Trade-Offs Between Operations and Economics in Domestic Use of Containers

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Intermodal containers, as differentiated from piggyback trailers, have proved highly useful in international trade, primarily because they eliminate the reloading of cargo at each intermodal connection and the attendant delay, cost, damage, and opportunity for pilferage. However, physical constraints make containers less-economic transportation units per se than the individual modes that they replace—truck trailer, rail boxcar, break-bulk ship, etc. When standard intermodal containers are included in the U.S. domestic freight transportation system, their operating shortcomings outweigh any theoretical advantages that may accrue to either shippers or carriers. Such shortcomings include relatively high tare weights, limited cubic capacities, and requirements for sophisticated loading and transfer equipment. Proposals to develop and adopt a form of domestic container raise the same questions of standardization, interchangeability, and retrieval that plagued the international container industry in its early years. Further, the proposal raises the yet more-serious question of the rationality of allocating resources to develop a separate series of domestic containers that could not be interchanged with the existing fleet of more than 1.1 million international containers, with an estimated replacement value (including interface equipment) of $12.0 billion. This paper discusses the domestic operational restraints inherent in the use of international standardized containers and applies these to similar problems that might be anticipated for a variety of different domestic containers.

This discussion of operations will be limited throughout to containers as defined by the American National Standards Institute (ANSI) standard for closed van containers (ANSI MH 5.1.1M-1979):

> An article of transport equipment employed for the transportation of cargo in large unit loads which is strong enough for repeated use; designed for the carriage of goods by two or more modes of transport without intermediate reloading; equipped with features permitting its ready handling and transfer from one mode of transport to another.

In this context, containers do not include trailers or semitrailers used in trailer-on-flatcar (TOFC), or piggyback, intermodal truck-rail transport operations. In essence, containers are boxes without chassis or wheels for use in the highway mode that must be loaded and unloaded by using special handling equipment. In contrast, trailers may be transported on their wheels directly in the highway mode, and the same wheels may be used to load and unload the trailers from rail flatcars in the absence of special piggyback loading devices.

BACKGROUND

The origins of the so-called container revolution in intermodal transportation have been recounted many times. Suffice it to say that the concept of unit loading for intermodal international transport began to develop into a major submode less than 25 years ago. [Part of the following discussion of containers and container standards has been reported elsewhere (1).] Originally, several ocean carriers developed proprietary systems designed to avoid cargo handling at intermodal interfaces. Later, the advantages of standardization of sizes, fittings, load ratings, and strength testing led to what is today known as the International Standards Organization (ISO) standard container. However, some of the innovators are still operating with equipment that, although acceptable as defined by ANSI, is not in full compliance with ISO standards.

Experience over the past quarter of a century has shown that the maximum degree of equipment use and flexibility can be achieved with intermodal containers that are standardized at a number of points and thus may be handled and transported by the maximum number and type of transport and transfer modes. Thus, most of the 2 million or so intermodal containers in use throughout the world [which includes the 1.13 million that touch U.S. territory in the course of their movements (2)] conform totally or partly to the ISO standards for such units. In the Western world, only two firms use international intermodal containers (a total of approximately 85 000 units) that are not in basic conformity with the ISO standards (3).

DESCRIPTION OF CONTAINERS

Subject to refinements and improvements, standard containers represent a family of units that measure 605.8, 912.5, and 1214.2 cm (20, 30, and 40 ft) in overall length and 243.8 cm (8 ft) in overall width to meet U.S. highway limits. Heights vary from 243.8 to 259.1 cm (8.0-8.5 ft). In addition, containers that conform only to the U.S. standard may have lengths of 732.0 and 1066.8 cm (24 and 35 ft). Although van containers predominate, other body types are used. The methods used to lift and secure intermodal containers have also been standardized through upper and lower corner fittings and a system of locking devices. The ANSI standard likewise covers unit strengths, maximum loadings, and appropriate testing procedures.

Containers constructed to standard specifications may be mated, or carried, aboard ships equipped with container cells and guides, on rail cars fitted with appropriate devices to hold them in place [container-on-flatcar (COFC) type], in the highway mode on a standardized-frame trailer chassis with matching hold-down equipment, and in some instances on aircraft. Through standardization, units constructed in one nation may be transported by any of these modes in another country. Similarly, handling and transfer cranes and hoists can be used worldwide due to the standard sizes and fittings employed.

The present size and dispersion of the world's container fleet attests to the success of this method of freight handling. However, without the advantages of full interchangeability, much of this success would have been impossible, since each individual container system would be captive to its owner and operator. Since freight is virtually never balanced at any given point, the problems of retrieval of empty containers and their movement while empty would negate any efficiencies that might be achieved. Standardized containers permit maximum use of equipment through interchangeability among users. Today, almost all intermodal containers are owned by leasing and shipping companies (2) rather than by individual shippers.

