Future Dynamics of United States Flag Oceanborne Transportation

F. Kosofsky* and S. Mazursky†
Litton Systems Inc., El Segundo, Calif.

The recent history of U.S. flagship merchant shipping has been, in general, a dismal picture of aging equipment, sharply reduced share of U.S. trade moving on U.S. flagships, and an evergrowing dependency on subsidy or government cargoes. This deterioration is especially a matter of concern in a world environment where trade is expanding rapidly, where total world tonnage has doubled in the last 12 years, and where strides have been made elsewhere in the world toward a reduction in unit cost for ocean shipping. Though the future of U. S. flag shipping is to a large extent in the hands of national policymakers, there are two possible avenues to an improved competitive position: 1) the application of technical innovation to oceanborne shipping and 2) a systems view of ocean transportation as an element of an intermodal transportation process. The "systems" view of ocean shipping represents as important an element for possible future growth as do technical possibilities, such as nuclear propulsion, hydrofoil, surface effect ships, or completely automated ships.

I. Introduction

THE objectives of this paper are twofold: 1) to briefly review some recent estimates of the future of world-wide oceanborne trade, U.S. oceanborne trade, and the role of U.S. flagships in this trade; 2) to show areas of possible investigation for improvement of the U.S. competitive position in world trade, specifically technological advances and a systems approach to trade.

A recent study[1] of U.S. and world-wide oceanborne shipping includes estimates of the quality and quantity of trade as far into the future as 2043 (75 years from 1968). We will consider estimates up through the year 2000, for the purposes of this paper. Some of the key findings of the referenced study are presented below. It is shown that though the volume of world-wide and U.S. oceanborne trade has been increasing, the role of U.S. flag shipping has been decreasing, and will continue to decrease, unless appropriate steps are taken.

Two of the more important avenues of investigation for improvement of the U.S. position in world trade: exploitation of the U.S. position in technology and technological application; and the use of the systems approach to cargo transportation as well as ship design are then discussed. Both paths will, hopefully, reduce system costs and permit the U.S. to successfully compete in oceanborne trade.

II. Oceanborne Trade Trends

World Oceanborne Trade

World oceanborne trade grew at an average annual rate of 7.4% between 1950 and 1966. The largest share of this growth was in the tanker segment of oceanborne commerce, which grew at a rate of slightly more than 9%, compared to 4.48% for the dry cargo segment. Tanker trade, which represented 42% of total oceanborne tonnage in 1950, passed dry cargo tonnage in 1960, and increased to 54% in 1966.

Projections of world tanker trade assume that the recent annual growth rate of 9% will continue at an 8% rate until the early 1980's, gradually settling to an annual growth rate of 3% to the end of the century. These reduced rates are based on an expected leveling demand in Japan and Western Europe, on a probable search for other energy sources because of air pollution, and on expected strong competition from nuclear power as a source of energy toward the end of this century.

Total world dry cargo trade has been projected using the 4.48% per year rate of growth experienced between 1950 and 1966.

Past trends are displayed, along with projections in Fig. 1. It will be noted that the expected declining growth rate in tanker trade results in dry cargo tonnage again becoming the dominant segment of ocean shipping early in the 21st century.

U.S. Oceanborne Trade

Trends in U.S. oceanborne trade

For purposes of analysis and projections, U.S. oceanborne trade is divided into tanker, liner, and nonliner‡ trade. Table 1 presents forecasts of U.S. trade, from Ref. 1. These forecasts are displayed along with recent trends in Fig. 2.

Tankers

U.S. tanker trade is dominated by imports, which have grown by 7.3% a year in the recent past. Future tanker imports [which are expected to increase by 3.3% per year (the historical rate of growth) until 1983, by 2% per year between 1983 and 2003, and by 1% per year after that] were forecast by correlation with U.S. demand for petroleum. This decline in the growth rate will occur because of increased competition from nuclear power as a source of energy, and because of pressures to reduce the sources of air pollution, as in the case of world-wide trade.

Presented as Paper 69-415 at the AIAA Industry Enters Into the Sea Conference, Seattle, Wash., May 20, 1969; submitted June 12, 1969; revision received July 14, 1969.

* Manager, Operations Analysis Department, Advanced Marine Technology Division. Member AIAA

† Manager, Cost and Economics Analysis Department, Advanced Marine Technology Division.

‡ See definitions in Appendix.

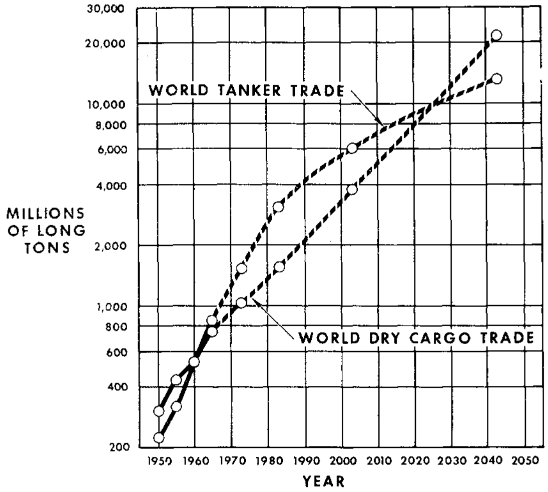

Fig. 1 World oceanborne trade 1950–1966, with projections to 2043.

