Evolution of STS Cranes

Michael Jordan at California-based Liftech Consultants talks to World Port Development and speculates on some of the issues facing crane designers over the next decade and also puts forward a concept that may offer a viable solution.

In our January/February issue of *World Port Development* we looked at some of the issues that container crane manufacturers are facing with regards to crane design. One of these issues was the evolution of ship-to-shore container cranes over the next ten years. In the article Michael Jordan from California-based Liftech Consultants pointed out that in his opinion computer controls will dominate in crane operations. He proposed that nearly all motions will be automated and the operator would not be on the crane, but instead in a remote location – as seen at the Manzanillo Container Terminal in Panama in a recent ABB project. Other developments that Jordan sees ahead include: on-deck containers will pause at a de-coning platform on the crane; motions that cause lateral displacements – such as lifted load, wind, vertical and lateral inertia forces - will be all co-ordinated with the structural response of the crane. He also mentions that structural problems will be detected and corrected before their consequences are serious. Eventually, fatigue crack initiation in critical members will be monitored by acoustical methods. One topic that Jordan finds long overdue is the integration of machinery motions and structural response. According to Jordan, cranes are still designed to control the structure's response to nearly arbitrary mechanical forces. This wastes material and increases the cost of not only the crane structure, but the wharf as well. The co-operation of the structural designer and the drive control designer will reduce cost and increase production. Not only should the crane designer and the control designer cooperate, but the wharf designer and crane designer should also co-operate says Jordan. A balance between the costs of the crane and the cost of the wharf should be reached. Of course, part of the reason for the less than economic solution is: one party often owns the wharf and another owns the cranes. Since an economic solution is best for all the stakeholders, Jordan expects cooperation will eventually evolve.

