of the ship. In this arrangement the AGV's carrying all the ship-to-shore container movements would run along the central spine and directly into the warehouse located on the land close to the head of the jetty.

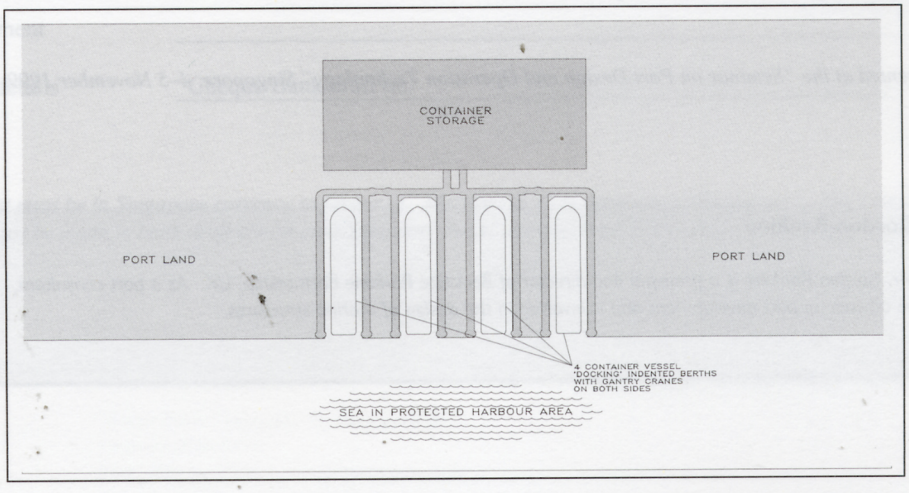

Figure 3. A Container Vessel "Docking" System with Indented Berths

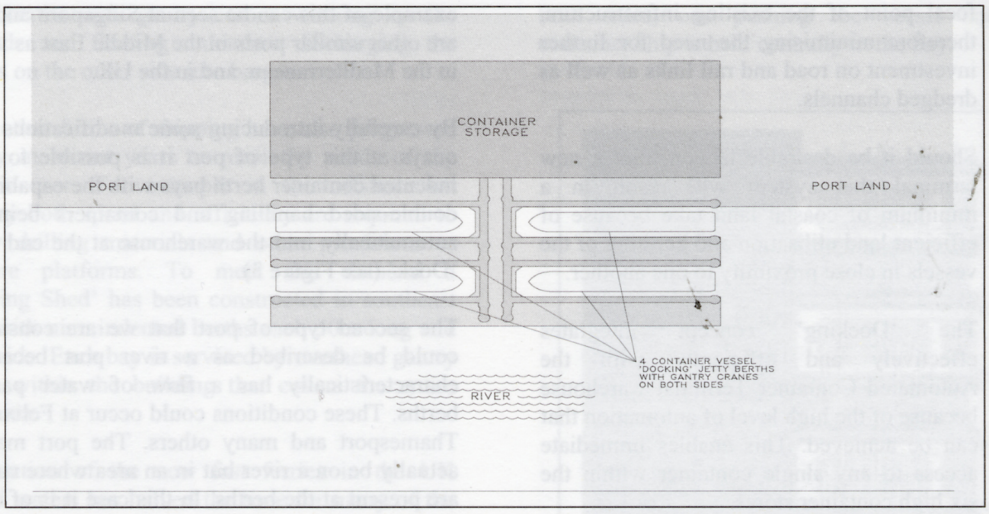

Figure 4. A Container Vessel "Docking System" with River Berths

The introduction of a container warehouse would save on land area by only occupying an area of about 40% of the conventional storage yard (see Figure 4).

CONCLUSION

The 'Docking' system can provide tangible benefits for container terminals, particularly in terms of making more efficient utilisation of restricted land areas and speeding up ship turnaround times.

The system of 'Docking' container vessels used in conjunction with the Automated Container Warehouse concept is most certainly achievable from the technical point of view. Its commercial benefit to each port operator will depend on how readily it can be introduced and this will depend on a complex set of factors, for example geotechnical conditions, the hydrodynamic regime, available land, restrictive working practices etc. It is inevitable that the degree of advantage that can be derived from the introduction of new container ship berthing systems will be different at each port.

An opportunity exists for the container 'Docking' system to be introduced at many existing container terminals. Greatest benefit is likely to be achieved by those who can adapt their existing facilities with efficiency and imagination.

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