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The Evolution and Economics of Barge Carrying Ships

*by Wallace T. Sansone**

ABSTRACT

THE LAST DECADE witnessed numerous changes in ocean transportation. Two of the most important were the dramatic increase in the size of vessels in the world merchant fleet and the construction of an increasing number of highly specialized ships. The following analysis examines the evolution of the barge carrier vessel in the light of these structural changes in shipping.

Although the LASH/Seabee operation is less than two years old, it is fast becoming a principal factor in integrating the inland waterways with the oceanborne movement of goods. It has made possible the transport of all types of cargoes to distant and difficult ports and by its application barge ship operators have established the optimum of productivity, as well as economy of scale in liner operations. The concept has already affected patterns, caused labor management confrontations, and even threatened the survival of some ports. It will undoubtedly continue to change many of the traditional approaches to ocean shipping in the future.

I. IMPROVED TECHNOLOGY IN OCEAN TRANSPORT AND THE ECONOMICS OF SCALE

Until a decade ago, progress in materials handling had been excruciately slow. Ships continued to carry cargo in much the same break-bulk fashion as they had for centuries. In fact, the cargo carrying characteristics of general cargo ships with the exception of perhaps a modest 10 knot increase in speed over sailing ships and the development of mechanical winches, conditions remained practically unchanged.

The non-liner trades were the first to adopt improved technology in ocean transport and the economies of scale achieved here have reduced the cost of liquid and dry bulk carriage. Ten years ago, in the non-liner trades the famous war-built 10 knot, 10,000DWT, liberty ship remained queen of the dry cargo tramp fleet. Today, including ships on order, more than 20 percent of the dry bulk carriers exceed 50,000 deadweight tons and within

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**An Intermodal Transportation Specialist for the Maritime Administration, has been with the Office of Ports and Intermodal Systems since 1970. Prior to that, he was with MarAd's Office of Government Aid. His previous experience includes a year as a logistics consultant for the U.S. Navy, three years in responsible ship operations and chartering positions in the Maritime industry and four years as a Merchant Marine Officer. He graduated from the New York State Maritime College with a B.S. degree in 1960 and from New York University in 1964 with an M.B.A. He holds the rank of LCDR in the U.S.N.R.*

the foreseeable future, shipments of dry bulk cargo in supercarriers of 250,000 to 350,000 tons deadweight can be expected. In 1959 the largest tanker had just edged past the fabulous 100,000 deadweight ton mark. That mark now stands at 375,000 deadweight tons and is expected to surpass 470,000 DWT shortly with sizes of up to 1 million tons being planned for the future.

World waterborne trade volume more than doubled between 1960 and 1969 and it's total in 1969, the latest year for which figures are available, amounted to more than 2.2 billion metric tons. This dramatic growth in international oceanborne trade boosted the demand for shipping services and led to the rapid expansion of the world merchant fleet which doubled its deadweight carrying capacity during the same period. The growing demands of new cargoes to be carried as well as the improvement in handling techniques through specialization and the resulting economies of scale have led to the building of larger, and more productive ships. During the last decade a period of almost insatiable transport demand, such highly specialized ships as supersized bulkers and tankers, containers, roll on/roll off, LNG, LPG, OBO,[1] mini, slurry, oceangoing tug/barge and LASH/SEABEE were developed.

In the liner trades, before the development of unitization, a process for speeding the handling of general cargoes, the most predominant types of packing were jute sacks, wooden crates, iron or wooden casks, bales and an occasional pallet. Things are different now. The productivity of containerships has already caused a veritable revolution in cargo handling and like the development of containerization the development of the barge carrier concept (LASH/SEABEE) is expected to have a profound effect on the form and efficiency of liner transport.

