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Foreword

The past decade has seen a rapid development of intermodal containers in handling and transporting the flow of freight. The concept of containerization involves the batching of smaller packages or pieces into larger reusable containers. These in turn may be transported over long distances by one or more modes of transport and not require unloading or reloading of the contents between the point of loading and the point of destination. The value of containerization is in the ease and efficiency of transfer at terminals and between modes of transportation, the protection of contents from loss or damage in loading or unloading at points en route, and increased speed of delivery. The tractor trailer and the railroad boxcar may be considered familiar older forms of containerization. The trailer or container on railroad flat cars and the sea-land containers developed by the maritime industry are more recent applications of containerization for intermodal transport of freight.

McCullough discusses point-to-point movement which he states is not only the most important aspect of containerization, but is the factor which has brought about a totally new concept of moving goods internationally. He points out that in the international movement of goods as a direct result of containerization, the movement is no longer a port-to-port operation. Major ports of call for containerships have in fact changed their role to that of way stations where loaded containers interchange between ocean and inland carriers. Also discussed are the regulatory and legal aspects of containerization.

Hammond discusses the emerging trends in container economics and the impact of these trends. He states that the key to success of container transport system lies in high utilization of capital resources and low-cost, rapid transfer between modes and terminals.

Grygiel discusses the "land-bridge" concept which is the movement of containerized freight across the United States as part of a through movement between the Orient and Europe. The author points out that the concept sometimes is used to denote a movement between the Pacific Coast and the Atlantic Coast or Gulf Coast in lieu of a movement through the Panama Canal with the origin or destination in Europe or the Orient. The author further discusses the impact of this concept on rail freight movement and the relative advantages of transport via the U.S. land-bridge.

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The Intermodal Aspects of Point-to-Point Containerization

JOHN T. McCULLOUGH, Chilton Company, Philadelphia

•THE week of October 7, 1957, was of great importance to the world of transportation. This was the week when space exploration was proved to be practical by the Russians' successful launching of the first Sputnik. The occasion was celebrated by news media throughout the world. Since then, billions of dollars have been spent by the United States and the Soviet Union to further develop the exploration of space.

Another event took place that same week although it attracted comparatively little attention. Yet this relatively unheralded event was destined to be of far greater importance to the transportation industry—at least in our lifetime. It was in this same week that Sea-Land's first cellular containership made its maiden voyage from New York to Miami. In the ensuing 12 years, billions of dollars have been spent by a vast number of carriers, ports, and governments throughout the world to develop the containerization concept (Fig. 1).

Today there is little question that the "container revolution" is well under way. During 1968, according to the Maritime Administration, more than two hundred thousand 20-ft equivalent containers moved in international trade in the North Atlantic trade routes alone. Despite the many problems, the statistics clearly show that both shippers and carriers have accepted containerization as a useful and effective tool to implement the transportation of freight.

The prime advantage of a van container is, of course, the fact that it can be employed interchangeably by all surface modes of transportation. The shipper can load a container at his shipping dock, close the doors, and have it moved by a combination of rail, truck, and ship to its destination without the contents being handled again until actual unloading by the consignee.

This point-to-point—or door-to-door or house-to-house—movement, as it is variously known, is not only the most important aspect of containerization, but is the factor that has brought about a totally new concept of moving goods internationally. Although there are a number of containers being filled with consolidated shipments by freight forwarders or ocean carriers themselves at port terminals, and a number of containers being similarly unloaded at ports of entry, the fact is that the majority of containers moving in the North Atlantic trade routes are being transported in complete door-to-door movements. Because of this, and because the door-to-door movement is the one that provides the maximum benefits of containerization to shippers and carriers alike, I have limited my discussion to this aspect.

What has happened to the international movement of goods as a direct result of containerization is that this movement is no longer a port-to-port operation. The major ports of call for containerships have in fact changed their role to that of way stations where loaded containers interchange swiftly between ocean and inland carriers. This change in roles has forced the world ports into a highly competitive race to attract containership operators by providing new, multimillion-dollar facilities for the transition of containers from one mode to another. Because of the efforts of the vessel owners to capitalize on the quick turnaround time afforded by containerships, they are sharply curtailing the number of ports of call. As a direct result, the shipper no longer

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Figure 1. Sea-Land container terminal at Port of Oakland, California.

automatically uses the nearest port to ship goods overseas. Great quantities of agricultural products from Florida, for example, are today being moved by rail and truck to New York's giant container terminal for transfer to fast containerships bound for Europe.

This revolution in international freight movement has provided new opportunities for shippers and carriers to expand their present markets and develop new ones. And, like all revolutions, it has also brought about a number of problems of varying degree. None of these problems is insoluble—some are already being solved. But they do exist—and they must be faced in any appraisal of containerization benefits.

REGULATORY ASPECTS

The intermodal characteristics of the container provide a curious anomaly. Although the great majority of containers are owned by ocean carriers, the regulations limiting their size and weight are enforced by the Interstate Commerce Commission (ICC) when the container moves inland. This factor explains in large part why the two pioneers in containerized movement in cellular containerships—Sea-Land and Matson—went in different directions. The 35-ft length of the Sea-Land container was established because, at the time Malcolm McLean conceived and implemented his plan to put a trucking operation to sea, this was the maximum trailer length permitted on Pennsylvania highways. Matson's 24-ft length was similarly selected because of California and Nevada's permitted use of double bottoms on state highways.

It is still a fact today that the size limitations of ocean-going van containers are governed not by the whim of the individual ocean carrier, but by individual state restrictions.

Of equal importance in the intermodal movement of containers is the "through rate" by which a shipper in the Midwest can load a container at his shipping dock for delivery to a European consignee, and ship the full container on a single waybill at a single rate for the entire point-to-point or door-to-door movement. Despite the obvious desirability of such a rate, the fact is that it does not yet exist and cannot exist under Federal law. No United States government regulatory agency has the authority to approve agreements between different modes of transport unless such modes are subject to the jurisdiction of that particular agency.

For this reason, neither the railroads nor the highway carriers can make any legal rate agreements with ocean carriers, because the latter are regulated by the Federal

Maritime Commission and the former are under the jurisdiction of the ICC. As we move into the era of giant jet aircraft, such as the Boeing 747 and the Lockheed L-500 with van container-carrying capability, the situation becomes even more complex involving the Civil Aeronautics Board and the International Air Transport Association.

The best that the shipper can achieve today is a combination rate with one rate from his loading dock to the port terminal, another rate for the ocean part of the haul, and a third rate for moving inland from the overseas port. This last rate is subject to considerable fluctuation because other countries do not have an equivalent of the ICC and its regulation of rates and practices. Thus the establishment of a rate involves striking a bargain with the for-hire carrier involved. For example, a variety of rates can be obtained for the same service on any given day. It depends on which carriers are contacted. Many of the approximately 14,000 Dutch trucking companies that handle 80 percent of Europe's over-the-road freight are small, family-type operations that may have shipments moving in one direction and are anxious to obtain return loads at almost any price offered.

However, there is a definite movement by carriers in the direction of providing a true through rate stimulated by the larger freight forwarders. F. N. Melius, president of U.S. Freight, said recently: "I don't know how or when other carriers—rail, truck and steamship operators—will work out arrangements for through, single-responsibility international container service. But as freight forwarders, whose basic mission is coordination, we cannot wait for them. Today, we can issue a through bill of lading in our own name, evidencing complete responsibility to the shipper from actual origin to ultimate destination. We have also established a through rate or charge which we quote to the shipper."

