

# Trade and Transportation: Containerization

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## **The Container**

The container, a standard size metal box designed to be moved with common handling equipment into which cargo is packed for shipment aboard in specifically configured oceangoing vessels, has evolved into the key physical and logistical support of international trade and globalization. Although available in several sizes, all containers adhere to a single standard, which accelerated containerization by permitting full access to the distribution system by reducing the risks of capital investment in modes and terminals. Another notable reason for the accelerated adoption of containerization was the speed at which it can be transferred intermodally, that is, transferring between ships, railcars, truck chassis, and barges using a minimum amount of labor. The container, therefore, serves as the load unit rather than the cargo it carries. Their relevance does not relate to what they are - simple boxes - but what they enable: the movement of goods fairly seamlessly across a variety of modes.

The reference container sizes are the "20 footer" and the "40 footer", which was agreed upon in the 1960s and became an ISO (International Standard Organization) standard. The 20 foot long box, commonly defined as a Twenty-foot Equivalent Unit (TEU), is 8'6" feet high and 8 feet wide. Initially, the "20 footer" was the most common container, and consequently TEU became the standard reference for measuring containerized flows. However, as containerization became widely adopted in the late 1980s and early 1990s, shippers began to switch to larger container sizes, notably the "40 footer". Larger sizes confer economies of scale in loading, handling and unloading, which are preferred for long distance shipping as well as by customers shipping large batches of consumption goods. The same ship capacity would take, in theory, twice as much time to load or unload if 20 footers were used instead of 40 footers. Thus, because of the desire to use the largest container size possible, the 20 footer is being gradually phased out. "Hi cube" containers have also been put in use, notably since they do not require different handling equipment or road clearance. They are one foot higher (9'6") than the standard 8'6" height, and a 40 footer hi-cube container provides about 12 percent more carrying capacity than its standard counterpart. Most North American double stack rail corridors can handle two stacked hi-cube containers, creating an additional multiplying effect in terms of total capacity per rail car. There are also 53-foot hi-cube containers, which are favored in the United States for domestic rail and trucking shipments. There are indications that maritime shipping companies are considering switching to larger container standards. For instance, in 2007 APL began offering 53-foot container service from China to

Los Angeles, which may become a norm since 53 feet is the maximum length for trailers on U.S. highways. Because containers have useful life of about 12 to 15 years, intermodal carriers cautiously transition to new standards because of prior commitments in capital investment in modal and intermodal infrastructures.

The container, as a standard load unit permitted a growing level of flexibility in the location of production with markets being serviced by global distribution strategies in which the container plays a key role. It is the main vector of international trade. More than a box, the container performs the basic function of being a load unit that can be transported by various modes; it is also a warehousing unit than can be considered as inventory in transit from a production or retailing standpoint. In some cases, the container has become the production planning unit with inputs and outputs considered as containerized batches, just as packets of data over the Internet. This resulted in the proliferation of time-based distribution strategies starting in the 1990s; shorter transit times are linked with lower inventory levels, which can result in significant cost reductions.

## **The Emergence of Containerization**

Despite Malcolm McClean being widely credited with the sailing of the first (converted) containership in 1956, containerization and intermodal transportation have much older origins. Containerization, in reality, was the logical outcome of attempting to transship freight more efficiently. In the late 19th and early 20th centuries, attempts were made to improve transshipments, particularly between road and rail. At the micro level, the pallet can be considered as the first successful intermodal unit; at the macro level, integrating rail and trucking initially took the form of simply loading trucks on rail cars. Although this trailer-on-flatcar (TOFC) approach, which began in the 1950s, provided a good source of income for rail companies since they were able to attract a new market segment, it still had significant limitations in terms of capacity (because of chassis wheels, far fewer transported per train), and thus turned out to be an intermediate phase of intermodalism; while over 95 percent of North American intermodal rail was TOFC in the late 1960s, TOFC traffic dropped below 15 percent by 2007.

It is the advent of the container that had the largest impacts on intermodal transportation. In its early years (1960s), containerization was seen as the simple application of temporary portable storage facilities, loaded with cargo, made mobile as a unit for intermodal unified transport. Core advantages were an ease of transfer and security from theft. Capacity was very limited and the ships used were simply inexpensive converted tankers (many World War II surpluses); such a radical shift in transportation was considered a very risky endeavor. Like many technological innovations, the container faced a period of introduction and experimentation. Although significant productivity improvements were realized along the transport segments it was initially applied to, major maritime shippers were unwilling to convert to containerization; each was waiting things out, particularly which standard would eventually prevail. Investing in an intermodal standard, which could turn obsolete, was seen as very risky. In the mid 1960s, the adoption of standard container sizes, particularly the now ubiquitous 20 and 40 footers, and of a uniform corner casting standard permitted the adoption of the container worldwide, not just simply over specific trade segments. Risk was no longer related to a standard, but

simply to the development and exploitation of market potential. Standardization, which simplified transfers among modes, marked the true beginning of containerization.

Long distance containerized trade quickly followed in 1966 with the introduction of transatlantic container services. Still, to make containerization fully effective with economies of scale, a specialized class of ships solely designed to carry containers was introduced in 1968. On the inland side, rail companies started to offer Container-on-Flatcar (COFC) services, but their extent was limited due to high intermodal costs. Inland freight distribution faced several hurdles as its modes, particularly rail, were heavily regulated and in many cases because of public ownership, as in Europe. The situation was much different for maritime transportation. Without the hindrance of regulations, many players jumped in as container services began to be offered across the Atlantic, and then the Pacific in the early 1970s. As a private industry with few regulations, maritime transportation quickly adapted to containerization since it saw clear performance and competitive advantages.