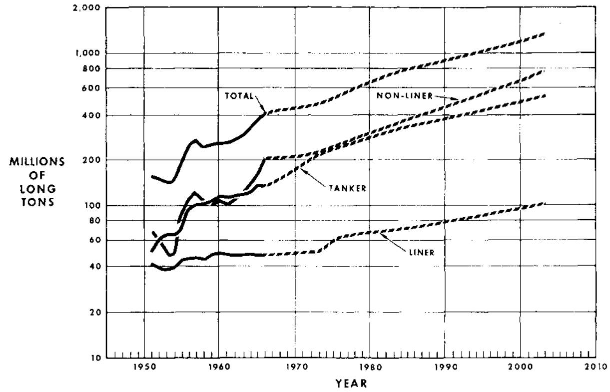

Fig. 2 U.S. oceanborne trade 1951–1966, with projections to 2003.

Liner trade

Liner trade, which has been increasing, but at a very moderate pace, will continue to do so. Exports will grow by 1.95% per year, imports by 1.7% per year.

Nonliner trade

Nonliner imports, which have been increasing by 9.3% per year since 1951, are expected to show an annual growth rate of 3.1–4.5%. Exports, which have been rising by 7.8% per year, will expand by 3.3–5.5% per year in the future.

III. Trends in World Shipping Capacity

Consistent with the very sharp rate of growth in total world oceanborne trade and in U.S. oceanborne trade, there has been an increase in the total world shipping capacity. The number of ships in the world fleet increased from 15,282 in 1950 to 18,423 at the end of 1966. World deadweight tonnage capacity increased from 107 million tons in 1950 to 232 million tons at the end of 1966. In comparison with this sharp growth rate, the U.S. flag privately owned fleet has decreased in the same period of time. Figures 3 and 4 are a graphic illustration of the decline of U.S. flag shipping in a period when total world shipping has been expanding. The U.S. flag privately owned fleet has declined since 1950 from 1087 ships to 965 ships at the end of 1966. Total deadweight tonnage has remained approximately constant over that period of time, reflecting the increase in average ship size in recent years.

The size of the world fleet was projected out to 1983, based upon projections of world oceanborne trade. Although the total world fleet will continue to expand as indicated in Figs. 3 and 4, the future of the U.S. flag fleet will depend to a large extent on Federal Government policy towards the Merchant Marine in the next few years. An examination of the relative age of the total world fleet and the U.S. privately owned fleet indicates that the decline of U.S. flag shipping will continue unless a maritime policy is developed to encourage replacement of average ships. The average age of all foreign flag ships at the end of 1966 was 14 years. The average age of privately owned U.S. flag ships was 19 years at the end of 1966. Replacement of the subsidized fleet was started in the mid 1950's but is considerably behind the original schedule. The bulk cargo fleet is probably the weakest element of the total U.S. flag fleet. Average age of foreign flag bulk carriers was ten years at the end of 1966, while the average age of U.S. flag bulk carriers was 22 years. Only one U.S. flag bulk carrier has been built since 1948, and there is very little prospect today of a change in that trend.

IV. Role of U.S. Flag Shipping

The decline in the size of the U.S. flag fleet, in a period during which oceanborne trade and the world trade is expanding, shows up in an examination of the role of U.S. flag shipping in the movement of U.S. foreign trade. Figure 5 indicates the trend in recent years, with U.S. flag participation dropping from 43% in 1951 to 7.2% in 1966. This decline would probably be even lower if not for the supports provided by the Federal Government. U.S. flag share of liner cargo movement is approximately 25% of total U.S. foreign trade, whereas the share of dry bulk cargoes is approximately 3% of total U.S. nonliner cargo trade. U.S. flag position with respect to liner cargoes is supported by the subsidy program. The dry bulk fleet, not covered under the subsidy program, is supported almost entirely by government sponsored cargoes, either DOD cargoes or AID cargoes shipped under the Cargo Preference Act.

It is not the purpose of this paper to propose changes in the subsidy program or in government support programs for ship operators. The purpose of the preceding comments on the status of the U.S. flag fleet was to highlight the existing situation, and to serve as an introduction to our comments about the future needs of U.S. flag shipping. It is not clear that more subsidy or more support is needed. It is our position instead that innovation, technological advances, and the application of the systems approach are the keys to the long term health of the U.S. flag fleet.

