The Shipping Container and the Globalization of American Infrastructure

by

Matthew W. Heins

A dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
(Architecture)
in the University of Michigan
2013

Doctoral Committee:

Professor Robert L. Fishman, Chair
Associate Professor Scott D. Campbell
Professor Paul N. Edwards
Associate Professor Claire A. Zimmerman

© Matthew W. Heins 2013

Acknowledgments

I wish to express my sincere and heartfelt thanks to my advisor, professor Robert Fishman, who has provided such valuable guidance and advice to me over the years. Ever since I arrived at the University of Michigan, Robert has been of tremendous assistance, and he has played a vital role in my evolution as a student and scholar. My deepest gratitude also goes out to the other members of my dissertation committee, professors Claire Zimmerman, Scott Campbell and Paul Edwards, who have all given invaluable help to me in countless ways. In addition I would like to thank professor Martin Murray, who has been very supportive and whose comments and ideas have been enriching. Other faculty members here at the University of Michigan who have helped or befriended me in one way or another, and to whom I owe thanks, include Kit McCullough, Matthew Lassiter, Carol Jacobsen, Melissa Harris, María Arquero de Alarcón, June Manning Thomas, Malcolm McCullough, Jean Wineman, Geoffrey Thün, Roy Strickland, Amy Kulper, Lucas Kirkpatrick and Gavin Shatkin.

My fellow doctoral students in architecture and urban planning at Taubman College have helped me immensely over the years, as I have benefited greatly from their companionship and intellectual presence. There are too many to name in full, but I particularly wish to thank Kush Patel, Aysu Berk, Nghi-Dung Nguyen-Phuoc, Douglas Kolozsvari, Laura Smith, Patrick Cooper-McCann, Conrad Kickert, Lori Smithey, Eric Seymour, Wonhyung Lee, Michael McCulloch, Neha Sami, Nicholas Senske, Deirdre Hennebury, LaDale Winling, Stephanie Pilat, Diaan Van Der Westhuizen, Kristina Luce, Elizabeth Vandermark, Matthew Weber, Robert Walsh and Elizabeth Keslacy.

In addition I give sincere thanks to my dear friend Sonja Janeva, and send along my best wishes to her.

The archivists at the National Museum of American History in Washington, D.C., were of great assistance when I visited their archives. Two librarians at the Art, Architecture & Engineering Library of the University of Michigan, Paul Grochowski and Rebecca Price, were also extremely helpful. Likewise Mindy Alguire, a librarian at the University of Michigan Transportation Research Institute (UMTRI) Library, provided valuable assistance.

My family is far away geographically, but always in my thoughts. I give special thanks and love to my mother Marjorie Heins, my father Gregory Heins, and my sister Catherine Boalch. I also send thanks and love to Karen Haas, Philip Boalch and Melanie Boalch, and I pay my deepest tribute to the memory of Robert Boalch.

To anyone I have left out, my apologies.

Table of Contents

List of Figures

Abstract

Over the past few decades the transportation infrastructure of the United States has been globalized by the shipping container, an object that carries vast amounts of global commerce. Best known for traveling over the ocean, the container's ability to move in trucking and railroad infrastructures is equally crucial. As its intermodal capability allows for easy transfer between transport modes without its contents being loaded and unloaded, a container is able to follow a global trajectory through the use of multiple infrastructures. Consequently the domestic American transportation system has been integrated into the worldwide network of containerized freight movement.

The American trucking and railroad systems have moved containers since the 1920s, and larger modern containers since the 1950s. Paralleling the dramatic rise in global trade, in recent decades the container has been widely carried by these two domestic infrastructures, and has also traveled on inland waterways sporadically. Trucking and railroads have been altered in many ways by containerization, both in terms of the necessary equipment and the routes of movement. Furthermore, the container's proliferation in the U.S. transportation network has necessitated the development of intermodal terminals, large facilities at key junctions of road and rail where containers are transferred from one transport mode to another.

Yet the U.S. national infrastructure has kept many of its longstanding characteristics, for the container does not replace or transform it but rather depends upon it. The container's impact is substantial and results in some important changes, as American transportation systems must accommodate its physical qualities and other characteristics, but the fundamental nature of domestic infrastructure generally remains in place. In this regard containerization is typical of many processes of globalization, in that change is largely carried out within and through existing frameworks of the nation-state. The way the container impacts American transportation, therefore, is deeply affected by the historical, geographic, social and political realities of the nation and its infrastructure. Globalization is not a top-down transformation in which the worldwide scale inexorably dominates national, regional and local contexts, but rather is a nuanced and contingent process.

Chapter 1 ~ Introduction

This dissertation examines how the American transportation infrastructure has been altered—in a sense "globalized"—to accommodate the internationally standardized shipping container. This process has taken place from the introduction of containerization in shipping in the 1950s up to the present day, and seems likely to continue. Over this period of time the domestic infrastructure within the American territory, well established and possessing its own distinct qualities, changed in many ways to suit the container. The United States, like so many other countries, has been integrated into the global networks of container movement and supply chains. Yet during this process American infrastructure retained many of its characteristics, for the container is designed to work within existing transportation systems already in place. So while it is the case that the container impacted U.S. infrastructure in certain ways, the global infrastructure of containerization has largely operated through national systems rather than transforming or replacing them. This does not mean globalization has failed to transpire, but rather that global processes are shaped by national and local circumstances and are carried out in ways that vary depending on specific contexts. Globalization is not a generic trend that flattens particularities of place, but instead coexists with these varied contexts and at times is even generated by them.

The bulk of the dissertation provides a historical account of the shipping container's effect on the American transportation system. The container's presence within the United States has been most prominent in two infrastructures, trucking and the railroad. From the early days of containerization until roughly the late 1970s these two infrastructures were relatively lightly affected by the container, and in the years since they have been far more deeply altered due to the massive growth in container traffic. The spatial and material qualities of trucking, railroads and the container itself have played a key part in this process. An additional component of this infrastructural transformation, especially since the 1980s, has been the development of large intermodal terminals where containers are transferred between train and truck. Placed throughout the country, the terminals are strategically sited at infrastructural junction points. The rising tide of containerization in trucking and rail has also led to a system of domestic containers, larger than the global (that is to say, normal) containers, that are restricted to traveling within North America. On the other hand, the American network of inland waterways, which has a vital (albeit often overlooked) role in moving freight, has failed to attract more than a pittance of container traffic.

In narrating this historical process, the dissertation explores how the preexisting character of American infrastructure was critical to the way it accommodated the container. The dissertation also delves deeply into the theoretical aspects of its subject. These generally revolve around two basic themes. The first is that of containerization as an infrastructure. As the container cannot form an infrastructure in its own right (as opposed to, say, the automobile or railroad), but instead depends on transport systems already in place that it links together, containerization is an unusual type of infrastructural network. The second theme concerns the globalization of the nation-state, and local regions and places inside it, through infrastructural connections and larger worldwide systems. Containerization reveals this to be a nuanced process, with power and agency wielded at multiple scales.