Twelve years after the first full containerships began operation or less than two years ago, an entirely new concept in ocean transport began with the world's first Lighter Aboard Ship (LASH). In undertaking an analysis of barge-carrying ships, an extraordinary new type of liner vessel, their advantages over conventional freighters quickly become apparent. As already noted, in the last decade we have experienced dramatic growth in the size and efficiency of non-liner vessels. In the liner trade rapid unitized cargo handling in containers and barges has drastically reduced port time and consequently, the optimal size of the liner type vessel has grown dramatically. Prior to the development of the container and barge cargo handling systems, it was not economically feasible to increase the size of a conventional liner vessel.

In many trades, liners spend as much as 65 percent of their productive lives in port. Due to long periods of waiting in harbors and slow conventional break-bulk handling a high fixed overhead results. Therefore, the newest conventional break-bulk liner vessels cannot benefit from the economic advantages of larger sizes much beyond 15,000 deadweight tons since the amount of port time increases in direct proportion to size. Under these conditions high sea speed is also costly. Contrast this with today's existing barge carriers and containerships approaching 50,000 deadweight tons and

1 LNG—Liquid natural gas; LPG—Liquid petroleum gas; OBO—Oil bulk and ore.

speeds of 33 knots and thereby permitting economies of scale virtually undreamed of less than a few years ago. From an economic point of view, container and barge systems are intended to achieve savings in transport cost per unit, not only through the elimination of the manual handling of individual packages at each stage of transfer but also through the higher productivity. As an economic consequence of shorter time in port and increased ship size the optimal speed of the vessel will also increase. Therefore, the investment required per unit/carrying capacity will decrease considerably as vessels grow more productive and allow an operator to replace conventional tonnage at a ratio of 4 to 1 or higher. Nuclear powered liner vessels of 100,000 deadweight tons, serving vast geographic areas with smaller vessels being assigned from distribution centers to inland consumption and redistribution points, may be possible before 1980. The economic effect of such sizes are many fold as vessels of such scale will undoubtedly establish a downward trend in liner freight rates just as experienced in the liquid and dry bulk trades which have already declined some 20 to 50 percent in the last 20 years.

II. THE BARGE CARRIER CONCEPT

Although the barge carrying ship is the newst form of intermodal transportation, it represents more than a decade of research and development, and design work by the naval architectural firms of Friede and Goldman (LASH), and J. J. Henry in addition to the Lykes Brothers Steamship Company (SEABEE). By its application barge ship operators have obtained the optimum of productivity, as well as economy of scale in liner operations. Basically, a barge carrier system involves a number of lighters, a ship which transports the lighters across the ocean and a lifting device in the ship for handling the lighters. Probably the most important element of the system is the lifting device which may be called the heart of the LASH/SEABEE system. The LASH design utilizes a 500 ton gantry crane capable of lifting four LASH barges per hour or 2,000 tons (1,480 tons of cargo) while the SEABEE design uses a 2,000 ton giant submersible elevator lifting four SEABEE type barges per hour which weigh, in total, 4,000 tons and can hold 3,400 tons of cargo. By comparison, 15 long tons per gang hour could be taken as an average productivity figure for break-bulk cargo loaded in conventional liners. Palletized cargoes can pass through the sideport of a palletship at a speed of 60 tons per gang hour with the operation of 3 to 4 fork-lift trucks. Containers can be loaded or discharged at the rate of 20 containers per hour with an average load of 10 tons each, resulting in a handling rate of 200 tons per hour per crane.

The self-sustaining characteristics of the barge carrier system allows it to lay off in a seaway to load and discharge its lighters containing cargo of virtually every description including containerized freight with savings in port time, over conventional vessels of as much as 90%. After discharge from the barge carrier, a tug then collects the lighters and moves them to the port or an inland terminal. Barge carrying vessels are more versatile than containerships since they do not require elaborate infrastructure, or a whole system of specialized terminals, inland depots, rail and road networks necessary to transport containers into the interior.