The waybill itself, of course, is just a small part of what has been aptly termed the "paperwork jungle" in international commerce. Arthur Bayliss, national director of the National Committee on International Trade Documentation (NCITD), has estimated that the mass of paperwork required for moving freight overseas is costing U.S. shippers and consignees almost $5 billion a year. It is hoped that the current efforts of NCITD, working with the Department of Transportation's Office of Facilitation, will be able to achieve a substantial and badly needed streamlining of the unwieldy and costly red tape. A major program of the latter group established a little over a year ago, is to permit shippers to move containerized cargo, from an inland point in the United States to inland points abroad, at a single joint rate, on one bill of lading, on uniform liability terms under single carrier responsibility.

Another point is that of container inspection and certification to insure conformity with established design and construction standards. The American Bureau of Shipping was established last year as the official United States container certification body. Several months ago, the Truck Trailer Manufacturers Association, in endorsing this program, asked that it be extended to cover European customs requirements for Transport Internationale Routiers (TIR) service. Such TIR certification is mandatory for U.S. container manufacturers selling to European customers.

LEGAL ASPECTS

Because containerized shipments in international commerce are generally carried by at least three different carriers, the question of liability is not easily determined in the event of damage to the shipment. Even under a through bill of lading, the question of who is responsible for loss or damage is of the utmost importance. An ocean carrier accepts liability for the carriage of goods "from time of loading" and, unless there is visible proof of external damage to the container immediately after unloading, it is unlikely that the ocean carrier can be deemed liable for any damage to the goods shipped. In response to the issuance of a through bill of lading by a shipper, a carrier will simply acknowledge receiving one numbered container in apparently good condition, and will expect to get a clean bill signed on delivery. Except for claims for obvious sea water damage, most losses will have to be paid for by either the shipper's or consignee's insurance company.

Although it was originally thought that sharp reductions in insurance rates would be among the benefits of containerization, in many cases these reductions have not been evident. In some cases, the rates have actually been increased. One of the reasons is that marine underwriters base rates on actuarial tables of previous experience. Sufficient data have not yet been accumulated on container experience to permit the lowered rates.

Underwriters are particularly concerned by the "optional stowage clause" of the ocean carriers' long-form bill of lading. Basically, this clause provides the carrier with the option of stowing the container belowdecks or abovedecks. Anyone who has seen containerships setting out across the ocean with row after row of van containers stacked three or four high abovedecks will understand some of the anxiety felt by the underwriters. This is because cargo underwriters take the position that containers stowed on deck are, per se, subject to greater risk than those stowed belowdecks. They also contend that most containers have physical capability no greater than ordinary highway trailers built to over-the-road specifications, and thus are not designed with the perils of the sea in mind.

The loss of 40 containers washed overboard by high seas in the North Atlantic in April 1967 gave considerable substance to the underwriters' fears. Following this heavy casualty, a number of marine insurance companies issued instructions to their assureds to advise carriers that belowdecks stowage of their cargo was specifically required. Most of the carriers have replied, in effect, that they cannot honor such requests and must retain the option of stowing either abovedecks or belowdecks.

In general, the ocean carriers feel that the underwriters give far too much weight to a single casualty of this sort, and that the overall benefits of containerization in the reduction of loss and damage will more than offset losses specifically related to abovedecks stowage.

Another point of contention among shippers, underwriters, and ocean carriers has been the Carriage of Goods by Sea Act of 1936. Known as the "Hague Rules," this act limits the amount for which a vessel or shipowner may be held liable for loss or damage to cargo to a maximum of $500 per package, or, in the case of goods not shipped in packages, to $500 per customary freight unit. With the advent of containerization, the question was, is the container itself the package or customary freight unit?

Many shipowners maintained that it was, while shippers regarded the $500 limitation for a full container as totally unrealistic. In May 1967, representatives of the maritime nations met in Brussels to discuss amendments to the Hague Rules. A number of proposals were made at this conference, including one proposed by the Norwegians to limit the liability to $3.70 per pound, the amount for which over-the-road carriers may be held liable in several European countries.

The Brussels Conference reconvened in February 1968 and adopted a new formula, that of $662 per package or $0.90 a pound, whichever is greater. At the same time, for purposes of assessing this liability, they defined a container as follows:

> Where a container, pallet or similar article of transport is used to consolidate goods, the number of packages or units enumerated in the Bill of Lading as packed in such article of transport shall be deemed the number of packages or units for the purpose of this paragraph, as far as these packages or units are concerned. Except as aforesaid, such article of transport shall be considered the package or unit.

The intent of this definition, according to Sir Kenneth Diplock, Chairman of the Committee drafting the Amendment, is to permit the carrier and the shipper to agree on whether a container should be considered a single package, or whether the contents of the container shall be considered as individual packages. Depending on what is agreed at the time of shipment, freight rates would be adjusted accordingly. The shipper would have the option of choosing.

TECHNOLOGICAL ASPECTS

Today's specially designed containerships are fitted with so-called "cellular" holds. These consist of a framework of vertical steel channels, spaced to accommodate the size container being utilized by the vessel. This framework extends down to the ship's bilges, permitting the stacking of up to six 8-ft high containers belowdecks in each cell. A containership generally has from 80 to 100 such cells. In addition, as previously mentioned, a typical containership will carry up to 300 containers stacked three high on deck.

The containers can be loaded and unloaded by various methods including heavy-lift cargo booms and ship-mounted gantry cranes. By far the most prevalent method is the shore-based gantry crane. Mounted on rails for maximum mobility, these 30- to 40-ton capacity cranes can load or unload a van container in less than two minutes. These cranes utilize a substantial framework called a "spreader" that fits on the top of the container. When in place, electrically operated locks engage the container's corner castings to lock the container firmly in place. Most spreaders currently have automatic load-leveling mechanisms, so that the container will always travel horizontally to the ground, even though one end may be heavier than the other. Once in place, the crane operator pushes a switch to disengage the corner locks.

The container transfer can be directly to a railcar, a flatbed trailer, or it can be placed on the ground. If the last method is used, special heavy-lift fork-lift trucks or straddle carriers move the containers to an upland area for temporary parking.

It cannot be said at present that there is any "best" method for use in loading and unloading containers at port terminals. Sea-Land, for example, built shipboard gantry cranes on several of its containerships six years ago, but then changed its method of operation to land-based gantries. Although the shipboard cranes permitted maximum flexibility in allowing speedy loading and unloading at even the most undeveloped port, they had several disadvantages. It was expensive to equip each ship with cranes, and when at sea the crane was not being used. When maintenance was required, it tied up the entire ship.

Such shipboard cranes are still very much in evidence, however, on a number of vessels of various ownership. They will probably always fill a need for use at ports of occasional call where the demand does not warrant huge investment in shore-based facilities.

By the same token, at the most modern container facilities to be found anywhere in the world (New York's Elizabeth, N. J., Marine Terminal) you will find Sea-Land unloading containerships directly onto flatbed trailers and, a few hundred yards away, Atlantic Container Line will be unloading onto the pier. Each of Sea-Land's containers is moved to the parking area on its own trailer, whereas Atlantic Container Line stacks its containers three-high utilizing a fleet of straddle carriers. Both operators obviously feel that their method is best for them.

