EVOLUTION OF A MARINE TERMINAL: A CASE STUDY OF THE PORT OF HOUSTON'S FENTRESS BRACEWELL BARBOURS CUT CONTAINER TERMINAL

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ABSTRACT

To survive in the competitive marine transportation industry, port terminals must adapt to changes in the business environment. This paper describes how the Port of Houston's Barbours Cut Terminal (BCT) has evolved during the past 22 years, becoming the premier container terminal on the U.S. Gulf Coast.

BCT has evolved into a multiuser facility servicing 24 steamship lines. Projected volumes for 1994 were 450,000 20-ft equivalent units (TEUs). The terminal averages 30 container moves per gang per hour on vessels. Ship turnaround time averages less than 12 hours, and truck turnaround time is less than an hour with proper documentation.

The terminal has five 1,000-ft container berths, and a sixth berth is scheduled for completion in early 1996 (Fig. 1). The terminal has 20 rubber-tired gantry and 10 wharf cranes. The terminal's 203 acres of marshaling area can accommodate more than 21,500 TEUs and 532 refrigerated units. Space is available for more than 4,000 wheeled units. Also available are a RO/RO platform, a LASH dock, two 100,000-ft^2 transit sheds and 44 acres of RO/RO marshaling area. A rail ramp is located near the 55,000-ft^2 container freight station. For trucks the terminal has 21 truck lanes and 12 scales.

The original concept for BCT is still intact: to develop flexible and efficient facilities in time to meet market demands and to remain as cost conscious as possible. The ultimate goal is to provide customers with the best service for the lowest possible price.

INTRODUCTION

In 1956 top executives of Pan-Atlantic Steamship Company (the predecessor of Sea-Land Service, Inc.) came to the Port of Houston to watch a converted tanker discharge the first load of containers and load a similar cargo for the return trip to New York. No one watching knew that this concept of an integrated transportation system was destined to start the revolution the shipping industry, now known as containerization.

Although the revolution started at the Port of Houston, the battles in the development of containerization were fought elsewhere. Steamship lines serving the Gulf Coast were slow to accept the new technologies; therefore, demand for container facilities at Gulf ports lagged behind that of other areas. Though initially frustrating, it gave the Port of Houston Authority the opportunity to benefit from the experiences of others. When the port began planning Barbours Cut Terminal (BCT) the concepts in the industry were maturing and technologies were tried and proven. By the late 1960s several important events had occurred at the Port of Houston:

- Containerization had taken hold. Three container cranes were in operation on the general cargo wharves. By 1970 more than 40,000 TEUs were being handled.
- The Port Authority had developed most of its property at the Turning Basin area and was unable to obtain enough additional acreage to build container terminals of proper proportion.
- Ships were being built in previously unheard of sizes. The Port Authority was facing the probability that these large ships would bypass Houston and the Turning Basin Facility rather than try to negotiate the twisting bends of the man-made Ship Channel, which is only 300-ft wide for the last 10 of its 50 mi.

To meet the challenges, port management knew it would have to develop a new facility at a site with plenty of room for future development and closer to the Gulf of Mexico. Using Elizabeth, Bremerhaven, Tilbury, and Skandiaharbor as examples, the Port of Houston Authority turned to Barbours Cut, man-made inlet 8,000 ft in length at Morgan's Point, 25 mi downstream from the Turning Basin (Fig. 2).

On August 5, 1970, plans for the development of the Barbours Cut Intermodal Terminal were announced. At the time it was envisioned as a 20-year project that would cost $100 million and
accommodate up to 20 ships.

LASH FACILITIES

The original and continuing concept behind BCT was and is to build new facilities to match anticipated business demands. No port can afford to be far ahead of user demands because of the enormous capital requirements for modern facilities. Likewise, if a port does not aggressively develop facilities on a timely basis, it can lose potential business to ports willing to take greater chances. Therefore, Houston port officials put a high priority on analyzing trade routes and in attracting steamship customers.

The decision to move forward with the new terminal was motivated by a steamship line's announcement that two LASH ships would begin calls to the Western Gulf Coast in 1972. These ships would call at Houston only if an appropriate berth was made available. The Port Authority thus decided to begin development of the terminal, with the construction of a LASH dock at the entrance to Barbours Cut.

The major components of the development were a U-head pier for LASH and Seabee ships (now LASH Berth No. 1) and a barge fleeting area. A U-head was chosen over the traditional T-head for versatility. With the U-head pier, containers also could be worked with ships' cranes handling the unloading of containers and loading of containers onto trucks that could use the second leg of the dock for a continuous path.