The barge carrier system is clearly optimized in those particular trades whose source of freight and its ultimate destination may be reached by inland waterways. Considerable advantages accrue to the shipper located along a waterway, for in the first place, he need not concern himself with the problems of mode transfer and the added costs of documentation and claims inevitably associated with inland movements. Secondly, the shipper if he wishes, can enjoy greater economies of shipping in larger or full barge load lot sizes.

Although the barge carrier concept has been in operation less than two years, it is fast becoming a principal factor in integrating the inland waterways with the oceanborne movement of goods. In the United States, the inland waterways excluding the Great Lakes has a commercially navigable length of over 25,000 miles, of which more than 15,000 miles are navigable at a nine feet draft or over. LASH lighters which are approximately half the size of the SEABEE lighters have a maximum draft of 8′8″ in fresh water as compared to a loaded draft of approximately 11 feet for the SEABEE type. Nevertheless, both types are afforded easy access over the major share of this country's vast waterway network, thereby offering shippers the opportunity to ship between underdeveloped plant sites which may lack facilities or sufficient depth of water alongside to accommodate deep draft ocean ships. Barges for example, can navigate year round from the Gulf of Mexico as far north as Chicago on our inland waterway network.

On our inland waterways, exclusive of the Great Lakes, about 550 million short tons of cargo was transported in 1969. In 1970, a special report on export shipments indicated that 45 percent of the total export tons was shipped from plant to port of export by water, as compared with 33 and 51 percent by rail and highway.[2]

According to the American Waterways Operators, Inc. data, since 1952 there have been 8,095 plants located on the national navigable waterways indicating a high degree of interest on the part of management to take advantage of lower cost barge transportation. Such transport costs in today's transport economy are nearly what they were in 1920–0.3 cents a ton mile on the average. That rate compares with 1.4 cents for railways and 6.5 cents for truck freight.

There are a number of other advantages which accrue to the shipper in utilizing the barge carrier concept, for example, LASH/SEABEE lighters may be permitted to act as a convenient reservoir or warehouse for both the receipt of and discharge of any commodity at a rate appropriate to the requirements of the shipper or receiver. In addition, this method avoids the need for a multiplicity or cargo-handling stages and activities. A barge carrier can call at any number of minor ports which would not be economic for large container ships or non-liner type vessels since the barge system permits rapid handling of a single barge without requiring shoreside infrastructure.

In summary, the key to the economics of the barge carrier operation is its ability to separate at a phenominal rate the motive part or mother ship

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2 1967 Census of Manufacturers, U. S. Department of Commerce, Bureau of Census, 1970.

from its cargo carrying parts or lighters with an almost absolute independence of shore based port facilities and inland transport land modes.

III. COMPARATIVE ADVANTAGE OF THE BARGE CARRIER SYSTEM

Technological developments such as containerization and the barge carrier concept changed the structure of the ocean liner trades from a labor to a capital intensive industry. The economics of ocean transportation have been radically altered due to the economies of scale that may be achieved by capital intensive ships. The comparative advantages of these systems has caused considerable controversy over which system is most appropriate for various operating circumstances. Since its introduction to foreign trade in 1966, containerization has spread rapidly to highly developed nations where the necessary inland transport infrastructure exists, i.e., Canada, United States, Europe, Japan and Australia. In contrast the most favorable trade routes for the barge carrier systems appear to be those routes between underdeveloped nations lacking ports or those countries with extensive inland waterways.

Ironically, North Europe was the destination for the first containership as well as the first barge carrier in foreign trade. North Europe, of course, has a highly developed road and rail network and an extensive inland waterway network. The origin points of these pioneer ship's seems to hold the answer to each type's comparative advantage. The containership emerged from the hub of a vast rail and road network at New York, whereas the barge carrier first sailed from the mouth of the world's most extensive navigable waterways system at New Orleans. The success of each ship type is critically tied to the availability of the inland modes and as a result the comparative advantages of each ship system will shift depending on the transport infrastructure of the areas to be served.