On the drawing board in the United States, the United Kingdom, Germany, and Japan are giant container handling and storage systems involving high-stack storage. These systems, similar in design to the Dortech cart-stacks for airfreight now in operation at airports in the United States and Europe, would hold several thousand van containers stacked up to 15 high. All operations would be controlled by a single operator through transverse cranes on top of the stacks. Such a system would require only a fraction of the upland area now needed for container parking areas and would enable land-poor ports to compete for container operations.

Although the overhead gantry can be used for transfer between surface modes of transportation in somewhat less expensive form (as by a number of U.S. railroads), such equipment requires a heavy capital outlay. Thus, many railroads are making use of side-transfer systems, such as the Steadman system (Fig. 2). This transfer device is mounted on a truck chassis and consists of two bolsters with guide channels over hydraulic leveling jacks in the front and rear of the chassis frame. The jacks align the transfer device with the container, lifting it to the proper height with the levelers.

Figure 2. Steadman system side-shifter moves containers between railcar and trailer.

A hydraulic arm hooks under the container and draws it from the railcar onto the chassis. In the same manner, the container can be moved to a flatbed trailer or another railcar.

One problem complicating all intermodal utilization of containers is the size of the container itself. As mentioned earlier, the two pioneers in mass containerization went in different directions. Sea-Land chose a 35-ft length; and on the West Coast, Matson decided on a 24-ft length. At the same time, Grace Lines began making heavy use of containers in its South American trade, and chose a 17-ft length as being best adapted to highway use in those countries.

As containerization increased and other ocean carriers built containerships of their own, the question became: what size should the containers be? The MH5 Committee of the United States of America Standards Institute (USASI) arrived at the following standards: Group I Demountable Cargo Containers, 8 by 8 by 40 ft, 8 by 8 by 30 ft, 8 by 8 by 20 ft, and 8 by 8 by 10 ft; Group II Demountable Cargo Containers, 8 by 8 by 6.5 ft and 8 by 8 by 5 ft.

These recommendations, along with specific details for corner castings, were approved by USASI and, in turn, passed along as the United States recommendations to the International Standards Organization (ISO). As a result, ocean carriers such as United States Lines (Fig. 3), American Export Isbrandtsen, Moore-McCormack, Pacific Far East Lines, American President Lines, along with the European consortium, Atlantic Container Lines, and the six Japanese lines have standardized on the 20- and 40-ft lengths, 8 by 8 ft in cross-section.

Although Grace Lines has phased out their 17-ft boxes, both Sea-Land and Matson have held to their original sizes which, in addition to their length, are nonstandard in height (6 in. higher than the ISO standard). In fact, Sea-Land now has almost thirty thousand 35-ft containers in service.

Obviously, standardized containers would make all of the carriers in all of the various modes involved much happier, and their job much easier. However ideal such a situation would be, the fact is that it does not exist; and a 35-ft container is not interchangeable with a 20- or 40-ft box when it comes to fitting in containership cells. (It is interesting to note that in this area Matson is currently building four new container-

Figure 3. U.S. Lines high-speed containership carries both 20- and 40-ft containers.

ships with flexible cellular construction, in which the cells can be adapted in a few minutes for carrying any size container.)

Pragmatically, even though there really is no set standard, it seems that shippers can live with the sizes currently in use. A shipper today can ship his product from any point in the United States, for example, to any point in Europe or the United Kingdom by intermodal container. He can make use of a 20-ft, a 24-ft, a 35-ft, or a 40-ft box. It can be 8 ft high or 8 ft 6 in. high. Whichever the shipper selects, the ocean carrier will provide the container at the shipper's dock. Once loaded, a highway carrier or railroad or combination of the two will take the container to the designated port terminal—and the container, whatever the size may be, will be moved inland to the consignee by rail or truck in Europe or the United Kingdom.

Looking at the railroad freight train, one can find all sizes and shapes of boxcars, hoppers, gondolas, tankers, and other specialized equipment. The only limitation is in overall width and height to permit adequate clearances, and overall length to accommodate minimum rail radii. And when looking at motor carrier equipment, one finds much the same thing. The only standard, or more properly restriction, is in outside dimensions, and these, of course, vary from state to state.

I suggest that the van container should be standardized, for the present at 8 ft wide. It should be no more than 40 ft long, and no more than 9 ft high. The 9-ft height currently available in very limited quantity, when placed on bogies or flat-bed trailers, would come within the 13-ft 6-in. maximum height in most states for over-the-road trailers.

OPERATIONAL ASPECTS

Although the success of intermodal containerization depends in large measure on cooperation between the inland and ocean carriers, in many cases inland carriers have been reluctant to further containerization. A number of railroads and the majority of highway carriers have stated publicly that containerization was primarily of benefit to the steamship companies, and was little more than a nuisance to the inland carrier. Highway carriers, in particular, have felt that a marine container leaves much to be desired in over-the-road movement. The container's tare weight eats into payload, it has a lower cube than a semitrailer of comparable size, and, loaded for optimum payload capacity for a ship, it may be too heavy for legal highway limits. As one operating executive of a leading interstate highway carrier recently mentioned, the 20-ft container in large use today is a "monstrosity from every point of view!"

New equipment currently being made available for over-the-road use may make containers, even 20-ft containers, more acceptable to the trucker. This equipment includes a twin 20-couplable chassis and a universal chassis capable of handling any size from 20 to 40 ft in length. Provisions have been made for various axle locations on the universal chassis, including West Coast settings. A new dual-purpose crank-operated landing gear box permits the positioning of the supports to clear 3-axle tractors, and also provides an extreme forward position up to 61 in. from the front to prevent nose-diving when the unit is uncoupled.

Containers with bogies attached or on flatbed semitrailers are now handled as ordinary piggyback shipments by all Class I roads. In the case of containers alone, several railroads are already equipped to handle these at various ramp locations, through gantry cranes or side-shifters. The only complaint the railroads seem to have is economic, that of getting some kind of compensation for hauling empty containers inland.

Currently, the railroads are becoming enthusiastic about the "land-bridge" concept. Originally conceived as a method whereby containerized shipments between Europe and the Orient would move by rail across the North American continent, rather than through the Panama Canal, it has been adapted to movement from the East Coast to the Orient and from the West Coast to Europe. One proposal, set forth by the Santa Fe and Penn Central, calls for an 80-car unit train carrying 160 forty-foot or 320 twenty-foot containers on a coast-to-coast schedule of approximately five days in each direction. Charge for the service, for which shippers would furnish flat cars and containers, is proposed to be $144,000 per train for a round-trip between coasts, subject to a minimum of 25 trips per year. In the past six months, similar proposals have been made by other railroads, including the Canadian roads that have the advantage of a unified coast-to-coast operation.

Although such movement may well come about, there are a number of problems that may make the land-bridge economically unfeasible for the immediate future. For one thing, the current ocean rates between Europe and the West Coast are relatively little more than between Europe and the East Coast. The same is true with regard to Japan. With today's high-speed containerships, the time advantage offered by the railroads is only about five days. Thus, the shipper would have to justify a considerably increased transportation cost in terms of the time savings. Then, too, the time saving of five days is a maximum. If a containership arrived in port, for example, the day after the unit train had departed, the entire time saving is lost, whereas the cost increase still remains. To work at all, such a program would mean that ports of call on both coasts would be reduced to a maximum of two ports, or even one.