The shipping container is a curious object. For a piece of technology so powerful and influential, its appearance could hardly be more banal. A long rectangular box of corrugated metal with swinging doors at one end, there is nothing about it to catch the eye. Its dimensions and other characteristics are set at the international level, and there are just a few standard sizes. The most common container size is 40′ long, 8′ wide and 8′-6″ high, and there are also many 20′-long containers of the same width and height. A few 45′-long containers, also 8′ wide and 8′-6″ high, are in use, but this size never really caught on. In addition there are numerous "hi-cube" containers, which come in any of these lengths (but most often are 40′ long), the same 8′ width, and a 9′-6″ height. A few other variations exist but are extremely rare. There are also containers used only in certain national or regional infrastructures, with sizes more appropriate to those contexts; the domestic containers of North America for instance are 53′ long, 8′-6″ wide and 9′-6″ high. Containers possess fittings at each corner, known as "corner castings," that have holes to allow for easy attachment to trucks, trains, ships, cranes and other containers. Every container in active transportation use has a unique identifier, a series of numbers and letters, clearly marked upon it.

The logic of the container, and its remarkable success, lies in how it links different modes of transportation together, often across national boundaries, and moves between them without the necessity of unloading and reloading cargo. Rather it is the container that gets moved, generally by some sort of crane, between transport modes. Hence containerization connects multiple infrastructures so that one container can bring freight all the way from origin to destination. Containers typically are carried on ships (primarily over the ocean, but also on inland waterways), trucks and trains. In theory they can also be transported by airplane, but this is almost never done. (There are other types of containers used to carry air freight, which are far smaller, customized for that purpose, and do not move by other transport modes.) The success of containerization testifies to the value of the intermodal approach to transportation. Intermodalism is a strategy whereby the overall journey (of a cargo or person) is viewed in its entirety across multiple transport modes, and so improving the links between modes can be as important as the modes themselves.

A typical container looks so generic that it fades into the background. For a long time the container's importance was similarly overlooked, but no longer; in today's heightened awareness of globalization, the container is perceived as significant. In practical terms the container is now understood as a key device enabling global trade, while on a symbolic level it has become an icon of globalization. At this point the general history of the container has been chronicled by several writers in a flurry of books and articles published during the past decade.[1] Most narratives of containerization concentrate primarily on the shipping industry and oceangoing trade. Indeed, it was shipping lines that took the lead during the 1950s and '60s by introducing various types of containers that gradually evolved into the globally standardized shipping container, while port authorities, governmental agencies, and nongovernmental institutions (especially the International Organization for Standardization, known as the ISO) also played a crucial role. The business of shipping was transformed by the need to build new ships and overhaul existing ones, develop better and larger ports, install new equipment, and fundamentally revise many practices. All this has been well documented in histories of the container. Some accounts also explore the tremendous growth of international trade and commerce since the 1960s, a phenomenon integrally tied to containerization as rising trade has both exploited the container and been enabled by it.

The intent of this dissertation is different, as should be already evident, for it examines containerization in the context of the domestic infrastructure of one particular country, the United States (with occasional coverage of Canada as well), and in the process ponders the container's significance at the national, regional and local level. The dissertation posits that the impact of the shipping container on domestic transport modes—primarily the railroad and trucking industries—is every bit as important as its effect on global shipping. I would argue globalization perhaps matters most when it reaches deepest into the nation-state, or into regional or local settings. In these accommodations between an overarching global network that aspires to universality and particular national, regional or local systems that reflect their own contexts, a worldwide infrastructure is shaped and implemented. It is important to realize containers would serve little purpose if their journeys began and ended at ports—the container's ability to move overland, in national territories on domestic infrastructures, is integral to its value.

As it depends on the basic transportation infrastructures of shipping, trucking and railroads, the worldwide network of containerization represents an atypical sort of infrastructure, one unified in some respects yet fragmented in its functioning. Seen in this light, the container's most distinctive feature is the way it links together preexisting infrastructures. Essentially a giant steel box with no distinguishing features or special technologies of its own, it gains central importance

[1] Examples include: Marc Levinson, *The Box: How the Shipping Container Made the World Smaller and the World Economy Bigger* (Princeton, NJ: Princeton University Press, 2006); Arthur Donovan and Joseph Bonney, *The Box That Changed the World: Fifty Years of Container Shipping—An Illustrated History* (East Windsor, NJ: Commonwealth Business Media [The Journal of Commerce], 2006); Brian J. Cudahy, *Box Boats: How Container Ships Changed the World* (New York: Fordham University Press, 2006); Richard Cook and Marcus Oleniuk, *Around the World in 40 Feet: Two Hundred Days in the Life of a 40FT NYK Shipping Container* (Hong Kong: WordAsia [NYK Group], 2007); Stewart Taggart, "The 20-Ton Packet," *Wired*, Vol. 7, No. 10 (October 1999), pp. 246-255; BBC News website, "The Box." (http://news.bbc.co.uk/2/hi/in_depth/business/2008/the_box/default.stm, accessed 6/23/11). Levinson's work is the only one to gain mainstream recognition and is probably the best single source, though Donovan and Bonney's book is quite good also and has the benefit of being well illustrated. The BBC video series has been widely viewed. The *Wired* article is ideal as a brief introduction to the container.

through its ability to be carried by basic modes of transportation. As it can also be so easily transferred between those transport systems, the container in effect constructs a cohesive network out of disparate parts. Scholars refer to such an infrastructure, which both links together and depends on more basic existing infrastructures, as a "second-order system" or "internetwork." Such second-order systems can be physical or informational, and seem to be proliferating for a variety of reasons in contemporary life.[2]

A device, object or tool that enables a second-order system by making the interconnection between different infrastructures possible, working with each separate existing ("first-order") system, is termed a "gateway.[3] Not every second-order system has a specific gateway that can be identified, but the container obviously is the gateway for the worldwide network of containerization, and as such is an extraordinarily important object. It is not an incidental or trivial part of the system, but pivotal to it. Global containerization is only able to accomplish what it does, creating a worldwide network of rapid, cheap, efficient and nearly seamless freight movement, by functioning as a second-order system with the container as its gateway. Its fragmented parts—ocean shipping plus two land-based transport modes in a multitude of nations—could not be bound together otherwise. In its dependence on these constituent systems, the worldwide container network is perhaps different from our conventional notions of infrastructure. As a second-order system, it derives much of its value from tying together basic systems that are already in place.