Some steps that are being taken or that might be taken in the future to encourage growth and innovation in the U.S. flag fleet are: 1) reducing ship acquisition cast within current

Table 1 Summary: U.S. oceanborne trade forecasts, millions of long tons

	Tanker		Liner		Nonliner		Total	
Year	Imports	Exports	Imports	Exports	Imports	Exports	Imports	Exports
1973	196.5	20.8	22.5	37.0	95.8	120.5	314.8	178.3
1983	307.4	29.2	26.8	45.0	148.5	205.9	482.7	280.1
2003	499.5	58.0	37.7	66.2	271.7	494.3	808.9	618.5
2043	786.8	227.9	75.0	143.7	1029.8	1789.6	1891.6	2161.2

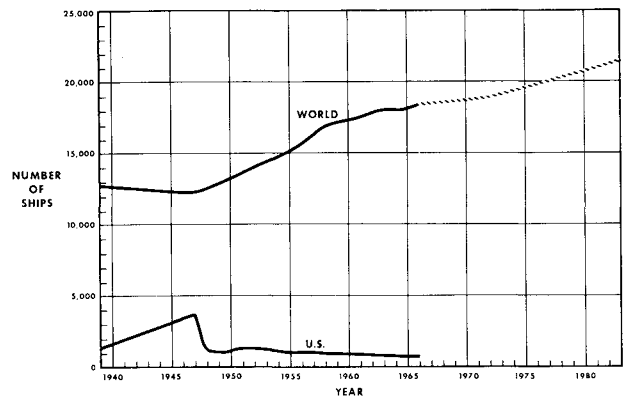

Fig. 3 U.S. flag privately owned vs world fleet (number of ships).

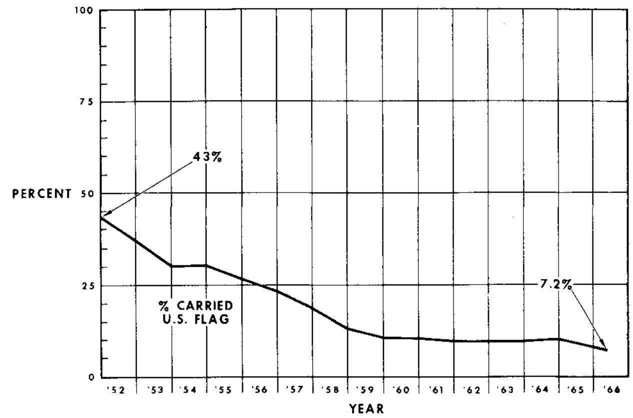

Fig. 5 U.S. flag participation in U.S. total trade.

technology by the use of standardized ship designs; 2) reducing unit shipping costs through application of a systems view to the shipping process; 3) research and development for future technological innovation. These steps are discussed below.

V. Effect of Standardized Ship Designs

Many reasons have been suggested for the decline of the U.S. flag dry bulk fleet. Without seeking to identify causes, it is possible to note some of the fact of life of U.S. flag dry bulk cargo operation. Dry bulk carriers are not currently covered under the construction subsidy program. U.S. flag operators, in order to be eligible for the Cargo Preference Act, must build their ships in U.S. shipyards. The cost of shipbuilding in U.S. yards is considerably higher than it would be in a foreign shipyard. Without access to construction subsideis, the bulk ship operator is at a disadvantage with respect to acquisition cost vis-à-vis his foreign flag competitors.

The amortization of initial acquisition cost, together with interest, accounts for about 60% of the daily operation expense for a typical modern ship. Any attempt to increase the competitive posture of the U.S. Merchant Marine must therefore address the problem of how this large element of cost can be reduced. The shipbuilding industry, unlike most modern production processes, is at present a largely "custom building" procedure, in which the yard simply executes a specific design that the prospective owner has decided is best for his particular needs. Needless to say, prospective owners rarely agree on the characteristics of ships that they want to buy, particularly since they will probably employ different design firms to prepare final plans. As a result, there are few opportunities for shipbuilders to produce a series of identical ships and thus achieve the economies of scale that have had such a dramatic effect on the costs of other manufacturer products.

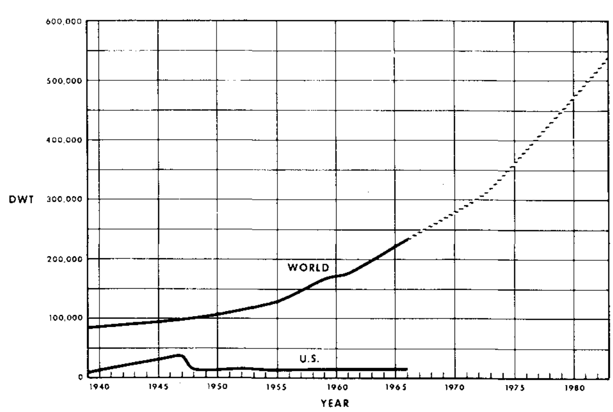

Fig. 4 U.S. flag privately owned vs world fleet (deadweight tonnage, thousands of tons).