Construction of the LASH dock and a 4-acre container marshaling yard was started in late 1971. The first vessel call was Combi Lines' 875-ft M/V Bilderdyk, on June 29, 1972.

The LASH dock has proven to be an invaluable asset, from the early development of the terminal through today. Although the last LASH liner service left BCT in 1982, the dock has continued to be used for random LASH vessels and more important, as a lay berth facility.

TERMINALS C-1, C-2, AND C-3

Flexibility and efficiency were key goals in designing BCT. Port management knew it had to balance the ability to grow and adapt to changes in the business environment, to prevent early obsolescence, with the need to be as cost conscious as possible. The basic elements of a terminal are an entry complex, operation buildings, a marshaling yard, a wharf, and container cranes. The major design variables are the amount of land to be utilized and the method of storing and transporting containers within the terminal. These variables are related because the operating system depends on the space requirement.

Choosing an Operating System

The three basic systems used in container terminal operations at the time were, and remain, the chassis system, the straddle-carrier system, and the rubber-tired gantry (RTG) crane system. After studying each system with regard to initial investment, land requirements, and operating and maintenance costs, it was determined that a combination between the chassis and RTG systems was the best solution for the Port of Houston.

The chassis system provides high production rates to vessels and road operations. The major advantage is that each container is immediately available for operations. The major disadvantage to ports is the high land requirement for a relatively small number of containers.

A straddle-carrier operation requires less land area than chassis operations, but more area than RTG cranes. Because Barbours Cut lies within the city limits of Morgan's Point, a bay shore village that contained about 300 homes before the Port Authority began developing the terminal, it was essential to disrupt the community as little as possible. Therefore, for the grounded storage portion of the facility, the RTG method was chosen because of its greater storage density.

Other factors that worked against the selection of straddle-carriers were equipment reliability and initial investment both in equipment and paving. Straddle-carrier cranes require heavy-duty paving of the entire marshaling yard. With the RTG and chassis systems that were chosen, the port only had to provide concrete runways 17 in. thick and 6 ft wide for the RTG cranes. The remainder of the yard was paved with 7 in. of asphalt, which at the time was considered to be adequate.

Flexibility

Once the container handling method was chosen and the decision was made to make each container wharf 1,000 ft long, flexibility was addressed in the terminal design. The plan was to provide a skeleton of a container terminal with the "meat" to be added as funds allowed and business demanded. As always, financing was a crucial factor; it was recognized that construction funds would have to be obtained through the issuance of revenue and general obligation bonds.

To prevent early obsolescence, the container wharves were designed for a live load of 1,000 lb/ft^2. The apron was designed so that railroad tracks could be introduced in the future. A strip of land was reserved within the terminal for rail access to the wharf apron. The yard crane runways and area drainage were designed and spaced to accommodate rail-mounted gantry cranes. The entry complex and the maintenance garage were designed for easy expansion.

Construction

Construction of the container terminal began in 1974. The first contract was for the construction of the bulkhead for wharves C-1 and C-2. This was followed by the contract for the wharves and then the contracts to purchase two wharf cranes and three RTG cranes. Because of financial constraints, only one-third of the container yard was initially completed.

A project of this magnitude is seldom completed without at least one significant change. In the case of BCT, the catalyst was the advent of straight stern and bow ramp RO/RO ships, then being built to serve the Middle East, a major market for the Port of Houston. In late 1976, with the planned 1977 opening day rapidly approaching, it was decided that a RO/RO ramp should be provided at BCT. The decision added approximately $1 million to the development costs, but the ramp was definitely needed at Houston, a port from which many large pieces of construction and oil field equipment are shipped. The ramp is still in use today, with weekly services to Europe and Africa.

Sea-Land Lease

During the planning of BCT, the Port of Houston Authority and Sea-Land Service conducted negotiations over the lease of a wheeled terminal to Sea-Land. Eventually a 20-year lease was signed for Sea-Land to operate Terminal C-3. Sea-Land moved to BCT in late 1978, occupying Terminal C-2 until Terminal C-3 was completed in early 1980.

Sea-Land's move to BCT marked the beginning of a rush to the facility. By 1980, 13 lines regularly called at the terminal. This shift of operations to BCT exceeded the Port Authority's expectations and caught it short of facilities. By 1981 the number of entry lanes had been doubled and the entire container yard was paved (increasing the storage capacity to 10,500 grounded TEUs and 700 wheeled slots), two more wharf cranes and six more RTGs were ordered, and 44 acres of heavy-duty concrete for the RO/RO marshaling yard were complete.

