

Intermodal Transportation

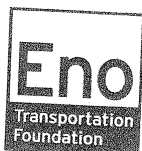
Moving Freight in a Global Economy

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Photo on page 66 (Illinois Central Railroad Freight Depot, Dubuque, Iowa) by Clayton B. Fraser, Fraserdesign, July 1987, for the Historic American Buildings Survey.

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Understanding the Supply Chain

Tom O'Brien

This chapter will provide an overview of the components of the supply chain and the dynamics influencing key actors in a globalized trade environment. Those dynamics include rising transport costs and the cost of regulatory compliance, as well as concerns about the safety and security of the supply chain. Safety and security concerns have become more pronounced as supply chains have become more complex, encompassing larger numbers of global participants and increasingly more dependent on technology. Technology helps to make the physical flow of goods across multiple modes of transport more efficient, and it is also essential to the information flows that link supplier, manufacturer, distributor, and customer. Those information links also increase the number of actors that can be impacted by changes to the supply chain.

Section 2.1 provides some context for this increasing complexity. It establishes the relationship between innovation and growth in trade, focusing on advancements such as containerization, which helped to reduce transport costs and make global trade possible.

Section 2.2 considers how these changes have redefined the supply chain over time. This includes a discussion of the evolving nature of logistics, which was once synonymous with transportation, but is now understood to include a range of activities from customer service through warehousing. These multiple players have contributed to our understanding of supply chains as systems. This section therefore looks at the channels and subchannels that compose these systems and introduces the actors involved at the various levels.

Section 2.3 focuses on the crosscutting issues that most affect the supply chain and its operations, including safety and security, rising transport costs, and the ability of global trading regimes to help supply chains respond to these

challenges. A common theme will be the conflict between the widespread benefits of globalized trade and the localized impacts.

Section 2.4 offers some concluding remarks about the key challenges facing supply chain managers in the future.

2.1 Changing Dynamics and the New Geography of the Supply Chain

The most dramatic innovation in world trade in the twentieth century was the onset of containerization in the latter half of the 1950s and the 1960s. (See Chapter 3.) Prior to then, most goods were transported in crates and then unloaded onto pallets. Not only was this a time-consuming and labor-intensive activity, but also one that left goods vulnerable to theft. In 1956, a company headed by Malcom McLean built platforms on the decks of several oil tankers so that they could carry 33-foot trailers between New York and Houston. The subsequent development of a standardized “steel box” to transport goods improved the speed with which containers could be loaded onto and unloaded from vessels and minimized the amount of labor needed to do the job, thus reducing the cost of transport.

Sealed containers allowed shipments to travel intact from origin to destination. By making pilferage much more difficult at intermediate points along the supply chain, particularly at ports, sealed containers led to lower insurance costs for the carriers and the owners of the cargo. This was another incentive for rapid adoption of the container as the principal means of transporting goods.

This use of the container as “hardware” revolutionized global trade, but in allowing for a box to be transferred from one form of transport to another, containerization also became the “software” allowing for true intermodalism—the coordinated flow of goods over long distances using different modes. (1) Furthermore, it created new markets for companies that help to package and negotiate intermodal transport services.

Containerization has had other dramatic impacts on the way goods are shipped around the world. It has facilitated the use of increasingly larger ships, designed to take advantage of economies of scale by carrying the greatest number of containers possible. These ships have given a comparative advantage to the ports that can accommodate them. *Post-Panamax vessels* are vessels too large to pass through the Panama Canal, and they therefore depend upon a vast network of roads, railways, warehouses, distribution centers, and transfer facilities to move goods across entire continents. Megaships encourage the growth of megaports, which not only receive goods for local markets, but serve as global gateways and transshipment centers for goods destined for markets all over the world.

New technologies, particularly information tools, have also revolutionized global trade. The Internet, electronic data interchange (EDI), and warehouse management systems, for example, facilitate better tracking systems and make the supply chain more transparent. Technologies also make it possible to reduce inventories through the use of just-in-time (JIT) delivery methods, expert forecasting, and automation.

Transport and information technologies have made the supply chain more efficient over time. As transportation becomes more efficient, its cost, relative to the total cost of a finished good, is reduced. This was true in the past, as in the case of the development of the Erie Canal in the nineteenth century, and it is true today. (2) Lower transport costs allow major transporters and retailers to take advantage of more affordable labor in overseas production centers. This increases the distances over which trade occurs, and it has also shifted the balance of power in global trade toward Asia.