A gateway on its own is usually not sufficient to create a second-order system, for existing infrastructures must be modified to acquire the capability of accommodating the gateway. The degree of difficulty involved in this may well determine how widely the second-order system spreads. In its dimensions and other characteristics, the container was explicitly designed—and for the most part, well designed—to be carried by the shipping, trucking and railroad transport modes, but this does not mean it has been an effortless process. The greatest challenge was undoubtedly in ocean shipping, both in terms of the ships themselves and the ports they dock at, but that is outside the main focus of this dissertation. For our purposes it is the U.S. trucking and railroad systems that are the main object of study. Both have been significantly changed in order to handle containerization, but in general these changes did not involve fundamental alterations or dramatic overhauls. Instead, devices that I characterize as "interfaces" have been developed to

---

[2] The concepts of second-order system and internetwork are described in: Ingo Braun and Bernward Joerges, "How to Recombine Large Technical Systems: The Case of European Organ Transplantation," in: Jane Summerton (ed.), *Changing Large Technical Systems* (Boulder, CO: Westview Press, 1994), pp. 25-51; Paul N. Edwards, "Y2K: Millennial Reflections on Computers as Infrastructure," *History and Technology,* Vol. 15, Iss. 1-2 (1998), pp. 11-14 (these page numbers for pdf version at http://pne.people.si.umich.edu/articles.html); Greg Downey, "Virtual Webs, Physical Technologies, and Hidden Workers: The Spaces of Labor in Information Internetworks," *Technology and Culture,* Vol. 42, No. 2 (April 2001), pp. 209-235.

[3] The idea of the gateway is discussed in: Tineke M. Egyedi, "Infrastructure Flexibility Created by Standardized Gateways: The Cases of XML and the ISO Container," *Knowledge, Technology, and Policy,* Vol. 14, No. 3 (October 2001), pp. 41-54; Paul A. David and Julie Ann Bunn, "The Economics of Gateway Technologies and Network Evolution: Lessons from Electricity Supply History," *Information Economics and Policy,* Vol. 3, Iss. 2 (1988), pp. 173-191.

allow the existing infrastructures to carry containers. These basically function as an interface between the global system of containerization and a particular national system (either trucking or rail), and are crucial in that they allow each system to exist more or less independently even as they work together.

The development of such interfaces is a key part of this dissertation's historical narrative. In trucking, the interface is the trailer chassis, which is specifically designed to hold the container and connect to the tractor (i.e., of a typical tractor-trailer setup). The trailer chassis in its workings and physical configuration simultaneously accommodates the global container and the domestic trucking system. For the railroads, the interface is a specially designed railcar that carries containers; as with the trailer chassis, this railcar makes the necessary connection between the global and domestic systems. Linking into each infrastructure, it (like the trailer chassis) is an interface between them in both a literal and metaphorical sense. Over the decades these interface devices have grown increasingly sophisticated, so as to carry the burgeoning quantity of containers more efficiently. In the 1950s and '60s in fact they were often merely slightly modified flatbed trailers or flatbed railcars, or other jerry-rigged solutions. They have since become far more customized for their purpose, which comprises not only holding the container but allowing it to be quickly put in place and secured, or removed. An especially important step in this evolution was the development of the double-stack railcar in the late 1970s and '80s (and its widespread use since), which holds containers one atop the other and greatly increases the capacity of a train hauling containers.

This double-stacking is of particular interest because it has forced clearances along many American railroad corridors to be raised so two containers can fit. This qualifies as a significant alteration in the railroad system, wherein its fundamental qualities are changed. The impressive amount of money and effort involved reveals the power of global containerization—or to be more specific, the profits railroad companies see in it. In this case the container deeply alters the preexisting infrastructure, whose characteristics are transformed. But this is a fairly rare example; in general the container works within systems and does not force this sort of wrenching change. Another type of transformation is the creation of new transport routes to handle container traffic, the Alameda Corridor in the Los Angeles region being the best known. But this is also uncommon, and such corridors are not especially long—most often these projects are meant to resolve bottlenecks at particular points. Flows of container movement are generally funneled through the country's existing transportation network.

Infrastructure functions on a broad scale; by its nature an infrastructural system pervades a large territory and/or group of users, and has a universal aspect to it. Yet for each user, and at every point where it functions, an infrastructure is particular or local in nature. This seemingly paradoxical duality of particular user and place versus broad overarching scope is inherent to infrastructure. Scholars Susan Leigh Star and Karen Ruhleder make the perceptive claim that "an infrastructure occurs when the tension between local and global is resolved."[4] Along similar lines, Stefan Timmermans and Marc Berg use the concept of "local universality," which implies that an infrastructure does not simply impose itself on local conditions and users, but rather is an ongoing negotiation between the local and particular on one hand and the large-scale and universal on the other.[5] Such insights are especially relevant to this dissertation, as the container network so clearly depends on other infrastructures that are embedded in local, regional and/or national conditions. The universal and particular are in constant interaction.

The shipping container is an object whose dimensions, as already noted, are standardized at the global level. Its length, width and height are fundamental to how it is can be held, carried or used, and how much freight can fit inside it—in short, this is an object whose size is its key characteristic, and that is tied to space and materiality in the most evident sense. As a box that encloses cargo and is held and moved by a plethora of devices and machines (ships, trucks, trains, cranes, etc.), the container's physical qualities, particularly its dimensions, are central to its use. The dissertation describes how this has played out in practice, in the context of American infrastructure, over the years. In particular I focus on how the container's spatial qualities intersect with those of the U.S. railroad and trucking systems, emphasizing that the way those infrastructures accommodate the container is inherently spatial in nature. I introduce and apply the concept of the "spatial regime" to describe how a particular set of spatial and/or material characteristics can be fundamental to certain infrastructures, bureaucracies, systems or regulations. During the history of the container, its spatial regime has intersected with the spatial regimes of shipping, trucking and railroads in complex accommodations necessary to make the entire network function; the result is an interlocking set of material systems, the result of precise spatial negotiations in which a mere inch can be critical.

This dissertation also deals with space at the far larger scale, that of geography. The insertion of the container into U.S. infrastructure extends along transportation corridors hundreds or even thousands of miles long that span great expanses of the vast nation. These routes and pathways are embedded in the history and character of the country, and are also affected by topography and other factors inherent to American geography. Some of the alterations made necessary by containerization must be implemented throughout these networks. As containers move along them, the role of the routes is augmented: formerly segments of the purely domestic infrastructure of the nation-state, they now become components of much longer global networks in addition. The container depends on these existing pathways of the nation-state, for it would be too difficult (and also unnecessary) to construct a wholly new system. The basic coherence of national infrastructure remains, even as the container enters into and in some ways modifies it.

The persistence of the nation-state's historical infrastructure in this new globalized reality is due in part to the enduring quality of infrastructure in general. Infrastructures are embedded in

---

[4] Susan Leigh Star and Karen Ruhleder, "Steps Toward an Ecology of Infrastructure: Design and Access for Large Information Spaces," *Information Systems Research*, Vol. 7, No. 1 (March 1996), p. 114.