TERMINAL C-4

In 1987 the Port of Houston increased its grounded handling capacity through the purchase of two more RTG cranes, bringing the total number available to 11. In 1984 Terminal C-4 was completed. This facility, due to increased customer demand was developed as a chassis terminal. Terminal C-4 increased the facility's wheeled slots by 1,300 and brought the total number of wharf cranes at BCT to eight.

Surfacing

Port engineers experimented with many types of surfacing materials for the marshaling yards at BCT. Due to the soil type and subsurface conditions at BCT, the concrete test areas have proven to be the most economical surfaces. Though more expensive to install than slag and asphalt, the concrete has proven to be much more durable and nearly maintenance free. Slag and asphalt require constant and expensive maintenance and repair. Paving stone surfaces proved to be more expensive to install and more expensive to maintain because of their tendency to "rut" in high-traffic areas. Therefore, C-4 was paved in concrete; the roadway is 10 in. thick, and parking areas are 7 in. thick. BCT has been designed for achieving specific objectives. High priority has been given to traffic patterns, improvement of RTG crane use, and the ability to handle multivessel operations efficiently.

Entry Complex

In 1988 a new entry facility was developed for the users of C-4. The entry complex consists of two inbound lanes with 60-ton scales, one outbound lane, a building for data processing, and a canopy. This facility has been very beneficial in terms of reducing overall gate processing times and in improving traffic patterns within the facility.

RTG Pads

Though originally developed as a wheeled operation, C-4 was designed to be easily retrofitted to RTG cranes. In 1992 the port purchased four new RTG cranes and retired the original three, bringing the total number of usable cranes up to 12. At the same time, construction began on crane runways for three RTG storage pads at C-4 waterside. With approximately 70 percent of the cargo grounded, it is important to provide grounded staging areas in each terminal, providing the shortest route between the staging area and each vessel. This improves traffic flow by reducing congestion. Eventually, pads will be installed on the water-side of Terminal C-3, thus linking the waterfront pads throughout the entire complex.

Reefer Facilities

Initially C-4 was developed with 80 electrical connections for refrigerated cargo. Changes in customer requirements necessitated the development of more plugs. In 1992 five additional acres with 236 plugs were developed on the southern end of C-4.

TERMINAL C-5

As cargo volume continued to grow and available space on C-4 became used, the port began to develop Terminal C-5. The first development was 10 acres of concrete marshaling space in 1987. Soon after, the bulkheads for C-5 and C-6 were constructed. Next, the port enlarged the vessel turning basin and the C-5 and C-6 berthing areas. In 1989 cargo volume again dictated more space, and an additional 10 acres of marshaling yard were developed. Construction of the wharf began in 1990.

Desert Storm

In August 1990 the U.S. military called on BCT to provide port facilities for vessels and equipment being shipped to the Middle East for Operation Desert Storm. The 20-acre marshaling yard at C-5 became the staging area for this movement, with the majority of vessels docking at C-4. During this operation and subsequent withdrawal, the terminal handled 97 ships and 48,000 pieces of military cargo. This accounted for more than 40 percent of the military cargo handled by U.S. ports. Military personnel remained on-site through most of 1991 as the last pieces of equipment were returned to the United States.

Wharf Cranes

During the design of the C-5 wharf, the port examined the benefits of 100-ft-gauge cranes versus the 50-ft gauge design on adjacent terminals. A major reason the port stayed with the 50-ft design was that mixing the two gauges on the continuous wharf would have required placing all three rails on the new dock as well as retrofitting C-4 for the 100-ft rail. The cost of this operation heavily outweighed the benefits of the 100-ft gauge cranes.

In 1993 the port completed the purchase of two 50-ton post-Panamax wharf cranes. Though no vessels currently calling at BCT require this size crane, they were purchased to provide the capability if needed.

RTG Pads

The next construction project on C-5 was the completion of four RTG pads between the wharf and the wheeled marshaling yard. When this project was completed in 1993, it linked the grounded space between C-4 and C-5. The pad area has plugs for 48 grounded refrigerated containers. In 1994 the port purchased eight additional RTG cranes, bringing the usable fleet up to 20.

Entry Station

The last project on C-5 was the completion of an entry complex in 1994. This facility consists of three inbound lanes with 100-ton scales, two outbound lanes, a data processing building, and a canopy.

TERMINAL C-6

Negotiations are currently under way with Sea-Land for Terminal C-6. The lease for C-3 expires in 1998, and this facility no longer meets Sea-Land's marshaling yard acreage requirements. When Sea-Land relocates to this larger facility, the Port Authority will have five continuous container docks to operate, thereby reducing docking and traffic congestion problems. Sea-Land has expressed the desire for an all-concrete facility designed for multiple container-handling methods if they become appropriate in the future. C-6 will have an additional benefit to Sea-Land in that it will have direct gate access to the rail ramp, on which Sea-Land heavily relies. Construction began on the wharf and 10 acres of the marshaling yard in 1994.