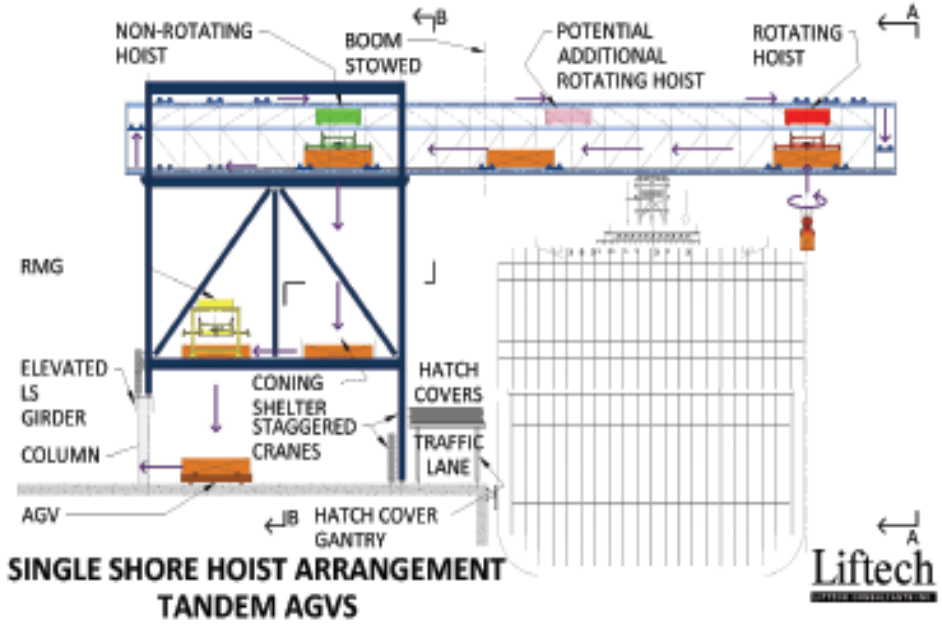

Figure 1: First configuration

Heavy utilised cranes

One of the more "conventional solutions" Jordan mentions is the APL crane which is currently being commissioned at the Port of Los Angeles and is perhaps most likely the model for heavily utilised cranes. Here the yard operation is designed to be automated, so longshoremen are not allowed in the same space as the AGVs and Automatic Stacking Cranes. An on-crane operator controls the ship trolley. Once the load is inside the waterside legs the computer controls the motions. The APL crane ship trolley has a single hoist while other cranes currently being designed for use at POLA will have a dual hoist trolley. Two FEU or four TEU will be handled in tandem. Currently the value of dual hoist trolleys over single hoist trolleys is nebulous. Of course for some operations the dual hoist is justified. The dual hoist system is still being improved. So Jordan expects that the single hoist or the dual hoist arrangement will be equally reliable. The unanswered question is: what is the lifetime cost and what is the value? If will be interesting to find the answer. Of course, one size will not fit all. And then of course, you have the "unconventional solution." The 'breakthrough' solution will be the development of STS cranes which service adjacent, rather the alternative, hatches on the new jumbo vessels. The design of an STS that is narrow enough to service adjacent hatches is a challenge. Some years ago Italy-based Regianne developed the "Octopus." This system deposited the container being loaded or unloaded to or from the vessel on 'runways' of the waterside crane legs. This system did not catch on and Jordan suspects, like all new concepts, the high capital investment and the uncertainty of the performance make investors select lower cost and more traditional approaches. ZPMC also spent considerable effort developing a very sophisticated system but to my knowledge, this system has not been used to date. AMPT has developed the Fastnet system that has also been widely publicised (note: Jordan is named as one Fastnet's inventors on the APMT's patent and one of the other engineers who all contributed to the Fastnet effort). Completing the design and constructing this massive system will be an engineering feat and require considerable investment. The system allows direct access to and from a variety of vessels. But the Fastnet system is complex and has been presented by APMT representatives on several occasions. Jordan explains that the intricacies of the system are beyond the scope of this article. The salient features are:

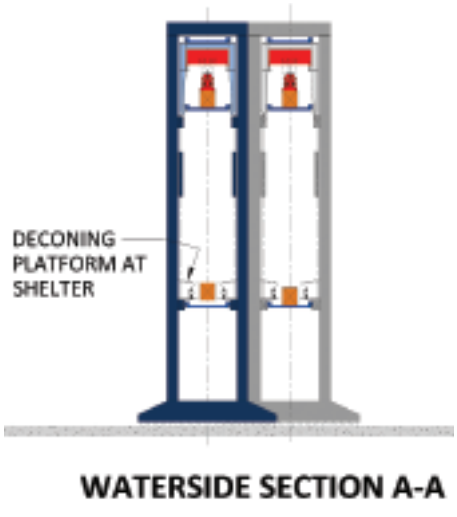

Figure 2: First configuration, waterside section A-A

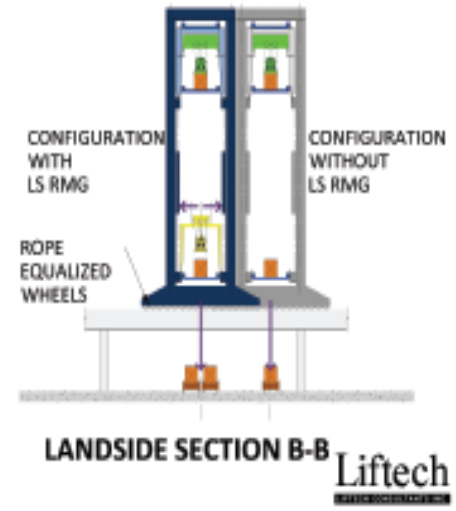

Figure 3: First configuration, landside section B-B

containers are handled by the STS cranes which are supported on elevated waterside and landside girders. The elevated waterside girders allow the container to pass from adjacent hatches directly to AGVs in the yard, while elevated landside girder allows the AGVs to enter the wharf area under the crane without being restricted by the usual gantry "tunnel." The Fastnet will significantly, perhaps nearly double the crane production.