[5] Stefan Timmermans and Marc Berg, "Standardization in Action: Achieving Local Universality Through Medical Protocols," *Social Studies of Science*, Vol. 27, No. 2 (April 1997), pp. 273-305.

social, political, economic and cultural milieus and do not change easily—minor adjustments frequently take place, but fundamental alterations are another matter. In this regard infrastructure represents far more than merely the use of technology, which can evolve quickly. A new technological capability is one thing, but implementing it through an infrastructure that the bulk of society actually uses is quite another matter. All this is true for the container network, with the added factor of the material, physical and spatial character of transportation systems. (The relevance of this materiality for the container itself has already been noted.) Nearly all infrastructures, even informational ones, have some physical manifestation, but transportation is especially material in its workings in terms of the devices that move, the cargo or people they carry, and the routes along which travel occurs. This physical quality gives transport infrastructures an additional inertia, an enduring quality over time; they do not change in the absence of compelling circumstances.

Containerization requires that infrastructures accommodate a standardized object, the container itself, but it is also constructed upon these multiple systems. Hence the container network is deeply affected by the characteristics and conditions of the nations and localities it passes through. The dissertation examines this phenomenon in the American context, arguing that this "globalization" of the nation's freight transport infrastructure is carried out in a distinctly American way, even while it becomes part of a universal worldwide network. The way containers move through the U.S. reflects the history, geography and particular qualities of the nation, and also of particular regions, cities, towns and routes within it. Historian of technology Thomas Hughes uses the concept of "technological style" to refer to how infrastructures, rather than being purely objective engineering solutions, embody aspects of national culture, politics and tradition.[6] The idea is applicable to containerization, and this dissertation puts an additional focus on preexisting infrastructures and geographical factors.

Certain infrastructural systems, such as roads for movement and aqueducts for water supply, have existed since the dawn of civilization. But the concept of infrastructure seems to encompass something more modern, more systematic and advanced. (The word "infrastructure," not incidentally, is of twentieth-century derivation.) Infrastructural systems are the organized frameworks that support modern human societies, which do not merely use them but depend upon them; they provide an invaluable foundation upon which other activities take place. In this role infrastructure is linked to another key component of modernity: the nation-state. Historically speaking, modern infrastructures—the first examples being the railroad and telegraph—played a major role in helping the emergent nation-states establish their power, territorial integrity and national unity. The scholar Michael Mann refers to the wide range of infrastructural,

[6] Thomas P. Hughes, *Networks of Power: Electrification in Western Society, 1880-1930* (Baltimore: The Johns Hopkins University Press, 1983), pp. 405-407; Thomas P. Hughes, "The Evolution of Large Technological Systems," in Wiebe E. Bijker, Thomas P. Hughes, and Trevor J. Pinch (eds.), *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology* (Cambridge, MA: MIT Press, 1987), pp. 68-70.

organizational and bureaucratic tools the modern nation-state draws upon as "infrastructural power."[7]

A nation-state is a remarkable assemblage of elements—governmental, social, cultural and economic—all unified in the same geographic space defined by national borders. This situation, with so many aspects of human existence spatially congruent under one system, was in no way typical until the rise of the nation-state; the more common historical pattern has been for these elements to coexist and overlap in different realms and territories. Our globalized future could once again see such a divergence. Yet only time will tell how the situation unfolds—over roughly the past decade the seeming inevitability of many aspects of globalization has been punctured by ongoing events. But certain trends continue, in particular the prevalence of worldwide trade in which the container plays such a prominent role. Given the nation-state's continuing fundamental importance in so many respects, the path towards globalization (and the means by which it proceeds) is by no means clear, and there is no institution of worldwide unity or power that is currently a match for the nation-state.

The shipping container, this dissertation argues, represents an exemplary case of how globalization is carried out in these circumstances. Many of today's global networks are woven from separate national infrastructures that when linked together can function in a somewhat cohesive manner (to a varying or lesser degree depending on the actual case). The container network is a perfect example. As a second-order system the infrastructure of container movement is well suited to function globally. As already described, a second-order system works through more basic, already existing, "first-order" systems. This is an ideal way to succeed at a worldwide scale, given the multitude of preexisting national infrastructures so deeply set in place. The fragmentation of the world's transport systems need not pose an insurmountable obstacle; on the contrary, those infrastructures are exploited by the container. The process is not without its strains and difficulties, as this dissertation will illustrate in the American context, but is far easier than creating new infrastructures from scratch would be. (Containerization is by no means the only second-order system to function on a worldwide scale—in fact the most celebrated global infrastructure of all, the internet, can be described as a second-order system.) Such a second-order global infrastructure reconciles the requirements of national and local conditions with the necessity for universal standards and an overarching international framework.

The coexistence of global, national and local infrastructures in this age of globalization has been the focus of much scholarly attention since the 1990s. The most prominent school of thought is represented by "splintering urbanism," introduced in the book of that name by Stephen Graham and Simon Marvin.[8] The concept has been influential and is broadly emblematic of a certain way of thinking, widespread among scholars, about infrastructure in this period of

---

[7] Michael Mann, "The Autonomous Power of the State: Its Origins, Mechanisms and Results," in: Neil Brenner, Bob Jessop, Martin Jones, and Gordon MacLeod (eds.), *State/Space: A Reader* (Malden, MA: Blackwell Publishing, 2003), pp. 54-55.

[8] Stephen Graham and Simon Marvin, *Splintering Urbanism: Networked Infrastructures, Technological Mobilities and the Urban Condition* (London: Routledge, 2001).

neoliberalism and global connectivity. Splintering urbanism posits that neoliberal doctrine and a lack of social cohesion has led to the splintering of once unified national infrastructures, as the modern ideal of universally available infrastructure has faded away, replaced by tiered services and exclusionary enclaves. According to this view, wealthy elites are increasingly tied into premium global networks while others are left with deteriorating systems or nothing at all. "World-class" cities and elite enclaves gain ever better access to superior infrastructure, engaging more and more with the rest of the globe even as they disengage from regions and neighborhoods around them.

Splintering urbanism presents a vision of simultaneous access and fragmentation, encompassing expanding worldwide networks and the deterioration of infrastructure and social unity. This resonates with real-world trends that are increasingly evident. It also recognizes the growth of local and regional autonomy in many places—at the expense of the nation-state—as such locations either link themselves into global networks or go into decline. But splintering urbanism has been criticized for romanticizing the modern era of supposedly universal infrastructure, exaggerating the nation-state's decline, and cherry-picking contemporary examples to present an overly grim view. The case of containerization reveals a somewhat different situation, it being a global network that pervades the entirety of so many national infrastructures rather than being limited to certain places, enclaves or territories. Yet splintering urbanism's vision is to some extent in sync with how this dissertation presents containerization: the container network allows national, regional and local qualities to coexist with an overarching global reality, and hence encompasses both fragmentation and unity.