Support Facilities

By 1980 a container freight station (CFS), a railroad ramp point, and a maintenance facility for Sea-Land had been built at the west end of the property, in an area that lacks water frontage. The location of the CFS was based on the belief that waterfront land is too valuable to use for such a building and that a remote site within the terminal complex would alleviate traffic congestion. This decision required the installation of an intraterminal private road to facilitate movements to and from the container terminals.

Since 1980 two 100,000-ft^2 transit sheds have been built in the RO/RO marshaling yard. Other facilities added in recent years include a chassis yard and three private empty-container storage and repair yards that are connected to the public terminal via the intraterminal road.

Highway Access

Highway access is a strength at BCT. Texas has an above-average network of highways, and Houston, as one of its most prosperous and influential cities, has been treated well by the state's highway department. After leaving BCT, a truck can be on a major thruway, heading in any direction, within 10 min (Fig. 2).

Although Loop 610 in Houston is congested at times, a new beltway is nearing completion just outside the city limits. The beltway will allow truckers to access four Interstate highways without encountering much metropolitan congestion. Recent improvements to Interstate 225 and planned improvements on Interstate 146 near Barbours Cut should keep pace with any increases in truck traffic along these routes. However, realizing that current environmental philosophies do not favor rapid growth in vehicular traffic, port officials are closely evaluating Barbours Cut's rail capacity.

Rail Facilities

Although little support was forthcoming from any of the railroads serving Houston, port management believed that a ramp point within the property would be a real asset. The port had fought the mini-land-bridge concept but in the end adopted the "If you can't lick 'em, join 'em" philosophy. The ramp point, which is also connected to the intraterminal road, has played an important role in the terminal's success.

The rail ramp consists of two working tracks, each 2,800 ft long, two holding tracks, and 200 parking spaces. The surface in the yard is slag, and the handling method is top-picks. The yard is maintained and operated by the Southern Pacific Transportation Company. In 1993 the yard handled 40,000 units. Projected volume for 1994 was 60,000 units. The 50-percent increase in volume is due in part to a new intermodal service linking BCT to major West Coast ports.

ISTEA

To ensure continued growth, improvements are necessary at the rail ramp. The Transportation Policy Council (TPC) of the Houston-Galveston Area Council (H-GAC) has recommended the Port Authority be awarded approximately $13.2 million in federal assistance to finance two capital projects at the BCT rail ramp. The improvements, the first Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) funding for rail projects ever approved in this region, include increasing the facility's ramp point capacity and adding mainline rail tracks to provide additional access to the terminal. This is the first time the Port Authority has been recommended to receive federal funding for the construction of capital transportation projects. The TPC's recommendation must still be approved by H-GAC board members. The region's federal Transportation Improvement Plan also must be accepted by several federal government agencies before proposed funding can be awarded.

Ramp Expansion

To protect the existing ramp business, the current plan for increasing the rail ramp's storage and handling capacity is to build a new facility bordering the existing ramp. The new ramp will be surfaced with concrete to reduce wear and tear on equipment and to enable the port to stripe, number, and "computerize" parking locations. The new ramp will consist of three working tracks, with 675 wheeled parking locations. The facility will be designed to handle the current chassis and top-pick handling method as well as RTG cranes if they are deemed appropriate in the future.

When construction is complete, existing business will be relocated to this facility with little or no interruption in service. When business requirements make it necessary, the original ramp will be resurfaced in concrete and renovated. If the original ramp is renovated before its capacity is required, existing business would have to bear the cost of overdevelopment.

Empty-Container Yards

The original master plan for BCT reserved land for privately run empty-container yards. This property is on the west end of the terminal, away from water frontage but close enough for direct discharge and loading of empty containers to vessels. Again, port planners believed that waterfront acreage was too valuable to tie up with the storage and repair of empty-container fleets. Therefore, the tariff for BCT was designed with incentives to promote the storage and repair of empty containers away from the public terminal.

The decision to lease the areas to private companies was based on the fact that they had been running these types of facilities at the Turning Basin yards for years. Because the mandate of the Port Authority is to promote the economic stability of Harris County through the creation of jobs, and therefore not to directly compete with private business, the port offered leases to the industry. In 1979 the first privately operated empty-container yard at BCT was leased to a stevedoring company. Today nearly half of the steamship lines calling at BCT move their empties through four private yards.