The ascendancy of Asia in general, and China in particular, as the center of global trade is due to a combination of factors, including lower labor costs, increased investment in trade infrastructure, and, in the case of China, membership in the World Trade Organization (WTO). China already processes more containers than any other country in the world, and it will likely be the leading shipbuilder by 2015. In 2007, China overtook the United States to become the world's second largest exporter of goods, after Germany.

China's prominence is not only tied to its production capacity. The nation—along with the entire region—is emerging as a leading consumer of goods produced both internally and externally. China is already the world's top importer of steel and the second-largest importer of oil. In 2007, Chinese imports, including items such as automobiles, surpassed exports for the first time.

The changing geography of globalized trade has also provided opportunities for the West. North American and European companies have reduced the costs of production by outsourcing production to Asia, and the rapid growth of imports in recent years through ports like Los Angeles/Long Beach, Seattle/Tacoma, and Vancouver is due in no small part to their relative proximity to Asian manufacturing centers.

With globalized trade expanding over greater distances and relying on new technologies, there are also new opportunities for the development of expert skills that add value to the supply chain. Third-party logistics coordinators handle a host of activities, including storage and returns, which allows other actors to focus on their core competencies. There are also opportunities for those who coordinate and process the increased flow of information made possible by new technology. These include such trade-related services as finance, insurance, research and development, and international maritime law. These services have become globalized, and their growth has paralleled the growth in manufactured goods in recent years. (Figure 2-1) Trade-related services are also increasing as a percentage of gross domestic product (GDP) in places like

In 1960 McLean arranged to have the Pan-Atlantic Steamship Corporation formally renamed Sea-Land Service, and for the next four decades Sea-Land would become a very dynamic and important force in the United States merchant marine. A total of 113 different seagoing containerships would operate under the Sea-Land (or Pan-Atlantic) house flag during this 40-year period. (9) Expansion was steady, and during the company's early years McLean took advantage of an almost limitless supply of surplus cargo ships from the war era to add new containerships to his fleet. Naval architects had perfected ways of splicing new hull sections into older vessels. The profile of a typical containership soon evolved into one with its superstructure and wheelhouse at the stern, with an uninterrupted series of holds forward to the bow where the vessel's containers were carried.

Many early containerships included on-board cranes so they could load and unload containers without any need to rely on shoreside equipment, but as the concept of transporting highway containers by ship grew in popularity, ports were soon equipped with massive gantry cranes that could unload and reload a container ship in a matter of hours. (Figure 3-1) Reducing the time a seagoing vessel spent in port, not to mention the number of dockworkers needed to service a vessel, was as critical an improvement in productivity as was the elimination of the breakage and theft that was part and parcel of break-bulk cargo operations. Also of importance was the shift in containership operations away from the confined and congested dock locations along the waterfronts of older port cities to more spacious outlying areas, where inbound and outbound containers could be conveniently stored in large open lots and where there was easy access to both highway networks and rail systems. McLean's vessels, for example, were loaded and unloaded at Port Newark, located adjacent to the New Jersey Turnpike, rather than along the crowded Hudson River waterfront on the west side of Manhattan.

On April 26, 1966, Sea-Land officials held a quiet celebration at the company's New Jersey headquarters to mark the tenth anniversary of the inaugural voyage of *Ideal X*. But on that same day, something even more remarkable was taking place. One of *Gateway City's* sister ships, a converted C-2 cargo vessel that bore the name *Fairland*, was off Cape Race, Newfoundland, steaming eastward across the Atlantic, bound for Rotterdam. What had begun a decade earlier as a modest effort to reinvigorate domestic

► **Figure 3-1** The COSCO containership *Feihe* is docked in the port of Boston, adjacent to shoreside gantry cranes that load and unload the vessel's containers.