In almost all discussions of the intermodal nature of containerization, mention is made of containers that can be used in all modes, air as well as rail, highway and ocean vessel. No such container exists today—nor is it likely to exist tomorrow. The reason, of course, is that the criteria are totally different. Today's van container, whether made of steel, aluminum, fiberglass-reinforced plastic-plywood sandwich, or any combination thereof, has a tare weight ratio of roughly four pounds per cubic foot of capacity. This is far heavier than any aircraft can afford to carry. In fact, it is considerably heavier than the highway carrier wants or needs. The heavy weight is necessary because the individual container must be strong enough to resist having five fully-loaded containers stacked on top of it. In addition, the sides must be strong enough to withstand the pitch and roll of heavy seas when the containers are stacked abovedecks.

At present, there is only one container made that meets both USASI standards and aircraft weight requirements: an 8- by 8- by 10-ft container made of lightweight alumi-

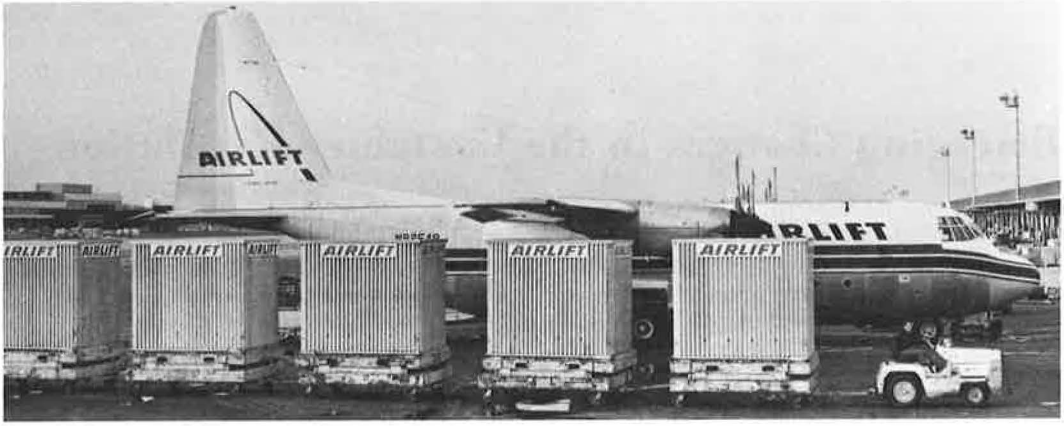

Figure 4. Lightweight aluminum 8- by 8- by 10-ft containers are carried in L-100 aircraft.

num for service in the L-100 Hercules (Fig. 4). But such a container is not strong enough for seagoing service. True intermodal service between air and surface modes could probably be best achieved with a lightweight air-container that could slide into a surface container. Such a compromise sleeve-type system would be suitable for tomorrow's giant cargo jets as well as all surface modes.

CONCLUSION

These, then, are the areas of problems and opportunities in today's container revolution: problems because they do exist and, in some ways, hinder the growth of containerization; opportunities, because they offer the chance to improve present methods and provide new ways to make containerization work even better. With the technological and economic skills present in this great industry of ours, I am confident that the challenge will be met.

Emerging Changes in the Container Revolution

ROBERT A. HAMMOND, McKinsey & Company, Inc., New York

•A NUMBER of emerging trends now affecting seaboard container economics will significantly influence the future of inland and land-bridge operations. First, container volume on routes in and out of the United States continues to grow rapidly. Seventy percent of all general cargo on the North Atlantic routes and 50 percent of general cargo on Pacific routes may be containerized by 1970. To build volume, steamship lines using East and West Coast ports are developing extensive and aggressive marketing programs, and some have already taken steps to move into forwarding, consolidation, and other inland activities.

Containership overcapacity is beginning to develop, especially on the North Atlantic routes. As many as 40 full containerships are planned for the North Atlantic routes by 1970, although 20 to 30 could handle the expected volume. This suggests that many containerships will be poorly utilized, forcing steamship lines to seek other routes. One source estimates that the ship capacity of lines serving West Coast routes will exceed all potentially containerizable cargo by 1970.

As a result of this developing overcapacity in containerships, many lines are now seeking to improve profit in a number of ways. First, so that they are free to move from one port location or one route to another, they are trying to avoid the long-term agreement with ports that characterize the early development of container facilities. Second, because running parallel services of break-bulk and containerships often proves uneconomic, many lines have decided to phase out their break-bulk and combination ships (which combine both break-bulk and containers) more quickly than originally planned and to concentrate on container volume alone. Some steamship lines are planning to move some of their containerships into new routes that currently have only break-bulk facilities.

Container facilities overcapacity already exists in some ports, and port costs are rising much higher than predicted. Poor utilization of facilities, high container consolidation costs, and escalating labor costs are all contributing factors. The clearest example is the recent labor negotiation setting the labor rates and policies for eastern seaboard ports. The high fixed cost of a container berth makes the average cost for each container significantly higher at low volumes. Thus, the cost of handling a container drops from \$100 to approximately \$30 as the weekly volume increases from 500 to 1,500 containers. Although the capacity of a typical container berth is at least 1,500 containers per week, many berths are currently used for only one ship per week. As a result, the cost to steamship lines is close to \$100 per container. A prime example of the rapidly developing capacity for handling container volume is New York, where 11 container berths are currently in use and at least 20 are in the planning stage or under construction.

Finally, methods of rate setting are beginning to change as competitive forces favor marginal costing and "freight-all-kinds" approaches. Although ship and rail costs for container operations clearly do not depend on the type of commodity, but vary directly with container volume, rates are still determined by commodity. However, railroads are now offering unit trains at substantially lower rates than were possible with normal service. In addition, European freight rates have already moved towards containers and away from commodity rate structures. To capture larger volumes, steamship

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lines may soon break away from their conferences, which establish rates, and begin to use rates based on freight-all-kinds.

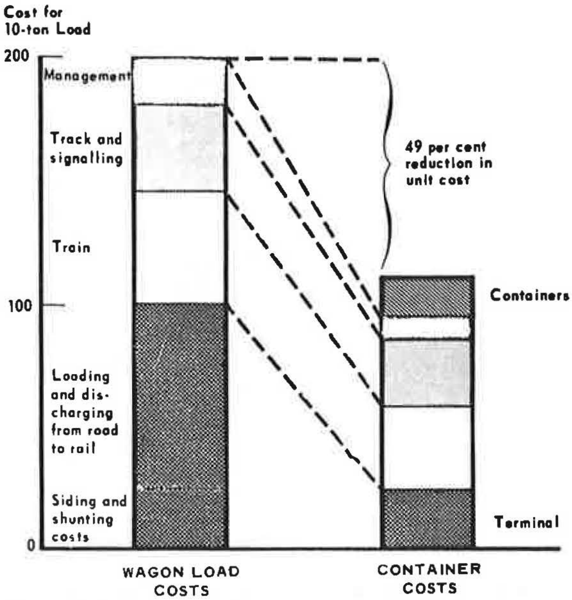
IMPACT OF CHANGING CONTAINER ECONOMICS ON INLAND TRAFFIC

In Europe, containerization is already beginning to have a significant impact on inland traffic. In the United Kingdom, for example, the "freightliner system" started only 3 years ago, now covers most large towns, and by 1970 is expected to handle over 1 million container movements per year. The road transport companies are climbing on the bandwagon by depending increasingly on rail for long-distance hauls and concentrating their business on collection, delivery, and consolidation of cargo. Recently, European railroads formed the Intercontainer Company with the objective of developing integrated container services throughout Europe linking the ports and all major centers of industry. They are now moving quickly to plan facilities, policies, and operating practices to meet this objective.