LIMITATIONS TO CONTAINER USE

To place containerization in its proper perspective, it must be recognized that a large portion of total

freight movements do not lend themselves to this method of unitized handling. Goods that move relatively short distances--less than at least 800 km (500 miles)--are not viewed as benefitting from containerization. Such movements may be made by highway on an overnight door-to-door basis by using standard highway trailers. In addition, many commodities do not lend themselves to containerization due to the nature of the freight, the equipment required, or both. These include such items as most bulk commodities, pipes, structural members, petroleum, ready-mix cement, and metal bars and coils.

The limitations of intermodal containerization are reflected in the present mix of standardized containers, of which approximately 90 percent are closed dry vans and the bulk of the balance are refrigerated vans (3). Another characteristic of containerized freight is its relatively high average density as indicated by the popularity of international containers 912.5 cm (30 ft) long. Almost two-thirds of all such containers are now of this length, as opposed to other lengths of up to 1214.2 cm (40 ft).

Containerization has sharply reduced time, handling, pilferage, and damage for international freight movements and thus, ultimately, costs. Freight may be loaded in containers anywhere in the world for transshipment by any transport mode to any other point in the world without further handling. Standardized handling and secured fittings, as well as standardized sizes, permit such interchanges at will. However, it is becoming apparent that containers per se are less-efficient units for transporting freight than are any of the individual modes that they have supplanted.

The explanation for this phenomenon is quite simple. The container box must be of a standardized size and strength in order to be accommodated by all transport modes. The strength requirements alone (dictated by the need to withstand wracking at sea, stacking, and transport by rail) require that the containers be so constructed that they weigh considerably more than, for example, the highway trailers that they replace. A 1214.2-cm (40-ft) container plus highway chassis has a tare weight approximately 1 metric ton (2200 lb) higher than that of a similar highway trailer.

Similarly, height restrictions of containers, dictated by the necessities of intermodal use, limit the container that is 1214.2 cm long to a cubic capacity that is as much as 30 percent less than the capacity of many now-popular 1397.5-cm (45-ft) highway trailers. These restrictions mean that containers carry less weight and less cubic capacity of freight than do highway trailers. It should be noted here that highway load weights in different states are based on total weight of the vehicle plus its load, and thus increased tare weights reduce the capacity to carry revenue freight.

Comparable losses of cubic and load capacity exist with regard to all other freight modes--rail, water, and air. Thus, the container achieves its efficiency not as a box per se, but rather as a means by which cargo rehandling at intermodal interface points may be eliminated.

Over the years, many thousands of containers have been injected into the U.S. domestic freight transportation systems in the course of moving such units to and from international interface points. For the most part, such movements have occurred over the highways with the container mated to a standardized chassis pulled by a truck tractor. Some use of containers has been made on the rails, as COFC or TOFC (by using a highway chassis), in the course of similar preinternational or postinternational movements or as part of a land bridge.

Motor carriers who have received intermodal containers have noted the reduced efficiencies associated with their use in these instances. Further, when the containers are reloaded, either for export or for so-called "free domestic" repositioning movements, the problems are repeated. Specifically, in comparing use of containers on trailers with use of standard highway trailers, the complaints relate to reduced interior heights and widths, reduced interior length, and reduced load-carrying capacity (within state weight limits). Also, use of containers both over the road and in TOFC operation effectively captures a container chassis, an expensive unit better used in positioning containers. The preferred ratio of chassis to containers is no more than one chassis for each five containers in service, and a prolonged mating results in a one-to-one ratio.

Rail operations with COFC are further restrained by a lack of the specialized handling equipment required to load and unload containers without chassis, especially at traffic points other than major ones. For this reason, most individual rail movements of containers are accomplished as TOFC, or piggyback.

The current fleet of international intermodal containers that operate into the United States has an estimated replacement value of $9.5 billion, and the associated highway chassis are estimated to have a replacement cost of $0.7 billion (2,4). Container and combination container-piggyback rail cars in service and on order for delivery by early 1980 have an estimated replacement value of $0.9 billion [based on 18 000 cars on order at an average current price of $48 000 (according to R. Brodeur of Trailer Train Company)]. An estimate of the replacement value of in-place container loading and handling equipment in the United States at the present time is approximately $1.0 billion. In total, therefore, the present value of containers and container transporting and handling equipment and facilities in the United States is approximately $12.0 billion.