Other concepts

Other concepts for servicing adjacent hatches are under development. Most are proprietary and Jordan expects that they will not be publicised until further development. Sometime during the next ten years, a system capable of servicing adjacent hatches will be developed and implemented. The system will be innovative and based on sound engineering analysis, as Fastnet is, and will have the following features; adjacent hatches will be serviced by the STS cranes, the system will be fully automated, the operators will not be on the crane, traffic lanes for ship utility and personnel transfer vehicles will be provided on the waterside of the structure's leg, some means of handling special and oversized loads will be provided outside the restricted automated yard, hatch covers will be stowed near the waterside wharf - either waterside or landside of the waterside rail. He also envisages that longshoremen will be protected from accidental falls of a container or its contents by placing de-coning platforms on the crane. The cones will be removed automatically or manually. The waterside crane girders will carry anywhere from150% to 175% of the customary loads from today's jumbo cranes. The landside crane girders will be elevated to eliminate the gantry tunnel and the containers in the yard will be handled by either AGVs or mini straddle carriers (the shuttle carrier).

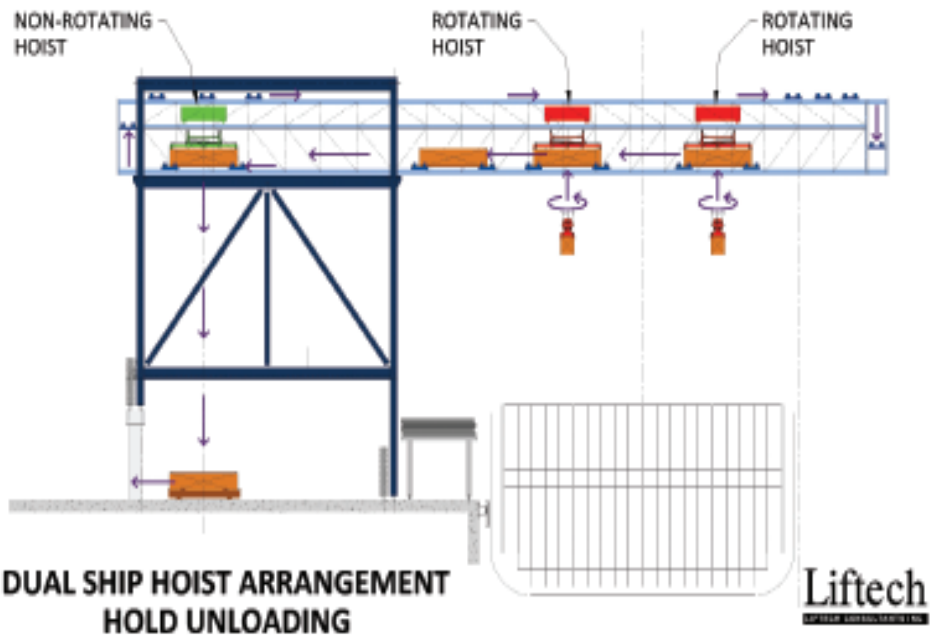

Figure 4: Second configuration, middle trolley over vessel

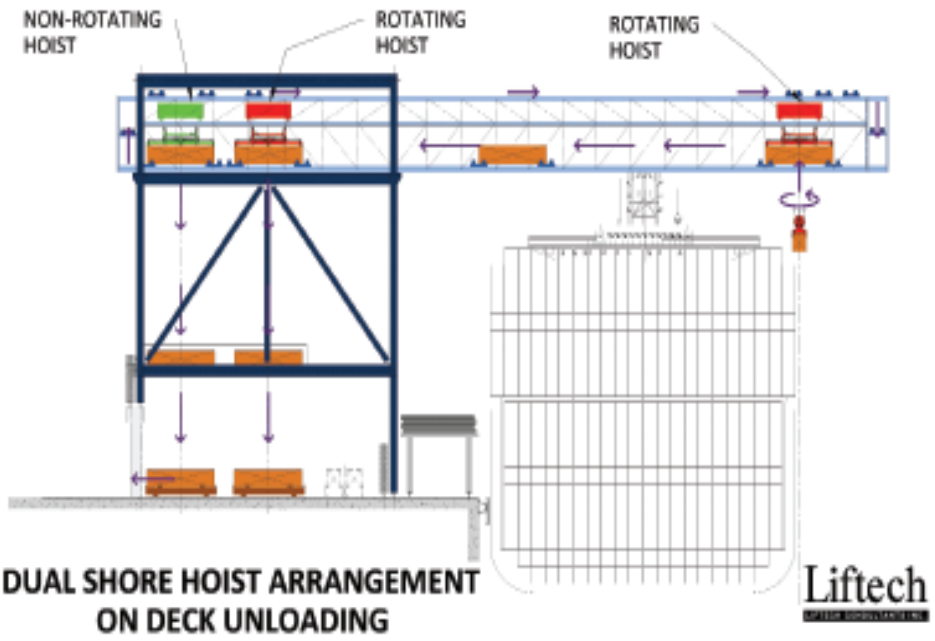

Figure 5: Second configuration, middle trolley over wharf

New concept - viable solution?

According to Jordan a possible viable solution (which is an off-shoot of the Liftech Super Crane which was first presented at a conference in Miami back in November 2002) is the Super Crane ship trolley which rotates the container by 90 degrees while it is over the vessel thereby allowing the container to pass through the crane legs the narrow way. The offshoot design will permit adjacent cranes to operate over adjacent ship hatches. Two configurations are proposed and both utilise three trolleys: a ship trolley, a middle trolley on the same girder as the ship trolley, and a shore trolley. The first configuration includes a ship trolley and a middle trolley, both on a shuttle boom, and a third trolley—an RMG on the portal beam. The ship trolley will park over a vessel container row. The ship trolley will transfer containers between