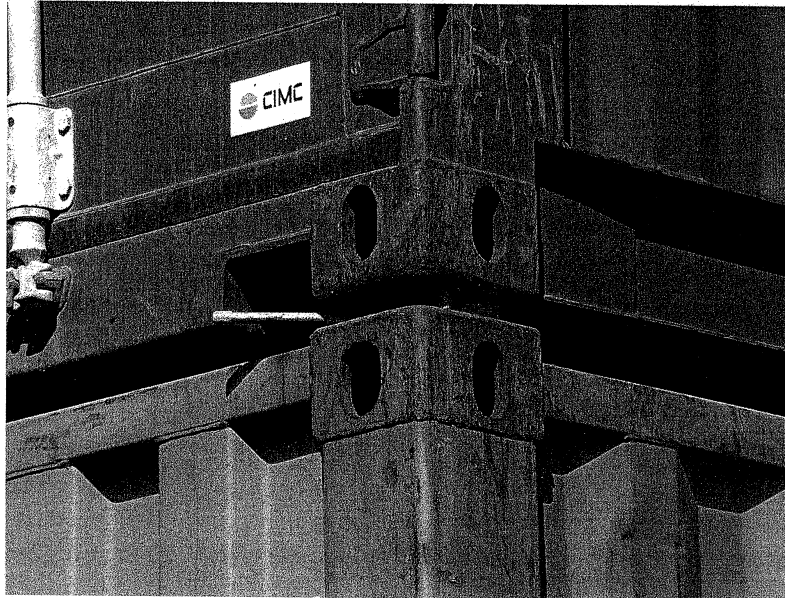
steamship service between American ports in cooperation with the intercity trucking industry had expanded into one of the premier intercontinental trade routes of all time—transatlantic service between North America and the channel ports of Europe. Containership service, inaugurated in 1956-1957 by Malcom McLean's Pan-Atlantic Steamship Corporation, stood poised to fundamentally alter the way freight was moved at sea, as well as on land, and to do so on an international stage. Other steamship companies, both in the United States and abroad, began to convert their break-bulk cargo fleets into cellular containerships. Underscoring the importance they felt that containerization would soon play, some companies, including Sea-Land in the early 1970s, began designing and building such containerships from the keel up, rather than converting war-era hulls.

3.3.1 The Hardware of Intermodalism

A word is in order on the importance of the container itself. Thus far, we have spoken rather uncritically of McLean's loading trailers aboard oceangoing ships, but this is more figure of speech than an accurate description. A typical trailer is structurally little more than a firm flat bed with a lightweight weather covering serving as both roof and sides. To enable such a vehicle to be removed from its running gear did not pose insurmountable technical problems, but redesigning trailers so that, removed from their running gear, they could be stacked one atop another involved fundamental structural change. Furthermore, to allow shoreside cranes to latch on to such a container and hoist it aboard ship quickly and safely, as well as ensure that the containers would remain in position when placed either on a ship's deck or on a truck chassis, a simple, but important, corner casting system was developed. A casting—roughly a 6-inch cube with oval-shaped openings on its three outside faces—was welded onto the steel frame of a container at each of its eight corners, four at the top and four at the bottom. Containers resting on one another thus make contact only by means of their corner castings.

A separate toggle-like device was also developed to secure one container's corner castings to those of another; although this is not necessary when containers are stacked atop each other in cells below deck, it is absolutely vital when containers are placed atop each other on deck. (Figure 3-2) In his authoritative account of the container revolution, Marc Levinson concluded that the true symbol of the new order in freight transport was not the seagoing containership or the new intermodal business models, nor was it the custom-designed railroad cars that permitted the carriage of containers stacked one atop another; rather, it was the simple box. (10, 11)

Equally critical to the emergence of a new style of cargo transport was the development of international standards for container design. While Sea-Land, Grace, and Matson initially developed customized containers, the companies



► **Figure 3-2** Two containers rest one atop another. They are joined to one another through the use of eight corner castings. The corner castings keep the containers securely stacked, and they provide a means for shoreside gantry cranes to latch on to a container.

quickly recognized that uniformity was far more important than individuality. Under the aegis of the International Organization for Standardization (ISO), a Geneva-based nongovernmental organization whose membership currently includes 157 countries, it was quickly decided that the basic container would be 8 feet wide and 8 feet high, and be available in lengths of either 20 feet or 40 feet; common corner castings would facilitate lifting, and strength standards would ensure containers could be stacked one atop another. Weight and loading limits for containers were also developed. Once the ISO standards were adopted, cargo loading pallets, forklift trucks, and other support equipment were built to dimensions compatible with the container dimensions. In later years, ISO specifications would be expanded to allow the use of longer 45-foot containers, some of which would be 9.5 feet in height.²

Using these ISO standards, the basic unit of comparison in intermodal cargo transport is the 20-foot equivalent unit (TEU). A contemporary containership will typically carry mostly 40-foot containers, but its capacity will be expressed as the number of 20-foot containers it is capable of transporting. (Figure 3-3) A containership thus might be said to have a capacity of 6,200 TEUs, meaning it can carry that many 20-foot containers, half that many 40-footers, or various combinations. (12)

As containerization evolved toward century's end, ISO standards sanctioned additional variations in size, including containers up to 53 feet long, which is

² Malcom McLean held a patent on a certain style of corner casting design. He freely gave up his design rights to facilitate standardization. (12)