When circumstances have permitted serial production runs, as in the case of certain naval ships or for commercial applications in which a fleet of ships can be used, the economies have been very impressive. Learning rates of 85 to 90% have been achieved, and many ship production experts feel that with proper conditions, such a rate of learning could be sustained over a very long run. Cost experience in foreign yards, where longer runs are encountered, suggests that these economies could be achieved.

Present conditions are not favorable to long runs of identical ships. Trade requirements vary, and each operator must select ship characteristics carefully to assure reasonable profit margins. Financing problems, and the difficulty of assimilating large numbers of new ships into an established route structure, make block procurement of an entire fleet available to very few.

One solution is to standardize ship types to allow quantity production while retaining sufficient design flexibility to accommodate the variance in design characteristics among the many possible users of the ship. This approach is now being investigated by the Maritime Administration in an attempt to revitalize the U.S. dry bulk cargo fleet, which has now almost reached the point of extinction. The investigation requires an optimal resolution between the two opposing factors that are involved in any standardization problem: maximum identity of product to reduce production cost vs maximum diversity of product to generate wide utility. When a ship operator uses a standardized ship, it will be less effective for him than a fully optimum design adapted specificially to his needs. Offsetting this lack of optimality, the acquisition cost will be lower due to the very extensive production quantity made possible by standardization.

Ship size is one of the most critical factors to the user of a ship. Operating costs per unit of cargo decline sharply as ship size increases. At the same time, route constraints such as draft limits in ports, or the availability of cargo, tend to limit size. The interplay of these factors determines optimum ship size, and severely penalizes ships having a cargo capacity differing from the optimum. In attempting to standardize the ship, one of the key problems is to provide size flexibility without impairing producibility.

Size variation is obtained by holding the midship cross section of the ship, as well as the forebody and afterbody, constant. Elements of midbody hull can then be added to or subtracted from the basic design to obtain a range of sizes. This approach allows the yard to treat the large, basic building blocks as items of serial production and to realize the accompanying economies of scale. To see how such a policy affects the economies of ship operation, we must adopt a measure of cost effectiveness and compare the custom and the standardized designs. A convenient measure is the required freight rate, the charge that the operator must levy against each unit of cargo to cover acquisition and operating costs, and provide an acceptable return on investment. Figure 6 shows how this quantity varies with ship size. The continuous curve describes a series of optimally-designed ships, each adapted exactly to a specific payload. The costs are calculated assuming a procurement of, say, two identical ships. The broken lines, in contrast, represent a series of ships obtained by lengthening or shortening a single parent hull.

The standardized ship displays uniformly higher costs of operation than the custom ship, except at the one point where it corresponds to the optimum ship, when it is built in the same quantity. But when built in the larger quantities made practical by standardization, the lower acquisition costs are reflected in lower freight rates, and the curve moves down to the lower position shown. The intersections define the region within which the modular design is more attractive than the custom ship.

The same type of presentation can be used to show the effect of imposing constraints on other design features. For example, the use of the same power plant over a range of ship sizes results in nonoptimum speeds for some of these sizes, but may demonstrate sufficient economies of production to justify the adoption of such a policy.

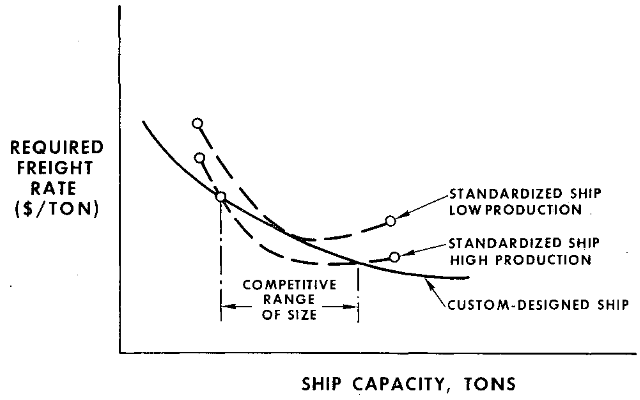

Fig. 6 Effect of ship standardization on required freight rate.

VI. Recent Developments and the Systems Approach

The most noteworthy change in the world fleet in recent years has been the very rapid increase in the size of bulk carriers, with supertankers currently operating that exceed 300,000 dwt. This is especially remarkable considering that in 1955 the largest tanker in the world was under 60,000 tons. Figure 7 provides an indication of the rapid rate of growth in the size of tankers. The trend towards very large tankers received its impetus in 1956 as a result of the closing of the Suez Canal. Companies moving oil from the Persian Gulf to Europe found that the added cost of shipping around the Cape of Good Hope could be neutralized by making a ship large enough to reduce unit costs. The attempt to achieve economies of scale found a breakeven point at about 75,000 dwt, at which point the unit cost of shipping oil from the Persian Gulf to Europe was equal to that achievable by the largest ship that could pass through the Suez Canal. Rather than stop at the breakeven point, tanker operators were encouraged by innovative Japanese shipbuilders to buy larger and larger ships, and this evolution has been a major factor in the very rapid growth in the Japanese shipbuilding industry.