Growth of International Container Services in Europe

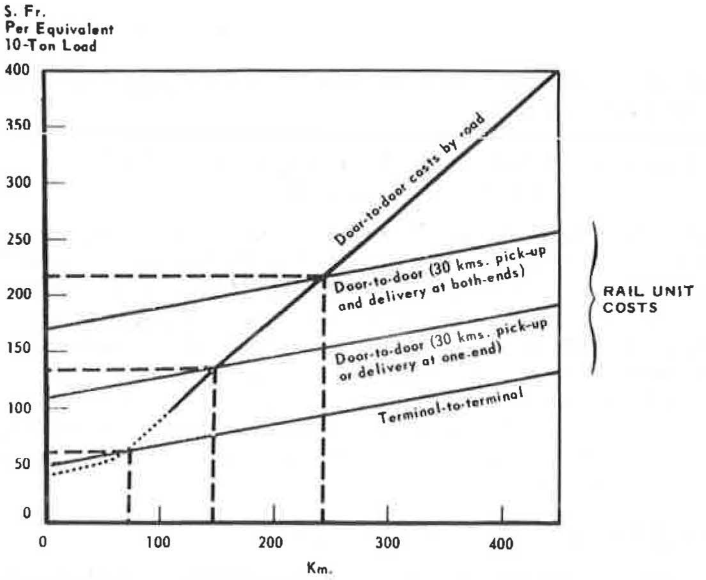
What are some of the reasons why international container services are growing extensively and rapidly in Europe? First, container service between rail terminals typically costs 40 percent less than regular service. This point is illustrated in Figure 1 which shows the typical cost of moving a 10-ton load on the railway either by regular service (described as a wagon-load cost), or by a container service using a special container train. The cost of management, truck, and train is slightly less with containers mainly because of more efficient use of equipment. However, greater cost savings are achieved in the terminal activity, with a reduction in costs of loading and discharging containers between road and rail.

A second reason why international container services are developing quickly is that on the longer hauls, the unit costs of rail movement are lower than the equivalent costs by road. Figure 2 shows the cost of shipping a 10-ton load over various distances for



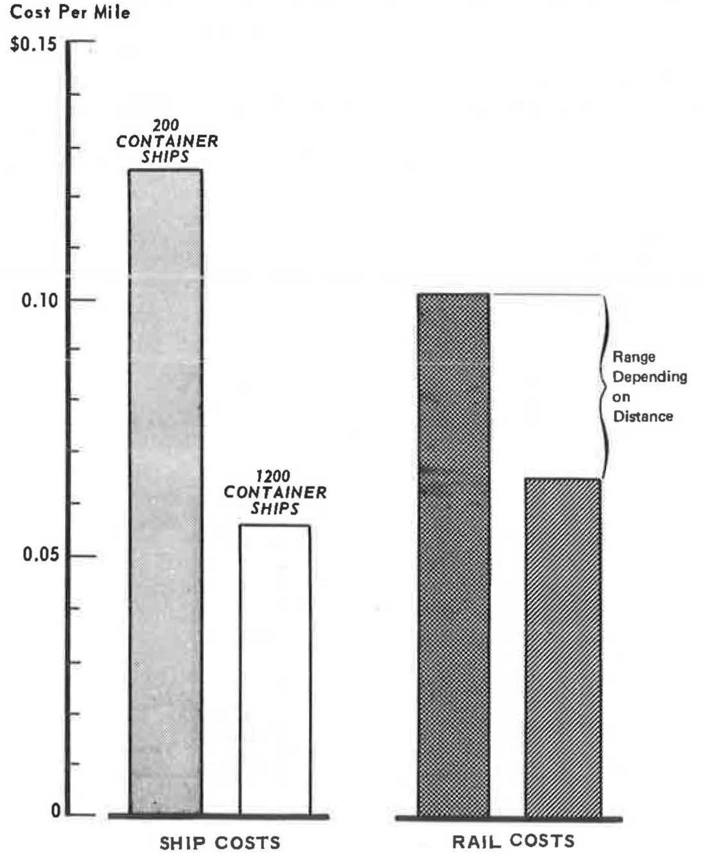
Source: McKinsey synthesized costs for a 320 km. haul

Figure 1. Container services between rail terminals can cost over 45 percent less than the equivalent wagon services.



Source: McKinsey synthesized costs

Figure 2. Unit costs by rail are substantially below equivalent costs by road on longer hauls.



Based on: (1) 85 percent load factor on both ship and train.
(2) One empty container in every four movements.
(3) Rail costs for a 45-container capacity train.

Source: McKinsey cost synthesis.

Figure 3. Rail has cost advantage over small containerships.

a door-to-door road movement or an alternative road and rail shipment. The costs of shipping terminal to terminal on the rail are substantially the same as the road shipment for distances less than 75 km; but above this distance, rail costs are lower.

A more practical comparison is between a movement involving a 30-km road pickup or delivery at one end and a door-to-door movement by road. In this case, the break-even between road and rail occurs at about 150 km, and above this distance, the combination of road and rail is cheaper. If the delivery is to include a 30-km road pickup and delivery at both ends, then the break-even occurs at 240 km.

Figure 2 compares costs for European transportation and is quoted in Swiss francs. Converting these costs to U.S. dollars per mile, road transport is 32 cents per mile and the variable costs of container rail transport are approximately 6.5 cents per mile. These costs are substantially the same as estimates for the United States, suggesting that a freight-liner service between major cities in the United States would have a substantially better competitive position than the railroad services currently available to a shipper.

A comparison of rail costs with costs of small containerships shows us the final reason why international container services are developing in Europe. Where land-bridge opportunities exist for moving cargo over rail, rather than via sea routes, freight-liner services give the rail a competitive advantage. Figure 3 compares the costs of moving containers via containerships with capacity of 200 twenty-foot containers with the costs of rail service. The rail service cost depends on distance and is 20 to 40 percent lower than the cost of a small containership.

Because of the difference in costs of the large and small containerships, however, land-bridge opportunities may not be as attractive in the United States as in Europe. In the U.S. case, a fair comparison would be with larger containerships with a capacity of 1,200 containers rather than the low-capacity ferry services in the European example. For the large ship, the cost of container movement is close to the cost over rail, and in the case of a 1,200-container-capacity ship, it is slightly lower than the rail cost.

Impact of Container Trends on U.S. Import-Export Traffic

To investigate the impact of container trends on U.S. import-export traffic, we will take the example of routes from the East and West Coasts to the Far East and Europe.

