Forward or aft?

Looking at self-unloading boom location

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Observers of Great Lakes shipping may have noticed the recent Canadian self-unloader delivery to Algoma Central Marine, and the announcement of a contract for construction of a new U.S. self-unloader by The Interlake Steamship Company, both with the unloading booms mounted forward.

Historians would point out the déjà vu aspect of this development by noting that forward-mounted booms were the norm for lake boats for about 60 years. There was a transition to aft-mounted booms starting in 1964 and the trend was so widespread that aft-mounted booms dominate the fleet today.

What are the considerations for selecting forward- verses aft-mounted unloading booms? There are a number of factors to be considered for the ship owner and the customers they serve.

Considering cargo hold volume. Maximizing the volume of the cargo hold is a prime consideration, especially when the vessel is designed to carry low density cargoes such as coal. It may seem, at first, that the location of the unloading boom has nothing to do with cargo hold volume, but the boom must be pivoted at the head of the cargo elevator.

Since the cargo elevator often takes up space in the hold, the selection of the elevator will often dictate the location of the boom. The three main types of elevators used on the Great Lakes are bucket elevators, inclined belts and loop belts.

Bucket elevators. As the name implies, bucket elevators are composed of a number of buckets mounted on loops of chain. The chains are connected to a motorized drive system that rotates the assemblage so the buckets are oriented to receive cargo from a hopper in the bottom of the hold, elevate the cargo above deck and discharge the cargo into a chute above the boom pivot. The buckets are returned to the bottom of the elevator upside down.

For about 60 years, nearly every Great Lakes self-unloader was fitted with a bucket elevator. The elevators were all mounted forward (as was the boom) on a steep angle toward the stern, such that the lower hopper could be located in the "dark hold" under the forward deckhouse, minimizing the volume lost to unloading machinery.

Inclined belts. The advantage here is simplicity—higher unloading rate (making it especially suitable for larger vessels), reduced maintenance and less noise. The major disadvantage is that the belts cannot be installed steeper than about 18 degrees because the cargo could roll backward down the belt.

A few ships were converted to self-unloaders by adding inclined belts in the cargo hold with extreme loss of hold space, but the delivery of the Canadian vessel *Cape Breton Miner* in 1964 marked the first time an inclined belt elevator was installed through the engine room and the boom installed at the stern.

Forward-mounted booms were the norm for lake boats for about 60 years.

The belts were placed in casings and discharged into a hopper near the transom, which transferred the cargo to a conveyor belt running forward through the upper engine room and lower deck house, eventually discharging to a chute above the boom pivot. While this arrangement is not well suited for self-unloader conversions, it was popular on new vessels, with about 14 ships built with this arrangement between 1964 and 1980.

All of them had the boom located aft.

Loop belt. The loop belt was first installed on a laker in 1972. It is an all belt system shaped like the letter "C" and incorporates an inner belt which is brought into contact with the main belt, "sandwiching" the cargo between the two belts. This system has the major advantage of requiring limited longitudinal space, making it well suited for both new construction and conversions. About 67 Lakes vessels now employ loop-belt elevators—40 newbuilds and 27 conversions.

The majority of these installations have the boom mounted aft. Only about six have forward-mounted booms.

Trim, shearing and bending. Designers must also consider trim, shear and bending moment as important parameters affected by the longitudinal distribution of weight, including cargo and unloading machinery.

Since shear and bending moment are increased when the distribution of weight does not match the distribution of buoyance, and since loop-belt elevator casings and machinery could weigh less than, say, the taconite cargo that could be located in that section of the hold, and since the buoyance distribution depends on differences in the hull shape, the selection of loop belt and boom pivot location—forward or aft—is a significant factor in providing acceptable trim, shear and bending moment.

Other factors in proximity. Another consideration in boom location is that the unloading system requires electrical power, compressed air, hydraulic fluid, etc. Installing the cargo elevator and boom close to the engine room could reduce the length of electrical cables and piping and place the major unloading machinery closer to the maintenance crew.

Since cargo-unloading operations produce noise and dust, locating the cargo elevator and boom away from the accommodations and the engine room is advantageous.

Visibility from the pilothouse is a major consideration. The pilothouse with a stern deckhouse and aft-mounted boom must have enough height to provide visibility over the boom lifting structure. If this ship has a forward-mounted boom, the pilothouse can be lower but forward visibility will be blocked by the width of the unloading casting. A ship with its pilothouse located forward and having a forward elevator casing will need bridge wings for aft visibility.

Considerations must include the overall design of the vessel, expected docks that will be serviced and other vessels in the fleet.

Many of the '50s-vintage ships with forward deckhouses have a passenger lounge with picture windows in the aft bulkhead of the deckhouse. Adding a forward elevator casing and boom would destroy the passengers' view, making it a consideration in boom placement.

Unloading dock. The arrangement of the unloading dock is a major consideration, especially if cargo must be placed into a hopper. Other factors include length of the dock, navigational approaches to the dock, the location of the hopper, mooring facilities, water depth, river current and obstructions such as bridges, etc.

One self-unloading barge built on the Lakes to serve a dock on the Mississippi River was built with a forward boom because: 1) the hopper was located upstream toward end of the dock and 2) the vessel was required to dock with the bow into the swift current—neither of which could be achieved with an aft-mounted boom. This barge has since returned to the Lakes and is in service for another owner.

Forward-mounted booms can have an advantage even if the vessel will discharge to open storage piles, if obstructions, current, water depth, need for tug assistance or other considerations restrict backing a vessel with an aft-mounted boom to the dock. The advantages of a vessel with a forward-mounted boom are particularly important in the late fall, when dock owners want to pack the corners of their dock with winter storage material. A vessel with a forward-mounted boom can more readily deliver cargo to a portion of a dock with shallow water.

A ship with an aft-mounted boom will expose the vulnerable rudder and propellers to damage if backed toward the shallow area of a dock, while one with the forward boom can approach closer to the shallow area because the bow plating is less sensitive to damage. As this ship unloads and takes on the customary aft trim, it can shift forward further over the shallow end of the dock and place additional cargo where it is desired.

To some extent, most fleets need at least one vessel with a forward-mounted boom to adequately service all of its customers.

Modifying existing designs. Converting existing ships and modifying existing designs to self-unloaders can sometimes be best accomplished with forward-mounted booms.

One ship owner converted a product tanker to a self-unloader by building a new forebody with a forward-mounted boom for the existing stern-machinery section. This technique reduced the modifications necessary to the existing portion of the ship. The unloading-system installation was completed more economically and timely as part of the new forebody construction.

Another ship owner had built a simple bulk ship but wanted a similarly sized self-unloader. The design was modified to add a forward-mounted boom, eliminating changes to the drawings of the stern section.

Just the opposite was done a number of years ago when a self-propelled laker was converted to a self-unloading barge by removing the stern-machinery section and building a new notch section—complete with the major unloading equipment and aft-mounted boom.

There are many items a designer must consider when selecting the arrangement of self-unloading systems, with special emphasis on the location of the unloading boom. It is not a selection that can be made in isolation.

Considerations must include the overall design of the vessel, expected docks that will be serviced and other vessels in the fleet. While the history of self-unloading vessel construction shows that some trends in the location of the unloading booms have existed, the boom can "go either way" in future designs. ■