The best accounts of global infrastructure take into account the agency of the national and the local, and understand globalization as the results of many actors operating at a variety of scales. Here splintering urbanism often falls short, as do many other theories of globalization both scholarly and popular, because it tends to assume neoliberalism and other global trends are imposed in top-down fashion or become pervasive in some unstoppable way. The activities of those in the local, regional and national spheres consequently are limited to how they respond to these larger outside forces. In this paradigm, power and agency invariably come from somewhere else, some mysterious distant location. While splintering urbanism is valuable in its attention to local scenarios, too often it fails to grant them their own measure of power and agency. This dissertation attempts to go further by regarding the local, regional and national not merely as recipients of globalization, nor as inevitably resisting it, but as active agents in the construction of the global. I draw upon the ideas of several scholars in advancing this view with regard to infrastructure. Two of particular value are Steven Erie and Julie Cidell. In his book *Globalizing L.A.*, Erie narrates how the Los Angeles region has actively built up key infrastructures in order to make itself into a global node.[9] In a series of articles, Cidell shows that

[9] Steven P. Erie, *Globalizing L.A.: Trade, Infrastructure, and Regional Development* (Stanford, CA: Stanford University Press, 2004).

the growth of the logistics industry in exurban areas outside Chicago (and elsewhere) depends on the character of those places, and the decisions made by their leaders and citizens.[10]

A problematic aspect of some globalization literature is a tendency to oppose global "space" with local "place"—the former portrayed as a smooth abstract matrix upon which capital and other global actors operate, the latter as the repository of cultural heritage and human-centered life. In this vision it is inevitably global space that is proactive and represents the future, while local place can only react and symbolizes the dying past. Curiously, both proponents and critics of globalization typically reinforce this simplistic view, disagreeing only as to whether it is a good thing or not. More perceptive writers look deeper. The work of Erie and Cidell on infrastructure has been noted, but of course many insightful scholars on globalization are based in the social sciences and do not study technology or infrastructure at all. Two of note are Michael Peter Smith and Doreen Massey. Smith's work on the world-spanning networks of immigrant groups demonstrates that the global and local are intertwined rather than opposed, and that globalization is often constructed from below rather than above.[11] Massey's widely read essay "A Global Sense of Place" gives a thoughtful and nuanced view of how local place intersects with globalization, arguing against static and traditional conceptions of place.[12]

My account of the shipping container's position in American infrastructure is indebted to such work, as I argue containerization in the U.S. context has not invariably transpired in a top-down manner from the global to the national and local. Rather, rising container use has been shaped by the existing qualities of American infrastructure, geography, and even society and politics. This has not just happened at the national level, but also at regional and local scales—that is to say, different regions and localities adopt the container in their own particular ways. They are certainly not free to ignore it, but have great flexibility and agency in terms of how they handle this new infrastructural object. In the course of making and carrying out these decisions, it is national, regional and local actors, rather than amorphous global forces, that actually do the bulk of the work in implementing globalization. In emphasizing this point, my argument owes much to the ideas of Saskia Sassen.[13] The agency of the national is especially pronounced in my narrative because the U.S. actually played a foundational role in the creation of the globally

---

[10] Julie Cidell, "Distribution Centers Among the Rooftops: The Global Logistics Network Meets the Suburban Spatial Imaginary," *International Journal of Urban and Regional Research,* Vol. 35, Iss. 4 (July 2011), pp. 832-851; Julie Cidell, "Flow and Pauses in the Urban Logistics Landscape: The Municipal Regulation of Shipping Container Mobilities," *Mobilities*, Vol. 7, No. 2 (May 2012), pp. 233-245; Julie Cidell, "From Hinterland to Distribution Center: The Chicago Region's Shifting Gateway Function," in: Peter V. Hall and Markus Hesse (eds.), *Cities, Regions and Flows* (Abingdon, U.K.: Routledge, 2012), pp. 114-128.
[11] Michael Peter Smith, *Transnational Urbanism: Locating Globalization* (Malden, MA: Blackwell, 2001); Michael Peter Smith, "Power in Place: Retheorizing the Local and the Global," in: Jan Lin and Christopher Mele (eds.), *The Urban Sociology Reader* (London: Routledge, 2005), pp. 241-250.
[12] Doreen Massey, *Space, Place and Gender* (Minneapolis, MN: University of Minnesota Press, 1994), pp. 146-156.
[13] Saskia Sassen, *A Sociology of Globalization* (New York: W. W. Norton & Company, 2007); Saskia Sassen, *Territory, Authority, Rights: From Medieval to Global Assemblages* [updated ed.] (Princeton, NJ: Princeton University Press, 2008).

standardized container. The container, at least in its contemporary form, has essentially American origins; European containers existed also, but the global standards for containers (especially for their dimensions) that developed in the mid-1960s derived primarily from American standards set only a few years earlier.

This dissertation seeks to be attentive to the interplay between longstanding national infrastructure and emerging global infrastructure. It is not a narrative of the national and local being subsumed by global forces, but neither does it deny the remarkable power of globalization. I argue that globalization, despite the excessive rhetoric that at times accompanies it, is a profound and powerful phenomenon taking place, and that the shipping container is one of its signal tools. Yet I emphasize that the network of global container movement is built upon the existing domestic infrastructures of the nation-state (except for the segments of travel by ocean-going ships). Because the container depends on particular modes of transportation for its actual movement, the container infrastructure by necessity must be constituted by those systems. The infrastructures that bind nations together possess their own distinctive qualities, and the container for the most part works within them, even though it also carries out alterations upon them. Globalization in this case does not act as an all-encompassing force that sweeps away all before it and creates a new reality from scratch, arising out of some qualities inherent to the global dynamic itself. On the contrary the global is often built upon, and shaped by, the characteristics and histories of national and local places. The national and local cannot ignore global forces completely, but they do possess the agency to reshape the global, or to determine their place within it. The process of globalized containerization has been a complex negotiation among various systems and scales, not a preordained wave of change.

Chapter 2 ~ The Rise of the Container as a Global Standard

The shipping container's rise to prominence as a global standard has been rapid, paralleling many other transformations associated with globalization in the postwar era. A brief account of it will be provided in this chapter, so as to put the specific narrative of the dissertation—the container's place in American infrastructure—in its larger context. The spatial aspects of the container, especially its particular spatial dimensions, will be emphasized, because this object's importance is inherently spatial and material. The container works so well with multiple modes of transportation around the world due to an interlocking series of spatial systems that involve the spatial qualities not only of the container but also of the transport infrastructures that carry it. In the so-called "knowledge economy," the container's success reminds us of the enduring importance of the material realm. This is doubly the case because containers carry products and goods that are most assuredly physical and material in nature.