Inland transport costs are crucial to any economic analysis of alternative transport systems. The analysis should consider the entire process as one integrated system, from inland point of origin to final destination. Given a particular trade route and transport demand to be satisfied, there are many variable factors and an analysis of these variables is too lengthy for consideration here. It is tempting, however, to touch on a comparison of costs in general terms.

The U.S. flag version of LASH originally cost nearly $22 million per ship. This price does not include the lighters which cost approximately $40,000 each and $5.9 million for the two full sets (146) required per ship. If converted to a full container ship, a LASH vessel could carry 1,500 - 20 foot container equivalents. The capital cost for a containership with the same carrying capacity is estimated at $18 million. The cost of containers varies with type but a purchase price of $2,000 each should be representative, or $9 million for the three sets required per ship. Some hold that two sets are more realistic, but this is, of course, dependent upon how many containerships an operator has in service. Chassis/bogies cost $5,000 per set and assuming two full sets (2 - 20 foot units on one chassis) the equipment cost is $7.5 million. If the LASH and containership in this example made twelve round trips per year and were utilized at 100 per cent of their carrying capacity, their annual lift, at 1.5 million cubic feet per voyage, would equal 18 million cubic feet of cargo in each direction. For the barge carrier, the resulting capital costs are $.77 per cubic foot, while the container ship's costs are more than $.95 per cubic foot of cargo carried.

In connection with this rough calculation it must be remembered that the various capital assumptions made and those capital, operational and cargo handling costs not considered here, do have a great bearing on the results of choosing the best system for a particular trade route. Nevertheless, there is no reason to assume that any one system will become universally adopted to the exclusion of the other.

The different systems may exist side by side on the same trade route oftentimes complementing each other since the cargoes they are capable of carrying are quite different.

The ability of barge carriers to carry containers provides an important transitional feature or hedge against the possibility that containerization may develop in a particular trade. On the other hand, thousands of tons of uncontainerizable neobulk[8] cargo which consists of those commodities which show an increasing trend toward movement in larger lots, in order to achieve greater economies, are moving away from conventional liners and container vessels. The movement of neobulk cargo in U.S. foreign trade is expected to increase rapidly in the next decade from the present 56 million long tons to an estimated 117.5 million long tons. Liner cargo volume during this same period is not expected to change significantly and should remain nearly static at about 50 million tons.

This development should add greatly to the barge carrier's market potential.

IV. GATHERING MOMENTUM IN BARGE-CARRIER TRANSPORT

The barge carrier concept is a development viewed with varying degrees of enthusiasm by differing sections of the industry, but events in the last two years alone served to show the gathering momentum for this form of transport of goods.

From the Gulf Coast of the United States the world's first barge carrier, the ACADIA FOREST, sailed on her maiden voyage to North Europe in November, 1969. Built in Japan, the ship is operated under long-term charter from Norwegian owners by Central Gulf Steamship Co. International Paper Co., the biggest exporter of paper products in the U.S., has a contract with Central Gulf that calls for the exclusive use of the vessel on all east bound voyages. In August, 1970 her sister ship, the ATLANTIC FOREST, joined in the service to link the vast waterways system of the Gulf with the inland cities of Europe.

On the North Atlantic/Mediterranean trade route, the first U.S. flag LASH ship, the LASH ITALIA, made her maiden voyage in January, 1971

8 Neobulk cargo is defined as that portion of the trade which, by virtue of its cargo characteristics, is showing an increasing trend towards movement by irregular service.