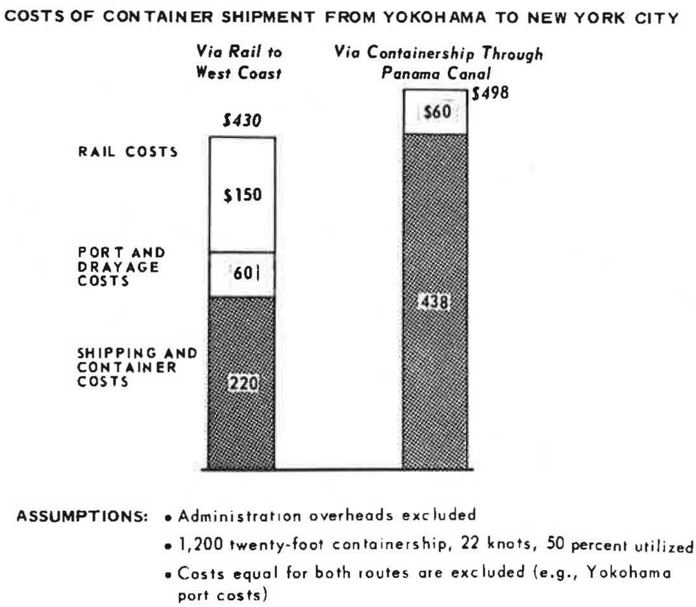


Figure 4. Cost economics favor container shipment to Far East via West Coast even from New York City.

This analysis leads to the conclusion that steamship lines on routes between the East Coast and Far East and West Coast and Europe will probably lose business to more direct overland routes. Currently the majority of cargo originating east of Chicago goes via an East Coast port. However, as the use of container trains increases, movements of container cargo from inland United States to the Far East are more likely to go via the West Coast. Taking the limited example of a shipment of cargo from New York City to Yokohama, the costs of shipment over land and by sea are almost identical. Figure 4 shows that cost economics (the basic costs of moving the cargo without regard to current rate structures, profit margins, or company overhead) favor container shipment to the Far East via West Coast ports even from New York City. The total cost of moving by rail to the West Coast is $430, whereas the cost by containership through the Panama Canal is nearly $500. These costs assume a highly utilized and dedicated unit train service across the United States; a more realistic level of utilization (which assumes a partial empty load in one direction), would probably increase the overland costs by $50 to $70, making the New York position about break-even for the two routes.

Nonetheless, this last example clearly shows that shipments originating from inland United States would almost certainly go by the more direct land route, if basic cost economics are the criterion for selecting the route, rather than current commodity rates. But railroads must meet the challenge quickly because steamship lines plan to have containerships on the route from the East Coast to the Far East by 1970.

Use of Land-Bridge Routes Between the Far East and Europe

A final example of the impact of the emerging trends in shipboard container economics is the possible use of land-bridge routes between the Far East and Europe. Figure 5 shows the transit times on competitive routes over land and via the Panama Canal. If containerships are installed on the Panama Canal route, there will be a small time difference between the sea and overland routes. At present, the sea route is handled by break-bulk ships, which are substantially slower than containerships, and typical time for movement of cargo from Yokohama to Hamburg would be 35 to 40 days. Therefore, the land-bridge route, using containerships on the Pacific and Atlantic routes and unit trains across the United States for a total transit time of about 23 days, has a substantial time advantage over the current sea route.

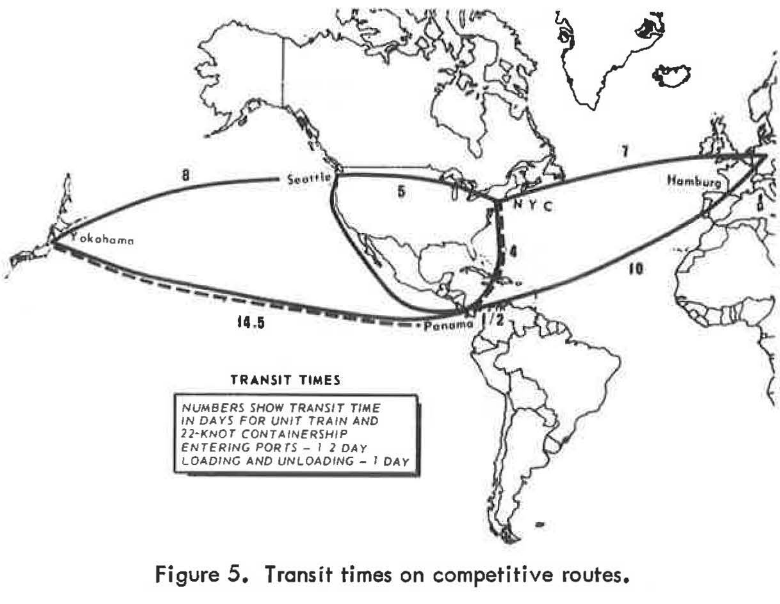


Figure 5. Transit times on competitive routes.

This example suggests that if the costs to the shipper are lower on the land-bridge or at least equivalent to the current sea route, the land-bridge may develop as a significant competitive alternative to the sea route. However, it is certain that steamship lines on the Panama route will eventually install faster containerships, and consequently, the time advantage will be almost completely removed.

Looking at the costs of the sea route versus the land-bridge route, we find that cargo movement on the land-bridge is more expensive than by sea, owing mainly to the handling costs through the ports. The costs are approximately $700 via the land-bridge and $550 via the sea route, with 50 percent utilization of ships; and the costs are roughly equal, with 35 percent utilization.

Because cost economics are against the land-bridge when containerships are installed on all of the sea routes, it would appear that land-bridge opportunities between Europe and the Far East will probably develop slowly. However, at present the land-bridge offers a time advantage for all cargo and a price advantage for some commodities. In the long run, steamship lines interested in maintaining Panama Canal routes will clearly be able to compete against land-bridge routes by cutting rates and using faster ships.

Land-bridge routes would develop faster if a steamship line (or consortium of two lines) with trade routes on both coasts tried to lead the field to capture more volume for its containerships and port facilities, or a port and/or railroad subsidized port operations to obtain land-bridge traffic. A final factor in this development is that railroads have already taken a number of steps to market their land-bridge routes and quote unit train rates across the country.

CONCLUSIONS

From this analysis of the emerging trends in container economics and the impact of these trends, a number of conclusions may be drawn. Potentially favorable economics of containerization, based mainly on major improvements in port productivity, are not always being realized. Overcapacity will soon plague many operations, and the advantage of U.S. land-bridge routes remains questionable. However, container volume on sea routes is growing rapidly, and containerization in Europe is already having a significant impact on the movement of inland traffic. Container rail services are rapidly developing in the United Kingdom and on the Continent, and clearly have the opportunity of becoming competitive with road for all but short hauls.

In the United States, import-export container traffic will go through rerouting changes toward shorter land routes during the next few years if railroads introduce container train services similar to those being installed in Europe. Railroads in the United States, therefore, have a significant opportunity to use containerization to competitive advantage in developing traffic and holding their share of market over road transportation. To do this, they will have to develop inland container train services not necessarily based on coast-to-coast, land-bridge operation, but rather on modern container train services with dedicated equipment and efficient, low-cost road/rail terminal operations.

It appears that the key to success of container transport systems lies in high utilization of capital resources and low-cost, rapid transfer between modes and at terminals. Where this is being obtained, development of container services is moving ahead quickly. But where the age-old inefficiencies and high costs of intermodal transfer are retained, development is stymied.

