Container Crane Recycling: Upgrade and Relocation

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ABSTRACT

With the slowing economy and rising prices of new cranes, renovating existing container handling cranes and bulk handling cranes deserves serious consideration.

Upgrading existing cranes to serve post-Panamax ships was common in the 1980s and 1990s. With the growth of Chinese equipment suppliers, new crane prices leveled off, and renovating existing cranes became less economical. Surging material and energy costs have escalated new crane prices, and current economic conditions have caused equipment owners to reduce their capital expenditures, making recycling existing cranes more attractive.

Existing cranes can be enlarged to serve larger vessels and modernized for increased productivity and easier maintainability. Depending on the situation, crane modernization can be achieved at a significantly lower cost than buying new cranes, and can be completed in half the time.

Existing cranes can also be relocated to respond to changing vessel deployment and business climate. The high cost of relocation within the USA does not always favor relocating the equipment. However, the cranes can be mobilized in a shorter time than purchasing new equipment.

This paper will present options and considerations for upgrading and relocating existing cranes.

BACKGROUND

Most maritime shipping companies were operating profitably through the summer of 2008 until the "perfect storm" of the credit crisis and the worldwide recession struck, leading to a major drop in world trade. The major ports across the United States and in other parts of the world have seen their throughput drop thirty to forty percent or more. The financial woes of the shipping industry have continued over several months with a series of warnings about the extent of the downturn and how long it will last. The economic conditions are not expected to improve significantly until after 2010.

Port authorities and terminal operators across the globe have substantially curtailed their capital expenditure and, in some cases, frozen it outright. However, some operators are faced with having to invest in equipment to improve terminal productivity, promote new business, or replace obsolete equipment.

The price of new ship-to-shore cranes has increased significantly over the last five years due to the increase in fuel and energy prices and changing market conditions. The financial crisis has not significantly reduced the price of new cranes. Terminal operators are taking a serious look at recycling existing cranes or investing in used equipment. Upgrading and recycling existing cranes may be worth consideration financially, with the added benefit of conserving precious resources. Money for recycling cranes is also primarily spent locally thus helping the local economy, whereas new cranes are purchased from foreign suppliers.

This paper presents the important aspects of recycling existing ship-to-shore container handling equipment.

RECYCLING

Recycling cranes includes refurbishing, modification, modernization, and relocation. Refurbishment could include catching up on deferred maintenance and correcting any existing problems with the crane's physical condition. The modifications generally involve geometry changes, which are primarily driven by the deployment of larger vessels or the requirements of a new terminal if the crane has been relocated. Modernization generally involves capacity and speed increases, which are driven by productivity and obsolescence. Relocation could be local, where the cranes are moved between berths or terminals, or across oceans. Relocating cranes frequently involves geometrical changes to adjust to the new terminal such as changing the crane's rail gage, adding and relocating stowage pins and tie-downs, or both. Recycling costs vary a great deal depending upon the type of work and the new location of the equipment. The cost of moving cranes large distances is often a deterrent to crane recycling.

Typical modifications include:

Geometry Changes

- Increase lift height
- Increase outreach
- Increase backreach
- Increase portal height
- Change rail gage
- Widen leg clearance
- Decrease overall width
- Strengthen for increased wind loads
- Add/modify tie-downs, stowage brackets, power connections

Performance Changes

- Increase rated capacity, including tandem lift
- Increase hoist speeds
- Upgrade drives and controls
- Upgrade gantry braking

Install snag protection
Install elevator
Convert shore power to diesel
Convert diesel to shore power

CASE STUDIES

The best way to demonstrate recycling cranes is to review what has already been done. The following examples are taken from Liftech's crane modification projects that are either recently completed or are underway.

Three Hitachi Cranes – Upgrade and Relocation – 2009. Matson Navigation and Horizon Lines vessels call at a terminal in Guam. The existing container cranes were too small and too slow to service the newer vessels and impractical to modernize. The Port Authority of Guam considered purchasing one or two new cranes at ten million dollars each.

Matson and Horizon located three retired cranes at the Port of Los Angeles, modified them for operations at Guam, and transported them to Guam. The Hitachi cranes were built in the mid-1980s and provided satisfactory service for the Port of Los Angeles until they were recently replaced by new cranes able to serve the larger container vessels. See Figure 1 for the unmodified cranes at Los Angeles.

The total cost of 18 million dollars to purchase and modify the three Hitachi cranes and wharf at Guam was less than the cost to purchase two new cranes for 20 million dollars, plus the cost of modifying the wharf at the stowage areas. Although the new cranes would have larger outreach, lift height, and capacity, the modified Hitachi cranes met the users' needs for the next ten years. The extra crane will allow faster ship turnaround and provides redundancy.