Computer System

The Container Inventory Control System (CONICS) was originally designed by IBM for the Mercy Docks and Harbour Corporation in Liverpool, England. When BCT opened in 1977, this software program was purchased and installed as an online, mainframe inventory control system. Since that time, the system has been updated continuously to meet the needs of the terminal and its customers.

CONICS has three main portions: Park Control, Ship/Interchange Control, and Bookings. Park Control controls the grounded yard allocations and locations for containers based on steamship company, vessel/voyage, size, port of discharge, hazardous label, and weight class. The proper segregation of grounded export containers is imperative to facilitate subsequent stowing of a vessel by a stevedore. Two Park Control coordinators direct road traffic within the terminal by helping direct RTG operators to locations where drivers are anticipated and by recording in CONICS the exact placement of containers in the "pads" or stacks of containers. Ship/Interchange Control is the real-time entry of vessel and gate moves. Data entry clerks record these movements as they occur so that agency personnel have the most accurate and timely information possible. Once import containers are entered on file, the steamship line may release them for pickup by drivers. Container throughput charges are invoiced automatically as moves occur at the gate. The Bookings system allows agency personnel to send booking information, including hazardous material data, to BCT in advance of the trucker.

CONICS is a flexible system that accommodates wheeled and grounded operations, multiple users, and equipment pools on terminal. In addition, proprietary information is safeguarded, and physical yard checks to confirm the integrity and accuracy of information are performed on a regular basis.

Access to CONICS

All liner services calling at BCT have at least one CONICS connection, which allows them to notify the terminal of bookings and import releases. In addition, steamship users have real-time access to inventory on terminal. Stevedores can access the system to determine export container numbers and can use "downloads" to help devise stow plans. Recently some local brokers were given access to certain CONICS screens to assist them in tracking BCT cargo movements. This pilot project will help determine the need for CONICS information by brokers.

Evolution of CONICS

Over the years, CONICS has evolved to meet BCT needs. Significant program changes include the following: automated work-order initiation and billing, automated turn-time calculation, the addition of a USDA inspection program, and a total renovation of the booking screens completed in 1993.

Another enhancement is the Container Inquiry System, which enables anyone with a touch-tone telephone to determine if an open booking is on file or if an import container has been released. Dispatchers and truck drivers are the main users of this voice response system, and the result has been fewer drivers arriving at the terminal with inadequate information.

EDI

CONICS has been programmed for electronic data interchange (EDI) transmissions. Currently 7 of the port's 24 lines receive gate transmissions, thereby eliminating the need for duplicate entry of equipment interchange receipts by agency personnel into their computer systems. Several shipping lines also receive vessel moves via EDI from CONICS. In the near future, the booking system will be programmed to receive information via EDI, thereby reducing the customer's need to enter bookings into CONICS before dispatching trucks. Another project will allow the automatic transmittal of import release information via EDI.

Future Computer Enhancements

As new technology continues to become available, Port Authority management searches for those technologies that are a good "fit"—ones that improve existing procedures and facilities and provide worthwhile benefits. One possibility is the addition of the functions needed for a truck pre-clearance station. Another is an enhancement of the Container Inquiry System that would reduce the need to check truck documentation at the gate. In addition, automatic equipment identification and pen-based computer technology have been considered as alternatives to costly, labor-intensive gate operations. For now, however, CONICS is able to proficiently and expediently process the volume BCT must accommodate.

Labor

At all terminals, labor is directly linked to the success of the facility. A flexible and productive work force can lessen facility and equipment requirements through better use of assets.

As a terminal operator, the Port Authority hires International Longshoreman Association (ILA) labor to operate equipment and perform clerking duties. In 1992 terminal management and labor changed terminal work rules to accommodate a cost effective method to keep the terminal open continuously from 7 a.m. to 6 p.m. Known as flextime, the plan consists of staggering employees' starting times and meal periods. Flextime allows greater use of facilities and equipment and improves customer service by expanding the terminal's working hours.

CONCLUSION

The container revolution has long been realized on the U.S. Gulf Coast, and a reasonable case could be made that Houston's port facilities helped bring it about. To date, approximately $250 million has been invested in BCT, one of the most modern intermodal terminals in the world. Inflation and the increased cost of technology have taken their toll, and the 1970 prediction of a $100 million price tag for the entire development is an all but forgotten dream.

Planners and engineers are currently working on projects that will soon be needed, as well as on projects for which there is less urgency. The Port of Houston Authority will continue to provide the finest facilities for intermodal service throughout the 1990s and beyond.