The trend in dry bulk carriers is a scaled-down version of the tanker trend. The largest dry bulk carrier today is approximately 140,000 dwt, and it is expected that dry bulk carriers up to 200,000 dwt will be constructed within the next ten years.

With respect to general cargo ships, the trend towards increased size has been very gradual, and the emphasis has been on increased speeds and on cargo unitization. This latter, reflected in the boom of container shipping, represents the most dramatic change in the technology of ocean shipping. The impetus to containerization derives from recognition that general cargo ships spend more than 50% of their total voyage time in port during which time they serve as a warehouse rather than as a mode of transport. The full containership can be loaded and offloaded in 24 hr compared to approximately 5 days to load and discharge cargoes for a typical break-bulk cargo ship. This reduction in port time enables the operator to achieve greater utilization of his investment and thus enables a reduction in unit cost. The result is that the leading containership operator today is a nonsubsidized U.S. flag operation that is competing successfully subsidized operators and with foreign flag operators.

One might say that containerization represents a first step towards application of a systems approach to oceanborne shipping. The container operator takes a broader view of shipment and thinks in terms of cargo shipment from inland point to inland point, thus moving towards the development of an intermodal transportation system. This is a step forward from the break-bulk cargo ship operator, who is concerned only with the port-to-port movement of cargoes.

A further step in unitization is about to be introduced within the next year with the delivery of the first LASH ship. This design is capable of carrying up to 70 barges aboard the ship. The barges are loaded and offloaded by a shipboard crane, and the result is that the ship is able to offload a barge at a destination port without stopping to tie up at a busy dock. The LASH ship can offload a barge in 15 min, and the entire ship can be loaded and offloaded in 8 hr. The first such ship was recently launched at the Uraga Shipyard in Japan, and 11 more are currently on order at Avondale Shipyards for two U.S. flag operators. Three similar ships, designated Sea Barge Clippers, are also currently on order by a U.S. flag operator.

All of these changes represent the introduction of a systems view to the ocean transportation problem. A similar introduction of a system approach to bulk cargo movement can be seen in specific operations where ships have been designed as part of an over-all plan for movement of cargoes, in conjunction with the design of appropriate terminal facilities and inland movement facilities to support the ships. The latter are noted primarily in those special cases where an industrial corporation is concerned with the shipping problem and provides all of the planning necessary. Thus, Gulf Oil Corporation, when they placed their order for six 300,000 dwt tankers, simultaneously made arrangements for the construction of an offshore terminal at Bantry Bay to handle these mammoth tankers. The Bantry Bay terminal was required since no existing port in Europe can accept ships of that size. The terminal will be used as a storage and transshipment point,

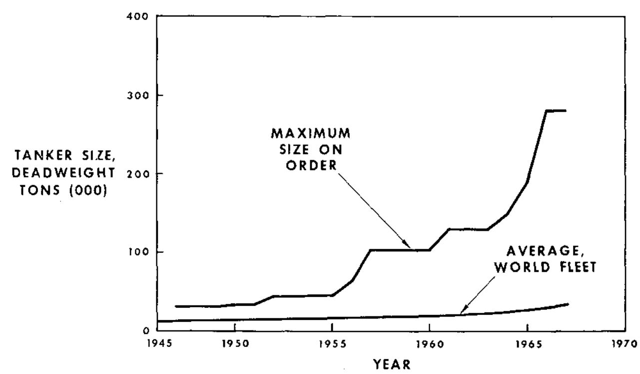

Fig. 7 Trends in tanker size.

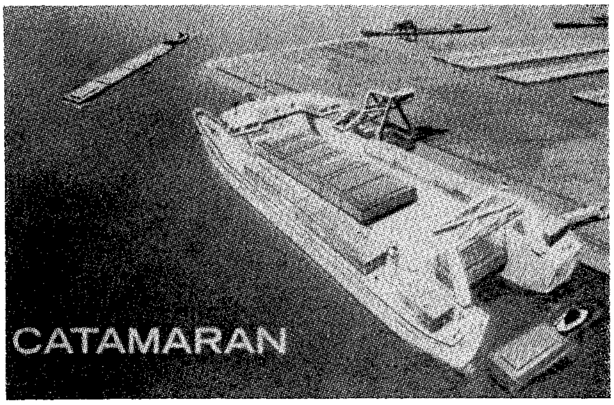

Fig. 8 Catamaran—artist's conception (source: Maritime Administration).

with the 300,000 dwt tankers delivering oil from the Persian Gulf to Bantry Bay, for transshipment via 100,000 dwt tankers to European refineries.