Figure 1. Unmodified Hitachi Cranes at Los Angeles

The changes to the three cranes included (See Figure 2):

Geometry

Increase the lift height by 8 feet to reach higher containers on deck
Reinforce crane structures to withstand Guam hurricane winds
Install new tie-downs and stowage brackets

Performance

New diesel generator set – EPA compliant
New drives, controls, and communication systems
New spreaders

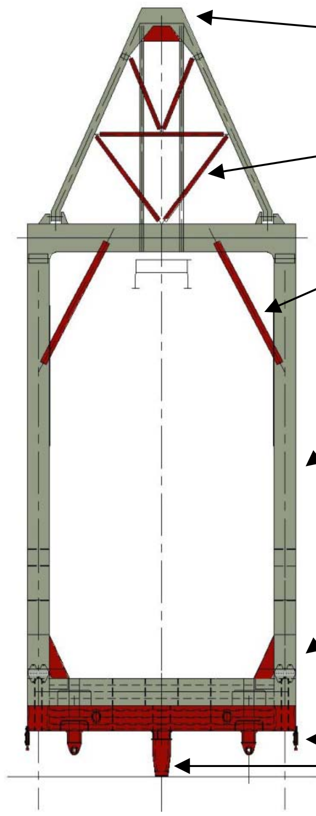

Figure 2. Frame strengthening for increased storm wind loads

Matson and Horizon also installed new tie-down and stowage sockets for the cranes, and modified the crane rail girders in the stowage areas.

The three Hitachi cranes are sister cranes to an existing crane at the same terminal and thus provide the benefit of having common parts, maintenance, training, and operations features. A significant benefit was the faster delivery of the three Hitachi cranes than the new cranes.

The three cranes were transported on one barge. Significant voyage bracing was required because of the long voyage across the open ocean. Ship transport was not an option since there were no US ships available that are capable of transporting the cranes.

Figure 3. Modified Hitachi Cranes at Guam

Drive Upgrade – 2009. A terminal operator operates four dockside container cranes: two built in 1980 and two built in 1994. The operator is experiencing difficulty obtaining mechanical and electrical parts, leading to high maintenance costs and unacceptable crane downtime. Replacing the cranes with new cranes was an expensive proposition as new cranes could cost 10 to 14 million dollars each.

The terminal operator opted to modernize the drives and controls of the existing cranes. At the time of writing this paper, bids have been issued to modernize four cranes with state-of-the-art drives, controls, and communication systems. The decision on how many cranes to upgrade will be made based on the bid price for the work. The upgrade project includes the following major items:

Replace the four major drives with current generation static drives having at least 20-year functional life

New centralized PLCs for crane control and new distributed I/O

New crane monitoring systems in each crane and in the maintenance facility

The average cost to upgrade one crane is estimated at one million dollars and the work is expected to be completed in early 2010. The two 1994 vintage cranes would be modernized at a fraction of the cost to purchase new cranes. The modernized 1980 vintage cranes would provide reliable supplements until the operator is able to replace them.

TWO A-FRAME CRANES RELOCATED FROM PANAMA TO MEXICO

SSA Marine operates container terminals in many parts of the world including Panama and Mexico. Their terminal in Manzanillo, on the west coast of Mexico, needed two dockside container cranes in a few months. Their terminal in Colon, on the Atlantic side of Panama, could spare two cranes. The two cranes, supplied by Hyundai Heavy Industries in the year 2000, were in good operating condition and met the operating demands at Manzanillo, Mexico. Liftech reviewed the structural design of the original cranes for Panama.

The rail gage at the Mexico terminal is 55 feet vs. 75.8 feet at the Panama terminal. The Mexico terminal is also located in an active seismic area. The following modifications were made to the two cranes to operate at the Mexico terminal.

Reduce Crane Gage. Various alternates were considered to reduce the rail gage of the two cranes and the scheme shown in Figures 4a-5b was selected. The portal beam was deepened and the landside legs were shortened and relocated from the 75.8 feet position to the 55 feet position.

Add Ballast and Tie-Downs. Since the rail gage was reduced, the cranes needed approximately 75 t of ballast at the landside for operating stability. Storm tie-downs on the cranes were added.

Relocate Elevator. The elevator is normally located on a landside leg. Since the legs were relocated, the elevator needed to be relocated also. The existing landside leg was used to support the elevator tracks up to the portal beam. A new support column was added above the portal beam to support the elevator track.

Crane Relocation. The two cranes were moved on a barge from Colon, Panama, to Manzanillo, Mexico. The barge transited through the Panama Canal. In order to clear the Americas Bridge at the Pacific side of the canal, the crane legs below the portal beams were cut off and the crane lowered to the deck. The cranes were raised upon arrival at Manzanillo, Mexico, the existing waterside legs were reinserted, and the modified landside legs were installed at the reduced rail gage.