The Land-Bridge and Its Impact on United States Land Transportation

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•THE term "land-bridge" is generally associated with the movement of containerized freight across the United States as part of a through movement between the Orient and Europe. However, it is sometimes used to denote a movement between the Pacific Coast and the Atlantic Coast or Gulf Coast in lieu of a movement via water through the Panama Canal with the origin or destination in Europe or the Orient. This international trade that originates or terminates in this country is equally as important. The large volume of through traffic is ideally suited for rail movement and is of particular interest to the Santa Fe Railway System. While sporadic shipments of single 40-ft containers could move between the two coasts by highway, unit train volumes could move only on steel rails.

William G. White, chairman and president of Consolidated Freightways stated in the October 28, 1968, issue of RAILWAY AGE that most large motor carriers derive most of their revenue from LTL shipments and comparatively little revenue from import or export traffic, so that the railroads' action have little effect on trucking operations. Thus, the land-bridge opportunity can be treated as one with special relevance to rail carriers, but with little effect on highway carriers except for sporadic movements of several containers or for short-haul movements.

The interest of Santa Fe in land-bridge has been evolutionary rather than revolutionary. Interest in the technology predates interest in the concept. When one thinks about containerization, land-bridge, and related subjects, the time span shrinks. It is within the context of such a time span that as early as 1965 Santa Fe began to recognize the benefits of containerization through competition from Sea-Land for transcontinental traffic. Early in 1966, Santa Fe formed a group from its market research, cost analysis, and technical research groups with an objective to define "the role of a container system on the Santa Fe." Their full responsibility during the following year was to research and evaluate a container system for use by the Santa Fe Railway System.

During that period these groups delved into all aspects of containerization—tare weight, aerodynamic characteristics, center of gravity, transfer techniques, transportation costs, and capital costs. They measured the impact of physical differences on railroad costs, and translated this into the effect on shippers' distribution cost.

The computer was also pressed into service. Through the use of a program specifically written by company engineers, we were able to simulate actual operating conditions on the railroad. By feeding the computer the data developed during the study, it was determined that containerization had the potential to offer an efficient and low-cost method of moving intermodal traffic.

This laboratory experiment was followed by a practical application. Two test trains were run on the Illinois Division of the railroad to measure the operating characteristics of an all-container train versus an all-trailer train. Both were run at speeds graduated from 35 to 90 mph. The results of these tests supported previous conclusions. Santa Fe's premium freight service "Super C" train, which operates between Chicago and Los Angeles in 40 hours, was a spin-off from this effort. The results of the container study were presented to management early in 1967.

Paper sponsored by Committee on Freight Transportation Economics and presented at the 48th Annual Meeting.

About this same time (June 1967), McKinsey & Company, Inc., completed a study for the British Transport Docks Board on "Containerization: The Key to Low-Cost Transport." It had as its purpose a qualitative evaluation of the impact of containerization on the need for port facilities in the United Kingdom. This work is widely quoted and is generally familiar.

Also during June 1967 the Arab-Israeli conflict broke out. This closed the Suez Canal, disrupting the normal flow of ocean commerce between Europe and the Far East for the second time since 1956.

Each of these seemingly unrelated events was important in its own right. Collectively they provided the impetus to chart a new course, water-land-water between the Far East and Europe in lieu of the traditional all-water route. If there were individual benefits to be derived from containerization on land and on the seas, then joining the two seemed inevitable.

This concept has fostered great interest. Canada claims the short route via Vancouver and Halifax. There has been at least one movement by way of the Soviet Union, and Mexico has recently been mentioned as another possibility to avoid the long sea voyage through the Panama Canal.

It might be valuable at this point to state why the United States is the realistic choice. First of all, distance only favors Canada to a modest extent. The distance from Yokohama to Rotterdam using normal all-weather operating routes is converted to a common denominator-statute miles (Table 1). The water route via the Panama Canal is 14,403 statute miles. The Canadian land-bridge through the ports of Vancouver and Halifax is 11, 925 statute miles. The U. S. land-bridge, using the ports of San Francisco and New York as an example, is 12, 310 statute miles.

The all-water route is more than 2,000 miles longer than either water-rail-water route. The overall distance is 385 miles shorter via the Canadian land-bridge than via the U.S. land-bridge. This modest difference is easily overcome by more relevant factors. Among these are:

1. The normal flow of high-value traffic through California ports in relation to Canada or, for that matter, ports on the North Pacific Coast;
2. Port facilities now available or under preparation in the United States; and
3. Commitments by steamship operators for these facilities.

The first factor cannot be stressed too strongly. Our staff has devoted a considerable amount of time to defining traffic flows between the United States and all parts of the world with particular emphasis on the Far East and Europe. With this accomplished, this information was converted to potential containerizable traffic on the major trade routes. We are convinced that containerized traffic moving between the Far East and Europe will more logically flow through California ports on the one hand and east coast ports on the other, using traffic originating or terminating in the United States as a base.

It would be well to comment briefly on the routes through the Soviet Union and Mexico. One movement was made through the Soviet Union; the question is whether the Trans-Siberian Railroad will physically be able to handle a sustained movement because it is operating at capacity now. Schedule reliability during severe winters presents another very real problem.

There are a number of disadvantages to the Central American route. The most important one is a lack of container facilities at the ports and actual absence of a railroad linking ports on the west coast with ports on the east coast.

Table 2 contains traffic flow data between the Far East, Europe, and

TABLE 1

DISTANCES

	All-Water Route	Land-Bridge Route	
Yokohama to	Panama Canal	Vancouver—Halifax	San Francisco—New York
London	14,355	11,878	12,263
Rotterdam	14,403	11,925	12,310
Le Havre	14,183	11,706	12,091

TABLE 2

TRAFFIC FLOWS

Traffic Flow	Export		Import	
	Tons	Containerizable	Tons	Containerizable
Pacific Coast to Far East, 1966	3,340,544	1,589,000	1,843,966	1,633,833
New York to Europe, 1964	1,862,345	1,544,288	1,909,150	1,618,058

the United States. During 1966, 3,340,544 tons were exported through Pacific Coast ports to the Far East in liner service. After a detailed commodity-by-commodity appraisal of this trade route, we estimate that 1,589,000 tons of this is containerizable. In the reverse direction the absolute volume of traffic is considerably less, but it is estimated that 1,633,833 tons are containerizable.

Between New York and Europe a similar pattern develops. Based on an analysis of their 1964 traffic, the Port of New York Authority estimates a potential containerizable volume of 1,544,288 tons outbound, and 1,618,058 tons inbound.

One can visualize the Far East on one side of the room and Europe on the other, with the United States in the middle serving as a connecting link. Figure 1 demonstrates this. By superimposing the statistics just mentioned, we find a good balance of containerizable traffic. Between the Far East and West Coast of the United States, there are 1.6 million tons inbound and 1.5 million tons outbound. Between Europe and the East Cost there are 1.5 million tons outbound and 1.6 million tons inbound.

Commerce between the Far East and Europe can move on the same vessels transporting goods to and from the United States. The collateral benefits of insuring complete utilization of the container vessels plying the Trans-Pacific and North Atlantic trade routes cannot be overemphasized.

One can now consider the volume between the Far East and the European continent. Published data are expressed in dollar value, metric tons, and other units of measurement. Admittedly, this area is very difficult to quantify. The best estimates we have seen are given in Table 3. This is estimated containerizable traffic based on 1967 tonnage. It shows a total potential from the Orient slightly in excess of 1.1 million long tons (554,000 long tons or about half as much in the reverse direction). There is a decided imbalance not only in the total but in each area ranging between two and three tons eastbound to one westbound.