BARGE CARRYING OCEANGOING VESSEL PROGRESS REPORT
(as of June 1, 1971)

Owner/Operator	Trade Route	Trade Area to be Served	Number of Ships in Operation	Number of Ships on Order or Under Consideration	Remarks
AMERICAN FLAG					
Central Gulf Steamship Corp.	18	U.S. Atlantic and Gulf/India, Persian Gulf, and Red Sea	0	3 LASH	Application Pending
Delta Steamship Lines Inc.	20	U.S. Gulf/East Coast South America	0	3-6 LASH	Delivery Dates: For 3 LASH 4 to 9/73
Lykes Bros. Steamship Co.	21	U.S. Gulf/United Kingdom and North Coast of Continental Europe	0	3 SEABEE	Delivery Dates: 1/72, 4/72, 7/72
Pacific Far East Lines	29	U.S. Pacific/Far East	0	6 LASH	Delivery Dates: 9/71, 11/71, 2/72, 4/72, 7/72, 2/73 Comm Ops 2/71, 2/71, 5/71
Prudential-Grace Lines, Inc.	10	U.S. North Atlantic/Mediterranean	3 LASH	2 LASH	Delivery Dates: 9/72, 11/72
Waterman Steamship Corp.	18	U.S. Atlantic and Gulf/India, Persian Gulf and Red Sea	0	3 LASH	Application Pending
	12/22	U.S. Atlantic and Gulf/Far East	0	4 LASH	Application Pending
	21	U.S. Gulf/United Kingdom and Continental Europe	0	3 LASH	Application Pending
FOREIGN FLAG					
Central Gulf Steamship Corp.	21	U.S. Gulf/United Kingdom and Continental Europe	2 LASH	0	Commenced Operations 10/69, 8/70
Holland American Line and Hapag-Lloyd (Combi Line)	21	U.S. South Atlantic & U.S. Gulf/United Kingdom and Continental Europe	0	2 LASH	Delivery Dates: 2/72, 8/72
TOTALS			5 LASH	26-29 LASH 3 SEABEE	

PREPARED BY: Office of Parts and Intermodal Systems—Division of Intermodal Transport after a two month delay due to painful labor disputes. By mid-1972 five Prudential-Grace LASH ships will be in operation.

From the Cockerill Shipyard in Belgium two LASH mother ships are expected to be delivered in February and August, 1972 to Holland America Line and Hapag-Lloyd for their joint service between the great river systems of the U.S. Gulf and North Europe. The service to be known as Combi Lines will compete with the existing LASH service of Central Gulf and the planned SEABEE service of Lykes Brothers.

Three Lykes SEABEE ships that are currently being built by General Dynamics, Quincy, Mass., are all expected to be in service by mid-1972. The combined barge-carrying cargo capacity of the three operations on the route from the U.S. Gulf and South Atlantic ports to North Europe will represent a combined lift capability of six million tons per year for the total of four LASH and three SEABEE class vessels. Total liner and non-liner tonnage in 1970 for this trade was 22 million long tons. Therefore, the potential cargo lift of just seven barge carrying ships may represent 28 percent of the trade route total (including South Atlantic tonnages).

Pacific Far East Lines expects to operate six LASH ships in its liner service from U.S. Pacific Coast ports to the Far East. The first of these vessels will begin operation in late 1971, calling on ports in Japan and Korea and as far south as South Vietnam and Thailand.

Delta Steamship Co. has three LASH vessels under construction at Avondale Shipyard in Mississippi for delivery in 1973. The vessels will be employed on Delta's trade route from the U.S. Gulf to East Coast of South America ports.

Sixteen barge carrier applications are pending approval of the Maritime Administration or are in negotiations with U.S. carriers. Waterman Steamship Co. has applied for ten LASH vessels, Central Gulf as well as Delta Steamship Lines have expressed interest in building three additional vessels.

With just five barge carrying ships in service, another sixteen under construction and plans pending for an additional sixteen, it may come as a shock to those out of maritime circles that the development of the barge carrier is well on its way towards changing the shipping patterns of the world. These thirty-seven barge-carriers, utilizing more than 4,000 lighters, represent the combined carrying capacity of one-hundred and forty-one conventional liners. Undoubtedly, the barge carrier concept will achieve a considerable share. of the ocean freight market within the coming decade.