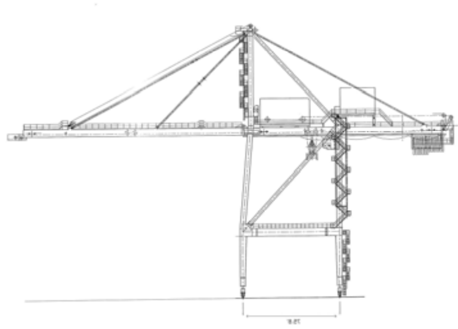

Figure 4a. Crane in Panama

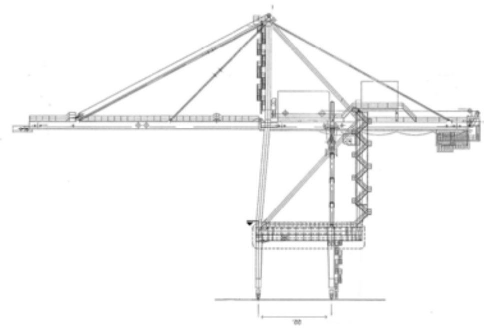

Figure 4b. Crane in Mexico

Figure 5a. Crane in Panama

Figure 5b. Crane in Mexico

IS THIS CRANE TOO OLD?

At some point, recycling a crane is no longer economically practical. The owner must consider all the costs of the recycling project including the desired life of the crane. Often the question is asked: but what about the structural life of the crane?

Structural failures, other than accidents, can be sorted into two groups: infant failures and aging failures. Infant failures occur during the initial operation of the crane and are due to faulty design, workmanship, or a combination of both. Infant failures are not of concern for cranes that have been operating for a few years. Aging failures occur over time and are due to slow crack growth. The application of fluctuating stresses causes small undetectable cracks to grow. If uncontrolled, these cracks grow until fatigue failure occurs.

Although the phenomenon is called "fatigue," it is only crack growth due to fluctuating stress. The steel does not get tired. The material beyond a crack is like new and is not affected by a nearby crack. If the crack and the small yield region in front of the crack are removed and the weld is repaired, the life of the structure starts over.

With proper inspection and repair of fatigue cracks, the occurrence frequency of new cracks is reduced. This phenomenon can be understood by considering a chain subjected to fluctuating stress. Links are inspected periodically for cracks. Cracked links are replaced with better than average links. As inferior links fail and are replaced with superior links, on the average cracks are less likely. Eventually the frequency of cracked links will stabilize. The frequency will be less than that for the new chain. The chain becomes more and more reliable.

Our experience indicates that most cracks occur at details that are either poorly designed, poorly made, or both. When the crack is properly repaired, a new crack is unlikely to occur.

When considering recycling a crane, maintenance and reliability need to be considered. How reliable are the existing details? How often have cracks been found and repaired?

ELECTRIFICATION AND EMISSIONS

Studies are underway at many ports around the world to convert diesel power of the existing Rubber Tired Gantry cranes (RTGs) to electrical power. The driving factors are to reduce emissions from the diesel generators and, in some cases, convert from high diesel cost to lower electrical cost. Unfortunately, with the recent economic downturn and drop in diesel cost, some of the momentum to electrify the RTGs has slowed down.

The electrification requires significant infrastructure improvements in the RTG yard. Some of the US port authorities have offered to pay for the infrastructure cost as an incentive for the terminal operators to modify their equipment. Various ideas to deliver electricity to the RTGs are: (1) cable reel either on the RTG or on a trailer attached to the RTG, (2) overhead bus bar system, and (3) overhead cable system like the street trolley car cables.

There are a few technical problems to overcome in converting the RTG diesel power to electrical power. Another problem is the difficulty in moving electrified RTGs between stacking rows. The authors are not aware of any conversion projects in the US at the time of writing this paper.

Stricter emission controls are mandated for many new installations. For such installations, some terminals are opting for Rail Mounted Gantry cranes (RMGs), which are generally electric powered.

We expect that some of the terminals from the West Coast of the United States will convert some of their RTGs from diesel to terminal power shortly.

COSTS

The cost of crane modernization and relocation depends a great deal on the extent of modifications and differences in the site-specific conditions. Cost estimates are shown below.

Table 1. Cost Estimates

Increase lift height 20 feet	$ 900,000
Increase outreach 20 feet	$ 1,000,000
Upgrade drives and controls	$ 1,000,000

The cost to dispose of a dockside crane depends on the type of crane and the price of scrap metal. In 2009, the cost of dismantling and disposing of a typical A-frame crane is about $150,000.

CONCLUSION

Recycling existing cranes may be the most economical and expedient option for some terminal operators if they need larger, faster, or more modern cranes. The size and performance of existing cranes can be increased often for a fraction of the cost of new cranes, but not always. The economics and practicality of modernizing the cranes depend on many factors. Each case should be looked at carefully.

Recycling cranes may have the advantage of helping the local economy as much of the work is performed locally.