the vessel and shuttle carts. The carts will create a conveyor system so the ship trolley will only lift the container from the vessel, rotate it and lower it to the carts, or vice versa. The ship trolley will not travel during every cycle - it will only travel to position itself over a stack of containers on the vessel. The middle trolley which is also on the boom will pick the container from the shuttle carts and, if the container is an on-deck container, lower it to the coning platform. Since the container is long ways, i.e. the long axis normal to the crane rails, the longshoremen, if de-coning is not automated, will always be to the side of the containers and never under the load. The middle trolley will set the container on a platform from which the shore trolley, a rail mounted gantry (RMG), will pick the container and place it on an AGV or on the wharf. The RMG can move the container laterally, so more than one lane of AGVs can be loaded or unloaded. This will provide a buffer between delivery of the container and arrival of an AGV. The wharf waterside crane girders will be at the wharf deck level. Two parallel waterside crane rails will carry overlapping adjacent cranes. The base of the cranes will be two hatches wide but the frame will narrow at the portal beam level so the out-to-out dimensions of the upper frame will be no more than one hatch wide. The wharf landside crane girders will be elevated with two crane rails. The hatch covers will be stored on moveable gantries near the vessel.

It only takes one operator to try this new idea and perhaps the rest will follow. As the saying goes – you have to speculate to accumulate.

Second configuration

The second configuration is similar to the first concept, except there is no RMG and three trolleys are on the boom. This arrangement allows for some flexibility. When the cycle time is controlled by the lift or set from the vessel, two trolleys will be over the vessel. When the cycle time is controlled by the transfer to and from the wharf, two trolleys will be over the wharf. Since these STS cranes and the infrastructure will require a large investment, and will not be proven before implementation, operators will, of course, be reluctant to make the needed investment. However, only one STS will need to be constructed to test the concept. It only takes one operator to try this new idea and perhaps the rest will follow. As the saying goes – "you have to speculate to accumulate."