There were sporadic early types of containers in Europe and the United States in the nineteenth century, used for goods that were transferred between trains and wagons, or between trains and barges that traveled on inland waterways. (Obviously the motor vehicle was not yet in use.) These containers were fairly small, generally between four and eight feet in each dimension, and constructed of various materials. Various innovators and transportation providers came up with their own designs, so broader standardization was out of the question. Around the turn of the century, the shipping industry began to use containers known as "lift vans" to transport household goods; these were larger, roughly 10′-20′ long with a width and height of five to eight feet, and moved on ships, trains and wagons. All these instances of containerization were quite limited in scope—there was no widespread adoption or use. In general the modes of transportation remained unchanged; the container would ride on a normal train flatcar, a normal flatbed truck, or a normal ship or barge. The typical procedures for holding and securing large freight objects in place were used, which was often time-consuming and labor-intensive. Use of the container was not sufficiently widespread to make it worthwhile to design railcars, wagons or ships specially for it. The transfer of early containers from one mode of transportation to another was also cumbersome and somewhat ad-hoc, usually involving cranes or some other mechanized device. Until the 1920s these efforts to use containers were tentative and quite limited.[1]

Broadly speaking, this early evolution of the shipping container proceeded along two lines. One approach was the gradual enlargement of boxes and crates, so that they eventually morphed

---

[1] John H. White, Jr., "The Magic Box: Genesis of the Container," *Railroad History*, No. 158 (Spring 1988), pp. 75-78; Frank B. Norris, *Spatial Diffusion of Intermodal Rail Technologies*, PhD Dissertation, University of Washington (Geography), 1994, pp. 30-32.

into something bigger, a shipping container. The other approach stemmed from the desire to carry a wagon or truck by rail or ship, coupled with the realization that the wheels were a waste of space and so one could merely carry the portion holding the freight itself, which amounted to a shipping container. In either case, one essential quality of the container was its ability to keep its cargo protected from all sorts of weather; unlike most boxes and crates, which are meant to be placed inside trailers, boxcars or ships' holds while they travel, the container was, and of course still is, designed to be exposed. This ties to another basic and important quality of the container that was evident from the start: it is fundamentally an object that is attached to a transport device, such as a railcar or truck, rather than being held within that device. (In shipping admittedly this is not so much the case, but most containers on a ship are still exposed to the elements.) The use of cranes, and other mechanized devices for lifting and moving containers, was also crucial in the development and use of these early containers, as the strategy of containerization obviously fails if the transfer of freight between transport modes is too burdensome. Unlike most boxes, crates, sacks and so on, the shipping container even in its earliest (and smallest) iterations was typically too heavy to be lifted by human muscle power.

In these halting early attempts at containerization, the beginning of the intermodal approach to freight transportation is visible. Intermodalism is a way of handling transportation that seeks to improve the transport infrastructure by making the varied modes of transportation work better with each other, in cooperation rather than competition. The intermodal vision, which is applicable for both freight and passenger transportation, sees the overall transportation infrastructure holistically in its entirety, and focuses not on bettering individual modes but rather improving the overall system. This involves better coordination of the overall network, and most of all it involves the development of better transfers and connections between the various transport modes. Intermodalism as a new practice of transportation is discussed in greater depth near the end of the dissertation, in chapter 12. What should be understood here is that intermodal transportation is by its nature far more seamless than traditional approaches, because the links between different transport infrastructures are no longer barriers that are costly and time-consuming in nature, but instead function to quickly shift people or cargo from one mode to another. With regard to freight transportation, what makes these links nearly seamless is primarily the use of techniques, containerization being by far the most important, that render it unnecessary to unload and reload the freight itself. (In fact, in American freight transportation today the term "intermodal" usually refers to use of the container, or to the hauling of containers.)

By the 1920s the railroad companies, dominant in overland transportation since the mid-1800s, were under competition from rapidly expanding automobile use. In the business of freight, the railroads could not ignore the growing threat from trucking. The animosity between the two modes made cooperation difficult, but railroads in both the U.S. and Europe made some efforts to gain traffic by coordinating with, rather than competing against, trucking. (It was primarily the railroads that carried out this strategy, as they were large corporations with deep pockets and long-distance networks while trucking firms were usually small.) There were—and still are—

basically two ways to do this, both falling under the intermodal concept. The most obvious is by carrying entire truck trailers (or even entire trucks) on train flatcars. (A similar practice was occasionally done earlier, before the days of the motor vehicle, with wagons being carried on trains—the horses were put in a boxcar, or new horses were used at the destination.) The other method is to utilize the shipping container, a giant box analogous to a trailer without its wheels and other external fittings. In either case the objective is for each transport mode to do what it does best: the train carries its cargo a long distance over a fixed route economically, while the truck picks up cargo at its origin and/or drops it off at its destination, moving flexibly as needed. The key advantage is that the cargo need not be unloaded and reloaded, and is shifted quickly from one mode to another. Some clarification of terminology is in order here: when a trailer is carried on a railcar this is termed trailer-on-flatcar or TOFC, though it is more widely and informally known as "piggyback," and when a container is carried on a flatcar this is termed container-on-flatcar or COFC.

The first use of piggyback in the U.S. came in 1926, when it was introduced by the Chicago North Shore and Milwaukee Railroad.[2] By this time some large trucks were composed of a tractor and trailer rather than consisting of one unit, and so it was logical for the train to only carry the trailer, not the tractor with it. Another driver and tractor would be arranged to pick up the trailer once it arrived at the end of its rail trip. Containers that were interchanged between trains and trucks had entered service slightly earlier in the decade, and came to be used by a few carriers during the 1920s and '30s. These containers were small, generally between four and ten feet in each dimension. The two most prominent container users were the great rivals the New York Central Railroad and the Pennsylvania Railroad, each of which introduced and utilized its own particular system. The idea of containerization though promising was generally not profitable during these years, and container use declined over the course of the 1930s. But the practice of piggyback rose concurrently, indicating the benefit of the intermodal approach. The use of containerization and piggyback in the 1920s and '30s is described in much greater detail in chapter 5, in the context of the American rail infrastructure, as it was the railroad companies that generally developed and controlled these systems.

Another explanation of terminology will be made. In the freight transportation business, particularly in industry and professional journals, the word "shipper" refers to the company or person whose goods are being shipped (and who is paying for the shipment), not the transportation company actually moving the goods. In the real world of course the term is used more loosely and broadly, but in this dissertation I try to be consistent with the way the word is used in the industry. The word "shipping" refers in the most general sense to the act of moving freight, packages, goods or cargo by any transport mode. As the word has transcended its origins in water-based movement, there is some ambiguity about how to refer to the companies that

[2] Brian Solomon, *Intermodal Railroading* (St. Paul, MN: Voyageur Press [MBI Publishing], 2007), pp. 27-29; David J. DeBoer, *Piggyback and Containers: A History of Rail Intermodal on America's Steel Highway* (San Marino, CA: Golden West Books, 1992), pp. 17-18. Some sources give later dates (even in the 1950s) for the first piggyback service, but they are incorrect.

provide ocean shipping. Within the industry the terms "steamship company" or "steamship line" are considered proper and often used, although these are something of an anachronism since the ships no longer actually use steam engines. The terms "shipping company" or "shipping line" are also used for this purpose, and though their meaning is arguably ambiguous with regard to the mode of transportation it seems sufficiently self-evident that I use this option. Thus in this dissertation I generally refer to a company that operates ocean-going ships as a "shipping company" or "shipping line."