This kind of approach is possible for a large industrial organization with a known long-term cargo movement requirement that assures that the investment can be recovered by virtue of the expected savings in shipping costs over a reasonably short period of time. For the general cargo ship, however, where no single shipper has a special interest, progress will be slower unless some steps are taken to coordinate shippers, terminal operators, and inland cargo movers. A case in point is the prospect currently under discussion of utilizing a load bridge system across the United States to move cargoes from the Far East to Europe. The concept would call for moving containerships from Japan to the West Coast of the United States, loading these onto unit trains that would move on a regular schedule across the country, and then reloading the containers on ships bound for Europe. The potential savings of five days compared to movement through the Panama Canal represents an attractive possibility. There are many obstacles, however, primarily because of the inability of the ship operators, the terminal operators, and the railroads to effectively operate as a unit in approaching the problem. Under these circumstances, there is a possibility that a U.S. land bridge might lose out to a Canadian land bridge, where rail and shipping facilities are all within the control of the government. An alternative competitor might be a land bridge across the U.S.S.R. connecting the Far East

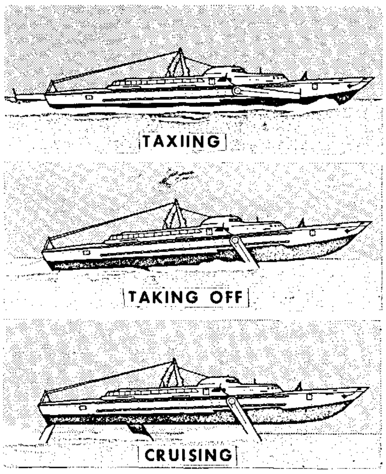

Fig. 9 Hydrofoil—artist's conception (source: Maritime Administration).

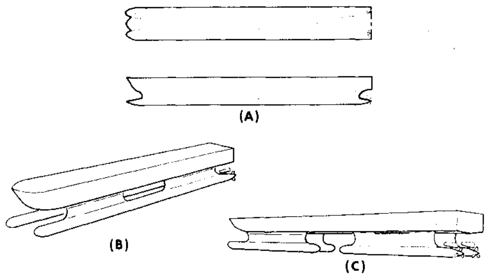

Fig. 10 Trisec arrangements.

with Europe. With such potential competition, it behooves the Federal Government to encourage such cooperation.

VII. Current Efforts on Technological Advances

In this day of rapid technological progress, the design of ship systems and shipping systems had changed very little compared to the rapid growth observable over the past 30 years in the air transportation field. Efforts at improving productivity of ocean shipping systems for the most part, have been limited to achieving economies of scale or improving efficiencies at the intermodal points, as described earlier. These approaches to improved productivity are available to foreign ship operators as well as U.S. operators, however, and the result is that the U.S. flag operator remains at a competitive disadvantage in the long run. In the field of container shipping, a U.S. flag operator was the innovator, and has been able to maintain the advantage up to now. It remains to be seen whether or not that advantage can be maintained without subsidy as the foreign flags build full container fleets.

Any hopes for making U.S. flag operations competitive with foreign operators must hinge on the application of a technological breakthrough. The major areas of technological investigation are aimed at reducing the two major elements of ship operating cost, fuel cost and crew cost. In order to remain competitive with other transportation modes, the general cargo ship operator must increase the speed of this ship. Higher speeds offer higher utilization by enabling more frequent turnaround, and also offer improved service to the shipper, thus improving the market position of the oceangoing vessel compared to other transportation modes. The natural barrier to high speeds, however, is the wave making or residual resistance encountered at the ocean-air interface. This barrier results in a very high penalty in shaft horsepower requirement (and the associated fuel costs) for a small increase in ship speed. Efforts at improving ship speeds have, therefore, concentrated on changes in hull form and on improved propulsion systems. Progress has been made in hull form through the introduction of bulbous bows, but the improvement does not represent a quantum jump comparable to the introduction of jet aircraft. In order to achieve a major improvement in ship speed without paying the very large fuel penalty, development has been aimed at new hull forms such as the catamaran, the hydrofoil, the trisec, and the surface effects vehicle (see Figs. 8–11). All of these hull forms are designed to eliminate or reduce the resistance encountered at the ocean air interface, so that higher speeds can be achieved.

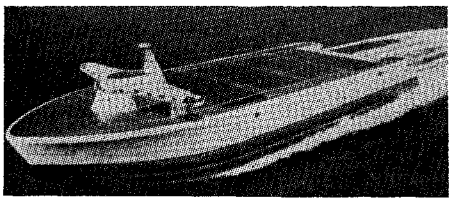

Fig. 11 Surface effect ship—artist's conception (source: Bell Aerosystems Co.).

Studies of these hull forms indicate that speeds of 40 knots or higher can be achieved, and in fact speeds of 100 knots or higher have been talked about for surface effects vehicles and hydrofoils. Shaft horsepower requirements to achieve these high speeds are considerably greater than currently installed in any existing ships, but they are a major improvement over what would be required to achieve higher speeds using standard hull forms.