► **Figure 3-3** This seemingly small truck trailer represents the basic unit of containerization. It is a 20-foot container owned by the Mediterranean Shipping Company, the second largest containership operator. The carrying capacity of containerships is typically expressed in units known as TEUs (20-foot equivalent units). A ship that can accommodate 9,000 TEUs can thus handle this container ... plus 8,999 just like it.

the maximum length of trailers permitted on public highways throughout the United States and which can be accommodated aboard container-carrying railroad cars. The below-deck cells of most seagoing containerships will not accommodate 53-foot boxes, but they have proven popular with companies that specialize in moving containers aboard barges. For example, containers on barges play a major role in cargo service between mainland ports, like Jacksonville and Miami in Florida, and the island Commonwealth of Puerto Rico.

Steamship companies typically own deepwater vessels, containers, and container-carrying rail cars, as well as open-frame trailers on which containers travel over highways and roads. The motorized tractors that haul containers and trailers between seaports and factories or distribution centers are, however, universally owned by separate firms, which contract with steamship companies for over-the-road services.

3.4 The Rail-Sea Interface

As noted earlier, railroads in the United States had begun to capture a measure of new business by hauling truck trailers on flatcars in the years after the Second World War. Unlike McLean's intermodal containers that were lifted off their running gear before being hoisted aboard ship, these were largely conventional trailers that were rolled onto specially designed flatcars and transported wheels and all.

But a new challenge was about to emerge. As the manufacture of more and more products began to migrate to Asian countries, the volume of containers arriving at West Coast ports increased. Trucks might be preferable for moving such containers to relatively close inland cities, but for longer transcontinental hauls, a new partnership with the railroads was necessary.

Malcom McLean inaugurated transpacific containership service in 1966 after convincing the US Department of Defense that moving military supplies into Cam Ranh Bay, South Vietnam, aboard break-bulk freighters resulted not only in the usual levels of delay, inefficiency, and breakage associated with such service, but also in substantial quantities of inbound cargo being diverted, through dockside pilferage, into the hands of the Viet Cong. The logistical supply chain that the United States was operating across the Pacific was, in effect, providing material to both sides of the conflict.

After making his case and securing contracts from the US military to move containerized cargo to Vietnam, McLean realized that, because world manufacturing trends were experiencing radical change, Sea-Land had a potentially valuable asset at hand in the number of containerships that were steaming eastbound across the Pacific hauling nothing but empty containers home from Vietnam. He made a fast visit to Japan and in quick order developed a more lucrative pattern: his ships would carry containers full of supplies for the military from the West Coast to Cam Ranh Bay, move the empty containers from there to Japan, and then, on the third leg of this triangle, haul Japanese-made merchandise to North American markets. Sea-Land inaugurated such service in late 1968, and transpacific trade soon eclipsed the transatlantic as a pipeline for imported cargo bound for the United States. When Sea-Land took delivery of a fleet of newly built, high-speed containerships in 1972, only two of the new vessels were deployed on transatlantic routes, while six were assigned to transpacific routes.

The problem this created, though, was that many of the containers from the Far East that Sea-Land and, soon enough, other steamship companies would bring into West Coast ports were destined for customers in more eastern locations, where substantial portions of the country's population both lived and worked.

Led by McLean and Sea-Land, but with another steamship company, American President Lines (APL), playing an equally important role, containership operators developed working relationships with US railroads that ultimately led to a key development in world transport history: dedicated freight trains hauling nothing but containers out of West Coast ports across the continent to eastern markets and even to eastern seaports, as many of the containers were bound from factories in Asia to retailers in the expanding markets of western Europe.

While still operating within the constraints of a highly regulated environment, US railroads tended to view steamship companies and their seagoing containers as just another category of freight customer, whose cargo would be handled in the same manner as other freight. Container-carrying cars would be coupled into general merchandise freight trains, and when such cars had to be forwarded to another railroad it would happen at major terminals and junctions in the same manner that railroads had been interchanging freight cars with each other for decades. Similar to the loading and unloading of break-bulk cargo in the maritime world, interchanging freight cars from one railroad to another was an exercise that was both labor intensive and time consuming. The practice put railroads at a serious disadvantage when over-the-road truckers began to compete for segments of various intercity freight markets that railroads once dominated.

It would take the deregulation of the railroads brought on by the Railroad Revitalization and Regulatory Reform Act of 1976 and the Staggers Rail Act of 1980, coupled with the elimination of the ICC and the complex regulatory