Driven by the need for efficient, rapid and well-organized freight movement at a worldwide scale, the U.S. military has often played an innovative role in cargo transport. Today's global freight networks possess a similarity to the approaches pioneered for warlike purposes, and it is no coincidence that the term "logistics" has a military derivation. The unitization of cargo progressed during World War II thanks to the tremendous demands of the American military as it sought to fight a worldwide war on two fronts. The main result was a huge boost in the use of the forklift and the pallet, two intertwined technologies. But there was some experimental use of containers also, and in the late 1940s and early '50s the American military continued with this, introducing the small CONEX container (known in early iterations as the "Transporter") with an 8′-6″ length, 6′-3″ width and 6′-10½″ height, and a capacity of about 9,000 pounds. CONEX containers were carried by ship, train and truck on global routes of movement, and were used during the Korean War and well into the Vietnam War (when their use overlapped with the newer full-size containers that ultimately replaced them). They could be stacked three-high and were generally carried by normal ships, trucks and trains, usually exposed to the elements (such as in a gondola railcar, flatbed/pickup truck, or ship's deck) as they were weatherproof. Eventually the military explored a few ideas for trucks and other equipment specially designed to carry these containers. The use of CONEX containers appears to be the first large-scale network of containerization operated on a worldwide basis over multiple transport modes.[3]

In the 1950s both piggyback and containerization reemerged in the domestic U.S. railroads, thanks partly to the "Twenty Questions Case" in which the Interstate Commerce Commission (ICC) reversed an earlier ruling and made intermodal cooperation involving trains and trucks easier. Consequently a few railroads began using containers again, most notably the New York Central Railroad with its Flexi-Van container. But the event of more lasting significance during this decade was the introduction of containers in ocean shipping. This was not a completely new phenomenon, as already noted, for the lift vans of the early 1900s usually traveled by ship, and the U.S. military was using CONEX containers on multiple modes including ships. A variety of other large boxes and crates that were sometimes categorized as shipping containers were also used in the marine industry. But the ocean-going containers introduced in the 1950s were used

[3] Department of the Army, Office of the Chief of Transportation, "CONEX: A Milestone in Unitization" ("TC in the Current National Emergency: The Post-Korean Experience"), March 27, 1957; Joseph Bykofsky, "Conex: A Milestone in Unitization," *National Defense Transportation Journal*, May-June 1958, pp. 49-73; U.S. Army Transportation Museum [website], "History & Development of the Container." (http://www.transchool.eustis.army.mil/MUSEUM/CONEX.htm, accessed 6/8/08).

on a far larger scale—especially when, as quickly became the case, they were carried on a container ship (sometimes written as one word, i.e., "containership") specially designed to hold them. A container ship is not just a ship that happens to be carrying some containers on deck or even in its hold, but a ship entirely designed for carrying containers.

Though the shipping industry introduced these marine containers, they were meant to travel by domestic modes of transportation as well. The objective was for the cargo to journey from origin to destination, not merely from port to port, in keeping with containerization's ability to utilize multiple transport modes and speed up the transfer of cargo between them. The container also served the purpose of loading and unloading ships faster, more cheaply, and with far fewer workers—compared to traditional "breakbulk" methods of loading shipboard cargo, the container is dramatically more efficient. This was highly desirable to the shipping lines, but less appealing to legions of dockworkers whose jobs would ultimately be lost. The decimation of longshoremen's employment through containerization and automation was not coincidental, but integral to the new object and the technologies surrounding it.

The new generation of containers that emerged in the 1950s, including those introduced by both the shipping companies and railroads, were generally much bigger than their predecessors, mainly because truck trailers (whose dimensions were pivotal to container size, as will be described later in the dissertation) had grown larger. Hence these containers were generally about 8′ wide and 8′ high, and anywhere between 20′ and 40′ in length. Smaller containers like CONEX did linger for a time—and a few new container designs were small, as will be noted—but the general trend was for larger units. In various European countries, where containerization also gained modest impetus in the 1950s and '60s, the size of containers did not make this leap and typically remained small. This was the case in Japan as well. The United Kingdom was an exception, as British Railways introduced larger containers in the mid-1960s.

It was several companies in the Pacific Northwest that first carried containers in large quantities over the water—albeit in coastal shipping rather than across the ocean—and interchanged them with land-based transportation networks. One was the White Pass and Yukon Corporation of Canada, a railroad that began to develop an interest in containerization in the early 1950s, and in 1955 initiated container operations. The company even commissioned its own ship, the *Clifford J. Rogers*, which was specially designed to carry containers (along with some other cargo) and surely ranks as one of the first true container ships.[4] With the involvement of

[4] There is surprisingly little consensus on the identity of the first container ship. Norris argues that it was the *Clifford J. Rogers*; see Frank B. Norris, "Cargoes North: Containerization and Alaska's Postwar Shipping Crisis," *Alaska History*, Vol. 7, No. 1 (Spring 1992), p. 24. But this appears to be incorrect, as Levinson points to container ships introduced by a Danish shipping line in 1951, which carried food and beer between Danish ports, as the first. See Marc Levinson, *The Box: How the Shipping Container Made the World Smaller and the World Economy Bigger* (Princeton, NJ: Princeton University Press, 2006), p. 31. Van Ham and Rijsenbrij describe these two Danish ships and their small wooden containers in slightly more detail, noting that the ships also carried passengers. See Hans van Ham and Joan Rijsenbrij, *Development of Containerization: Success Through Vision, Drive and Technology* (Amsterdam: IOS Press, 2012), pp. 6-7. Levinson also mentions (in an

trucking as well, the White Pass and Yukon created a remarkable and well-coordinated network of container movement that utilized all three modes of transportation. The company's containers were small, however, being 8′ x 8′ x 7′ in size.[5] Another pioneer was the Alaska Steamship Company, known as "Alaska Steam," which ran between Seattle and several Alaskan ports. In 1951 it started a service in collaboration with the trucking firm Ocean Van Lines carrying 30′ containers, and in 1953 abandoned this partnership and began working with the Alaska Railroad to move much smaller containers. In 1956 Alaska Steam began carrying 24′ containers, also in cooperation with the Alaska Railroad. Meanwhile the trucking and barge company Alaska Freight Lines took possession of many of the Ocean Van Lines containers and began its own containerized operation.[6]

These innovations were still limited to a fairly small scale, but in 1956 a more important and influential figure emerged: Malcom McLean, who began his Sea-Land container service in that year. (His original first name was Malcolm but for some reason he changed the spelling to Malcom in 1950.) A former trucker and trucking executive, McLean was well suited to perceive the merits of more efficient freight transfer between land and water; by his own account he came up with the concept of the container while waiting impatiently at a port for his truckload of cargo to be placed on a ship. Often called the "father" or "inventor" of the shipping container, McLean does not merit such a title (as should be already evident) by any reasonable criteria. It was his impetus, however, that played a key role in building the gradual momentum for successful, profitable and widespread container use around the world. The trend to container use was clearly growing over the course of the 1950s, and McLean in a sense was only one of many, in both ocean and land-based shipping, who innovated with containers. But his greater degree of success and larger scale of operation represented a turning point.