In addition to improvements in hull forms, research and development has been aimed at improving propulsion systems so that increased horsepower requirements will not impose a major increase in fuel requirements. Nuclear power plants offer some possibility in the long-term future, since large increases in shaft horsepower can be achieved with very little penalty in terms of fuel weight. Based on the evidence gleaned from operation of the Nuclear Ship Savannah, the use of nuclear power for a commercial cargo ship in the near future is not competitive with conventional fossil fuel powered ships. It is possible, however, that the evolution of nuclear power plant design over the next 20 years could bring the cost of nuclear power down to the point where it would be practical to install nuclear power plants yielding very high horsepower in a novel hull form that could enable achievement of speeds of 100 knots or higher.

A third area of improvement is in the introduction of automation in the operation and maintenance of ships. Considerable progress has been made in recent years in automating ship designs, so that ships have been built with automatic engine rooms and automatic ship controls. It is technologically possible today to build ships that can be operated with crews half the size currently being applied. Within the foreseeable future, it would be possible technologically to design "slave" ships that could be crewless, and would be controlled remotely. Certainly a technology that can send ships to the moon without a crew can move them across an ocean. The cost of instrumentation for such ships would be extremely expensive, however, and it is not clear that such a ship will be economically feasible in the foreseeable future. Further, there are institutional constraints to reducing crew size that will have to be faced as part of the broader national problem of living with automation in the future.

VIII. Policy Implications of the Systems Approach

Integration of Transport Functions

The transportation industry exists today as a number of largely unrelated enterprises. The different forms of transport (rail, truck, barge, shipping, air, and pipeline) are separate and often competitive activities; and ordinarily, supporting functions such as stevedoring and freight consolidation are also separate. Attempts to consolidate these functions have, in general, been regarded as contrary to public policy.

Related governmental activities have likewise been fragmented. These activities include the Department of Transportation, the Federal Maritime Commission, the U.S. Army Corps of Engineers, the Interstate Commerce Commission, and others. Many other agencies whose activities affect the transportation industry operate on the Federal, state, and local level.

Analysis of the transportation system comprising all of these elements suggests that closer integration of many services and modes would produce a lower total cost than can be achieved under present circumstances. Integration may include like functions or unlike functions. As an example of the first, Atlantic Container Lines, a multinational consortium of six shipping companies, has been formed to provided a combined container service between U.S. East Coast ports and Europe. Examples of integration of unlike services are much more common in Europe than in the United States, and typically include working arrangements between rail and shipping organizations to provide through service. In the United States, piggyback services, combining the best features of rail and highway transportation functions, have demonstrated significant cost savings. Integration of services produces higher volume, smoother flow, and improved equipment utilization. Apart from the increased efficiency obtained, there may be other advantages as well. The combination of functions increases the predictability and homogeneity of markets, and contributes to a sound climate for investment in improved facilities and equipment; shippers deal with only one agent and may have a considerably lower volume of paperwork; a unified transport service is better able to guarantee timely delivery. As trade volumes increase and ports become more congested, such unified transportation systems will become essential.

Specialized Ports

Ship operating doctrine will change to conform with new conditions; the trend is toward a pattern of service between a very limited number of major ports. In the movement of crude oil and of many bulk cargoes, shipping and receiving points are becoming specialized to permit the use of larger ships. A similar development is taking place on the principal general cargo routes, where container facilities are being prepared. The present system involving several ports-of-call at each end of a transoceanic route will be phased out and will be replaced by direct turnaround service operating in conjunction with land feeder networks. Seaborne feeder systems will not be able to compete with rail and truck systems except in special circumstances. In consequence of these trends, many smaller ports will cease to exist or will be significantly reduced in volume.

At the same time, increases in size, speed, and cargo handling rate will increase the capacity of individual ships and of individual berths. Taking containerized general cargo as an example, the annual tonnage capacity of a typical break bulk cargo liner operating between the U.S. and Europe is about one quarter of the amount of modern container ship will be able to handle. Similarly, the capacity of a typical modern general cargo berth is between 70,000 and 100,000 tons/year, whereas container berths in operation today can handle up to 500,000 tons/year. When we realize that approximately 70% of general cargo traffic can and probably will be containerized by the end of the century, the impact upon port traffic becomes clear. The British Transport Docks Board has estimated that four ports having twenty modern container berths could handle all container cargo to and from England. Necessarily, of course, these facilities are extremely costly. The Elizabeth, New Jersey terminal being constructed by the Port of New York Authority will cost 150 million dollars when completed. The costs of large bulk terminals are also very high.

Apart from the problem of cost, some ports cannot be adapted to the expected needs. Frequently, space limitations do not allow the construction of large new facilities. In other cases, the land transport network associated with the port is inappropriate to very high volume operations. Finally there are a great many ports at which the channel cannot be appreciably deepened without incurring prohibitively high costs, or interfering with other functions. The presence of rock or subsurface improvements, such as tunnels, may prevent dredging beyond a limiting depth; in some harbors there is no adequate spoil-disposal area that can be used. Other factors, that have been cited as interfering with channel deepening projects include the presence of important fresh water sources in strata underlying the harbor basin, and the possible interference with wildlife resources.