The inherent nature of a containership system dictates maximum utilization of equipment. For this reason capital commitments in ships and containers would be governed by the smaller flow of traffic.

Full containerships already ply the North Atlantic. Containership service was recently inaugurated between Japan and the West Coast. By the end of 1968, the Japanese had six full containerships in service. This is in addition to service by Matson and Sea-Land.

Figure 1. Balanced flow.

Only recently has any mention been made of containerships between Japan and Europe. Long-range plans of the Japanese contemplate three ships in this service, possibly by 1971. It is our contention the land-bridge concept is a more realistic way to serve this trade route. There are two reasons for saying this: the first is the large sum of capital needed to build containerships and assessorial equipment; the second is the ocean freight rate structure between the Far East and Europe.

TABLE 3

LAND-BRIDGE TONNAGE

1967 Traffic Tonnage	Mid Europe	Northern Europe	Southern Europe	United Kingdom	Total
From the Orient to—	625,000	80,000	111,000	284,000	1,100,000
To the Orient from—	351,000	33,000	33,000	137,000	554,000

For the distance involved, commerce from Japan to Europe is far less remunerative than to the West Coast of the United States. Yokohama to San Francisco is 4,536 nautical miles. Yokohama to London is 12,483 nautical miles. This difference in distance is not reflected in the ocean rates. As an example, let us look at three representative commodities and their rates from Japan to European ports versus ports on the West Coast of the United States as shown in Table 4. The rates are expressed in U.S. dollars per 2,000 pounds or 40 cubic feet. Rates to Europe take into consideration devaluation of the pound sterling.

It seems logical that container systems will be confined to the best revenue-producing trade routes. It is quite possible that containerships will not be feasible between the Far East and Europe. As an extreme example, let us say that ships will be built to handle a maximum amount of tonnage subject to the balance restriction mentioned before. This would still leave half a million tons moving from the Orient to Europe. The following lists details of the Santa Fe unit train proposal:

1. $144,000 per round trip.
2. Eighty-car train provided by shipper: railroad provides motive power and crews.
3. Minimum of 25 round trips per year.
4. One way trip, approximately five days.
5. No switching other than primary break-up and make-up.

This unit train proposal is based on an 80-car train capable of handling 320 twenty-foot containers. Using an average of ten tons a container or 3,200 tons a train, it would take 160 unit trains just to move this half million tons.

In the meantime, to permit movement of single car and multiple car lots of land-bridge traffic, a number of railroads have joined in providing the rates shown in Table 5. Some feel that there is not enough traffic to justify a land-bridge unit train. It seems that they have gone only as deep as a comparison of ocean rate factors. They add the rate from Japan to the West Coast to the rate from the East Coast to Europe as a basis for evaluating the merits of land-bridge.

There is another factor that has been overlooked. There is a tendency to look at the rate per ton and to ignore the density. Ocean rates are quoted on the basis of 1 ton or 40 cu ft, whichever produces the greater revenue. This means that any commodity with a density less than 50 lb/cu ft is rated by cube and not by weight. It is safe to say that fully 70 to 80 percent of containerizable traffic is measurement sensitive. Table 6 lists four commodities,

TABLE 4

OCEAN RATES PER 2,000 POUNDS FROM JAPAN

Items	European Ports	U.S. West Coast Ports
Electrical goods	$37.60	$38.25
Synthetic fibre	39.42	35.25
Canned fish or fruit	29.36	31.00

TABLE 5

SINGLE CAR AND MULTIPLE-CAR RATES ON LAND-BRIDGE TRAFFIC

No. of Cars	Charges Per Car (one way)
1 through 10	$1,320.00
11 through 20	1,220.00
21 through 30	1,120.00
31 or more	1,020.00

TABLE 6

OCEAN CHARGES BASED ON CUBE

Items	Ocean Rate		Stowage Factor	Shipper Cost	
	Japan to Europe	Cost Per Hundredweight		Cost Per Ton	Actual Revenue
Cotton piece goods	$41.10	$2.06	2.2:1	$ 90.42	$ 4.52
Toys	32.90	1.65	7.5:1	246.75	12.38
Tires	28.11	1.41	4.1:1	115.25	5.76
TV	50.08	2.51	2.9:1	145.23	7.26

the ocean rate from Japan to Europe, and the equivalent cost per hundredweight. The stowage factor is also shown. It should be understood that this will vary depending on packaging and other factors, but can be considered a reasonable average. The last two columns show how this affects the actual cost. The actual cost per ton or hundredweight is increased by the stowage factor. For cotton piece goods the actual revenue to the ocean carrier is $4.52 per hundred pounds, not $2.06; on toys it is $12.38, not $1.65, and so on. The water carriers collect on the basis of measurement, but pay the land-bridge carrier on the basis of weight.

One can visualize a containership sailing from Japan directly to a California port with a full complement of loaded containers. Some will contain normal Trans-Pacific traffic; the remainder will move transcontinentally by unit train to the East Coast where they will be reloaded onto a container vessel serving the North Atlantic-European trade. In the opposite direction the procedure will be reversed (Fig. 2).

Santa Fe is not alone in its interest in land-bridge. Many other U.S. rail lines are now actively seeking to develop this source of traffic through the single car and multiple car rates shown in Table 5. While we have tended to emphasize the unit train concept and we have the concurrence of several Eastern carriers in unit train movements, virtually all U.S. rail carriers would be willing to provide such a service when this volume of traffic is available.

Land-bridge offers many things to many people: to the railroads, a new source of business; to the shipper, the tangible benefits of containerization, plus a reliable and shorter transit time; to the steamship operators, a realistic method to service another trade route with an existing system but without the inherent consequences of additional

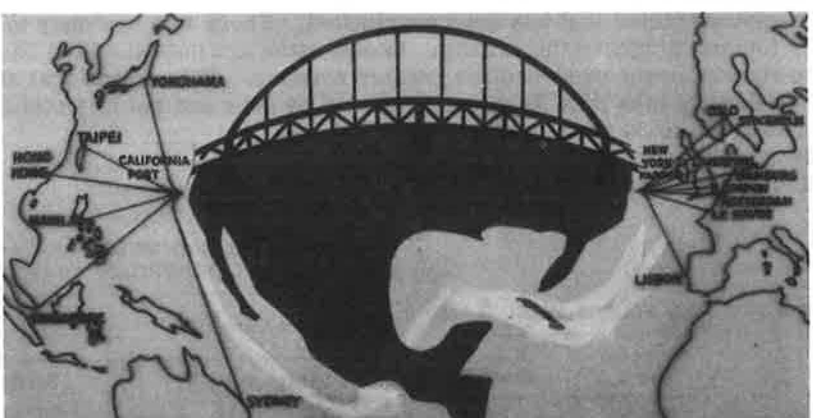

Figure 2. The land-bridge across the United States.

capital expenditures; to railroad and maritime labor in this country, more jobs and handling traffic now moving in foreign bottoms; and to U.S. government, a favorable balance of payments impact.

This analysis is perhaps more interesting to rail fans than to highway enthusiasts; however, there are many opportunities for highway participation, especially in the early stages of the land-bridge operation.