Proposals to develop and adopt a domestic container system raise the same problems and questions of standardization, interchangeability, and retrieval that once existed with regard to the international intermodal containers. The idea of a separate domestic container system also raises what may be still more onerous questions concerning the rationality (and the resource allocation advisability) of developing a separate series of domestic containers that could not use the $12.0 billion replacement-cost investment in existing international container equipment.

However, no system that is not fully standardized (which would make it both intramodally and intermodally interchangeable) would have much national application or use. In fact, several of the present experimental domestic container systems suffer from exactly this problem. They are captive to the firms that have developed them and usually cannot be interchanged with other carriers in the same mode or with noncaptive equipment of other modes.

Although some of these developments may contain within them the embryo of a future standardized domestic intermodal container system, their present diversity (if continued unchecked) can only lead to a proliferation of individual proprietary systems. What is more alarming is that the proprietary systems, being captive, have reduced utility overall due to inherent problems of retrieval and return loads. This introduces a built-in inefficiency. Still further, there is the basic economic question whether a separate new series of domestic containers is really justified.

In this regard, there is no consensus of what size or shape such containers should assume. It would be logical to assume that, since most freight originates, terminates, or both via highway, highway size and weight limits should dictate the basic criteria. However, even here, highway limits are still developing, and the question whether domestic containers should follow present highway limitations or those envisioned for the future is apropos. The problems center around such limits as gross weight, which is currently 36 288 kg (80 000 lb) total in most states, and overall width, currently 2.44 m (8 ft).

If we assume current limits, a standardized system would then be locked in for the foreseeable future, especially with regard to dimensions. On the other hand, the assumption now of some future limits would require a careful determination of such limits and of the problem of making all existing equipment obsolete. Other questions and conflict areas abound. For example, current popular highway trailer lengths are 919.2, 1214.2, and 1397.5 cm (28, 40, and 45 ft). Each of these lengths is utile for one or more major types of freight movements. The shortest is used in twin or double-trailer combinations, while the two longer sizes are used for single-trailer movements of high- and low-density freight, respectively.

Aside from the physical limits of a domestic container series, there remain the questions of fittings and strength to withstand stacking and wracking loads. The existing ISO fittings and locking devices have been well proved in use. Moreover, existing expensive container lifting and transfer equipment has been designed around the ISO fittings. Thus, acceptance of the ISO-type system into a domestic container series would eliminate the need for development of a new approach and also provide for the use of existing handling equipment.

International intermodal containers are constructed to a high strength standard in order to withstand the rigors of use, which includes stacks of six loaded containers in the hold of a ship. When not more than two containers will be stacked and they will not be placed aboard ship, strength standards (and tare weight) may be reduced substantially. This has been done in the case of the special series of existing air-truck containers, which have a maximum capability of stacks two containers high. However, these air-truck containers cannot withstand the forces generated by rail transport.

CONCLUSION

When international intermodal containers are used in domestic freight transport within this country, they have been found to have a number of operational disadvantages in terms of transferability, weight, and cubic capacity, especially when operated in the highway mode. At the same time, these containers are virtually fully interchangeable on an intermodal basis due to a high degree of standardization of sizes and fittings.

A number of proprietary series of domestic intermodal containers are now being developed, none of which is fully compatible with the standardized physical and handling parameters of the existing fleet of more than 1.1 million international intermodal containers that operate into and through the United States. The actual need for a domestic container system must be viewed in terms of a fully compatible, interchangeable system in order to justify the costs and resource allocations involved. To date, none of the domestic container proposals has met these criteria.

In terms of maximum equipment and investment use, it is suggested that if any national series of domestic containers is developed, such a series, in order to gain acceptance from both transporters and shippers of freight, should

1. Have physical dimensions compatible with existing highway and rail equipment standards,
2. Have load-carrying capacity at least equal to that of present highway trailers,
3. Be equipped with corner fittings and locking and securing devices fully compatible with existing ISO standards for such equipment,
4. Be capable of withstanding loading forces imposed by rail and highway movements,
5. Be capable of being stacked two high when fully loaded,
6. Be physically distinguishable from international intermodal containers (to avoid accidental shipboard loading), and
7. Not require duplication of the $12.0 billion U.S. replacement-cost investment in ISO containers and container support equipment.

To meet these conditions for a series of domestic containers, it would appear that the best overall approach may lie in a program focused on ways to reduce the tare weight of the existing series of ISO international intermodal containers. In this way, one single container series could be used in both domestic and international trade, which would result in a very substantial saving in investment made in containers, chassis, and handling equipment.

Finally, it is believed that sunk cost requirements alone may dictate the fate of domestic containerization. Unless a domestic container series can use all or most of the existing equipment, duplication could cost at least another $12.0 billion. Such duplication would represent an economic waste and a misallocation of resources and could easily negate any benefits that might arise from freight containerization.

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