The trend toward fewer, larger and more specialized ports must, therefore, result in reduced volume at these locations where improvements are not practical. The tendency toward selective port development will be strengthened by the reductions in land transport costs that will result from wider use of unit trains and containerization; lower costs of land transportation give inland shippers a wider selection among available ports, and make port volumes more sensitive to activities in adjacent areas.

The readjustment of traffic among seaports, and the financing of the needed improvements, will create policy problems of great importance and difficulty. Communities and port authorities, acting individually and without coordinated planning, cannot hope to produce an optimum system; the most likely outcome is a substantial overcapacity. An ill-advised investment in port facilities, unlike an error in ship acquisition, cannot be transferred to another route. When ports decline in importance as primary trading centers, alternative uses will have to be found for them.

It is likely that the trend toward fewer ports is inevitable, and is a necessary part of achieving a rational transportation system. If this is so, then an essential element of policy should be to develop a plan for accomplishing the transition in an orderly fashion, so that duplication of facilities and sudden economic losses are minimized. The existence of a uniform plan of construction and improvement would provide a baseline that could serve as a valuable guide to industrial plant location and to related rail and highway development.

In establishing a port development plan, consideration must be given to the national defense aspects of the problem. A system consisting of a very small number of large specialized facilities, although more efficient, is also more vulnerable than the dispersed system we now have. In addition the loss of even one of the specialized facilities could be extremely serious. Similar considerations apply under peacetime conditions, where natural disasters and labor disputes have similar effects.

Offshore Discharge of Oil or Bulk Commodities

To a certain extent the introduction of large tankers and bulk carriers into U.S. trade will depend on the results of policy decisions with respect to such port improvements. The oil companies or industrial organizations that would benefit from such improvement have the alternative, in the absence of channel and harbor deepening, to invest on their own in offshore facilities. These might include offshore terminals to be used for the transshipment of oil or bulk commodities in a manner similar to the Gulf Oil Corporation's Bantry Bay enterprise. Another alternative is to provide offshore discharging buoys linked by pipeline to refineries or shoreside storage facilities.

Although the potential savings from supertanker operation on specific trade routes might not be high enough to encourage oil companies to make their own investments, a port improvement program sponsored by the Corps of Engineers, which is essentially cost-free to the user, might provide the impetus for the introduction of supertankers. The policymaker, in evaluating the decision for extensive port improvements, must consider the potential payoff to the general public. Such decisions are based on cost-benefit analyses that evaluate the potential benefit in terms of reduction in transportation costs to be derived frm the port improvements, compared with the expected cost of a program.

IX. The Path to the Future

As has been indicated, the future hopes of U.S. flag oceanborne shipping hinge upon the application of the systems approach to ocean shipping, and the introduction of new technology that will provide an advantage for U.S. operators over foreign flag operators. Bringing U.S. flag shipping into a compretitive position is not something that will be accomplished overnight. It will be an evolutionary process that calls for dedication on the part of industry, the maritime community, and the Federal Government. The evolution of intermodal transportation requires cooperation on the part of ship operators, terminal operators, and inland cargo movers. It also requires the cooperation of the government to simplify documentation and to clarify the legal responsibilities and limits of participants in intermodal shipping operations.

The development of new technology is extremely expensive, and will not be accomplished if left to individual ship operators or shipbuilders. Just as the development of a supersonic transport calls for pump priming in the research and development phase on the part of the government, the development of advanced hull forms and advanced propulsion systems will require assistance from the Federal Government. These needs have been recognized, and the new administration has indicated that a maritime policy is being developed that recognizes the need for greater expenditures in research and development on maritime related problems, as well as the need for changes in government policy that will encourage investment and innovation on the part of the ship operators and others interested in the future growth of the U.S. maritime industry.

Appendix: Definitions

Liner (berth) service is a scheduled operation by a common carrier whose ships operate on a predetermined and fixed itinerary over a given route, at relatively regular intervals, and are advertised considerably before sailing in order to solicit cargo from the public.

Nonliner or irregular service is comprised of "tramp" and other types of service which do not conform to the criteria described for a common carrier in "liner" service. A tramp ship in traditional terms is one that operates on an irregular or unscheduled basis from one port of lading to one port of discharge, lifting one dry cargo commodity, usually of low value, without mark or count, and from one shipper to one consignee. The tramp operator does not usually hold himself out as a common carrier and his ship is free to travel anywhere on any terms, not infrequently being chartered out on "time" terms.

References

[1] "Oceanborne Shipping: Demand and Technology Forecast," Dept. of Transportation, Contract T8-233 (Neg.), June 1968, Litton Systems Inc.

[2] "Changing Patterns in U.S. Trade and Shipping Capacity," Rept., Dec. 1964, U.S. Department of Commerce, Maritime Administration.