After the North American rail industry was deregulated in the 1980s, inland freight transportation systems quickly adapted to containerization. Companies were no longer prohibited from owning across different modes. Shipping lines, in particular, began to offer integrated rail and road services to their customers. The advantages of each mode could be exploited in a seamless system. Customers could purchase the service to ship their products door-to-door without having to concern themselves with modal barriers. With one bill of lading, clients were able to obtain a single rate, despite the transfer of goods from one mode to another. Additionally, doublestacking, Inter Box Connectors (which removed the requirement for bulkheads on doublestack rail cars) and the development of landbridges in the mid 1980s, proved to be a boost to long distance inland containerized distribution in North America.

## **Containerships**

The first generation of containerships was composed of modified bulk vessels or tankers that could transport up 1,000 TEUs. At the beginning of the 1960s, because the container was an unproven transport technology, reconverting existing ships proved out to be the least expensive and risky solution. These ships carried onboard cranes since most port terminals were not equipped to handle containers. The ability of ports to handle containership ceased to be a major concern with the setting of specialized container terminals around the world, which permitted cranes to be removed from the ship design, allowing for more container capacity.

Once the container began to be massively adopted at the beginning of the 1970s, the construction of the first cellular containerships (second generation) entirely dedicated for handling containers started. All containerships are composed of cells lodging containers in stacks of different height depending on the ship capacity. Economies of scale rapidly pushed for the construction of larger containerships in the 1980s. The larger the number of containers being carried the lower the costs per TEU. The process became a virtuous circle compounding larger volumes and lower costs. The size limit of the Panama Canal, which came to be known as the panama standard, was achieved in 1985. This third generation capacity of 4,000 TEUs lasted about a decade before a new generation of larger containerships arrived. It took a while to go beyond panamax because of the perceived risk in terms of the configuration of the

networks, additional handling infrastructure, and draft limitations at ports. In 1995 the fourth generation of containerships arrived, breaching the 4,000 TEU barrier with capacities reaching 6,600 TEUs in 1996 with the Regina Maersk. The size limits quickly went to the fifth generation (Post Panamax Plus) with capacities reaching 8,000 TEUs in 1997.

Economies of scale are not without risk. Each subsequent generation of containership faced a shrinking number of harbors able to handle them. Containerships above the third generation require deep water ports (at least 43 feet of draft) and highly efficient, but costly, transshipment infrastructures. Containership speeds have peaked to an average of 20 to 25 knots and it is unlikely that speeds will increase due to energy consumption, which accounts for about 40% of containership operational costs. The deployment of a specialized class of fast containerships has remained on the drawing boards because it is perceived that the speed advantages they would confer would not compensate for the much higher shipping costs. Supply chains have simply been synchronized with container shipping speeds. Although economies of scale would favor the construction of larger containerships, there are operational limitations to deploy ships bigger than 8,000 TEU. Containerships in the range of 5,500 to 6,500 TEU appear to be the most flexible in terms of number of port calls since using larger ships along trade routes would require fewer calls and thus be less convenient to service specific markets. Still, in 2006 sixth generation containerships came online when the maritime shipper Maersk introduced a new class having a capacity of about 14,500 TEUs. This generation will take the new specifications of the expanded Panama Canal, which is expected to open by 2014, so "New Panamax" can properly define it. It remains to be seen which routes and ports these ships would service. They are limited not only by port infrastructure, but also by the logistical challenge of inland transportation. For example, moving 14,500 TEUs could fill 70 or more 100-car double stack trains.

## **Containerization and Trade**

In addition to containerization becoming a dominant component of the physical infrastructures of global trade, the array of goods being carried in containers has also changed. By lowering the cost of shipping, containerization enabled global trade and permitted a higher level of reliability of global freight distribution systems. It permitted completely new practices, namely global supply chain management. A variety of goods, from toys to apparels, could be easily traded, which enabled many supply chains to be securely expanded to low labor and material cost locations with their integrity and reliability readily maintained. The impact on maritime shipping has been astounding; while containerships account for about 10 percent of the total tonnage, by 2005 they carried about 30 percent of all the ton-kms handled.

For manufacturing parts and finished retail goods, containerization can be considered as essentially complete, with the bulk of this trade being containerized, particularly in sectors related to retailing, intermediate and consumption goods. Containerization has largely achieved a phase of maturity where its market potential has been mostly captured. For instance, commercial trade between China and the United States is almost completely containerized. Future containerization growth is thus more likely to be linked with business cycles than with market diffusion.

Yet a new segment of containerized transportation, commodities, has experienced a spectacular growth in the last decade. While commodities have always been containerized to some extent, particularly with the usage of refrigerated containers in the food sector (reefers), there are many types of commodities where a substantial containerized niche market is being established. Grains, wood products (e.g. paper, pulp, paperboard, lumber), scrap materials (e.g. recycled paper and waste iron), produces and processed food products are particularly suitable for this transition, but require the setting of specialized supply chains. From a mode that virtually did not exist in the 1950s, global transport systems have adapted to containerization to substantially transform international trade.

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