Sea-Land's earliest container runs were between the Northeast and the Southeast, generally from Newark to the Gulf Coast or Florida; as with the pioneers of the Pacific Northwest, McLean initially engaged in coastal shipping. (Originally these container operations were part of McLean's Pan-Atlantic Steamship Corporation and merely branded "Sea-Land," but the corporate name was soon changed to Sea-Land Service.) His first ship, the *Ideal-X*, was a converted tanker that carried 33′-long containers upon a special deck designed for them, but the containers were not stacked nor were they carried in the ship's hull. The *Ideal-X*'s first voyage carrying containers was in April of 1956. About a year later Sea-Land introduced its first true container ships, with vertical "cells" in the hull where containers, now 35′ in length (as Sea-Land containers would remain for a long time), were stacked upon each other.

---

endnote) that some identify the Alaska Steamship Company's *Susitna*, which carried small containers, as the first container ship; see Levinson, *The Box,* p. 292 (endnote 25).

[5] *Canadian Transportation,* "The Ms. Clifford J. Rogers," Vol. 59, Iss. 1 (January 1956), pp. 48-49, 51; *Canadian Transportation,* "The Year in 1954 for White Pass and Yukon," Vol. 58, Iss, 8 (August 1955), pp. 425-427; Norris, "Cargoes North," pp. 22-24.

[6] Norris, "Cargoes North," pp. 19-22; Edwin M. Fitch, *The Alaska Railroad* (New York: Frederick A. Praeger, Publishers [Praeger Library of U.S. Government Departments and Agencies], 1967), p. 125.

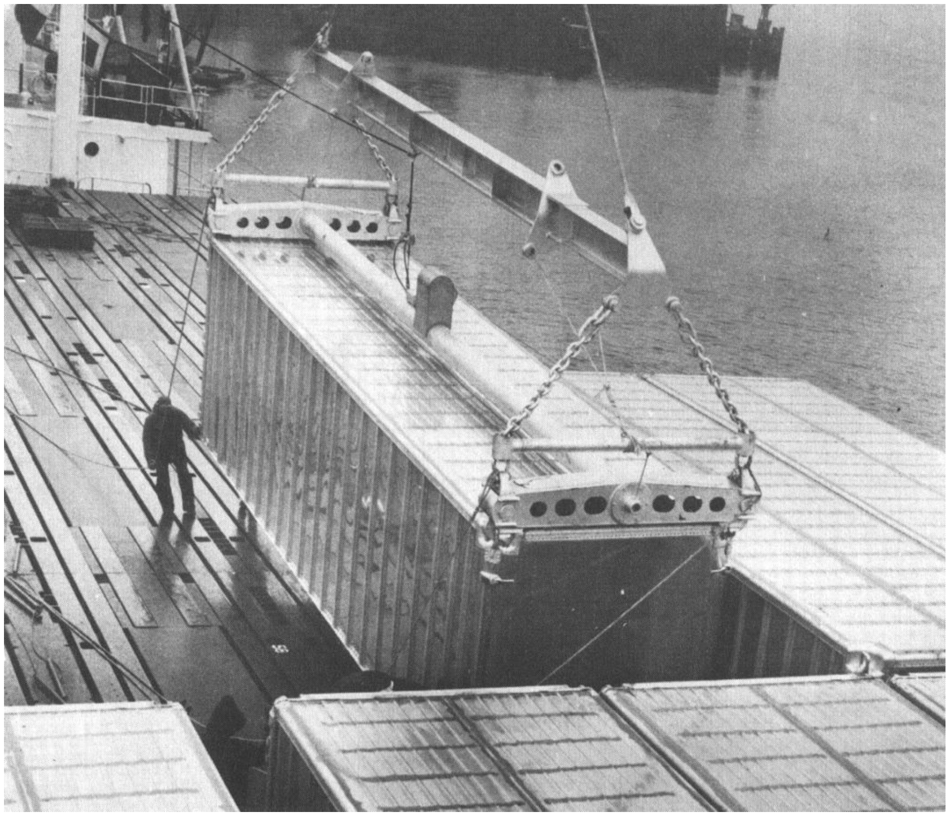

Figure 2.1: Early Sea-Land containers being loaded on the ship's deck

Source: Arthur Donovan and Joseph Bonney, *The Box That Changed the World: Fifty Years of Container Shipping—An Illustrated History* (East Windsor, NJ: Commonwealth Business Media [The Journal of Commerce], 2006), p. 60

Not long afterwards another domestic marine shipper began using containers, as the Matson Navigation Company introduced containerization on its routes between Hawaii and the West Coast. Matson unlike Sea-Land was a well-established shipping line, having long engaged in both passenger and freight transport. The company had been considering containerization for several years, and news of Sea-Land's innovations in the East was probably an additional spur. In 1958 Matson started carrying 24'-long containers on the decks of its existing ships, while continuing to carry most cargo in the holds below. Finding that containerization did not mix well with the traditional breakbulk style of carrying freight, Matson introduced container ships in 1960. Though Matson was moving containers on domestic routes (Hawaii being part of the U.S.), these voyages across the ocean differed from the coastal shipping of Sea-Land; where coastal shipping was a substitute for rail or road-based transportation, a voyage over the sea was another matter. The next logical step was to carry containers across the ocean between different continents, but one problem facing such an idea was how to move containers in the domestic land-based infrastructures on each side.

The challenge of moving containers on such global trajectories was taken up by others in the early 1960s. Morris Forgash, president of the United States Freight Company, was already one of the foremost proponents of intermodalism. As a freight forwarder Forgash could not implement container use entirely on his own, but his experience was in working with freight transport companies and linking them with customers. In 1960 he started moving containers from the U.S. to Japan; the cargo traveled from New York to Los Angeles by rail, across the Pacific to Yokohama by ship, and to its final destinations in Japan by truck. Forgash emphasized that his new service gave shippers the simplicity of one single bill of lading for the entire journey.[7] In 1959 the Flexi-Van containers of the New York Central, already in extensive domestic use by rail and truck, began to be carried on ships across the Atlantic and Pacific oceans. By 1964 this service was established on a regular basis, with several shipping lines carrying the containers.[8] A few other types of containers were also traveling on international voyages by the mid-1960s, at least on a sporadic basis. United States Lines, one of the major shipping companies, experimented with carrying containers that had been put into use by the Southern Railway, and the American military began moving containers across the Atlantic to support its Cold War presence in Europe.[9] But none of these transnational services involved container ships; the containers were carried as special cargo on regular ships and generally placed on the deck, being waterproof by design and furthermore too large to pass through the hatches into the hold. It was not until 1966 that container ships would enter international shipping, making possible the advent of large-scale containerization on a worldwide basis.

The greatest obstacle to global use of the shipping container ultimately was not the need to build container ships, nor any other technical challenge. Rather, the primary challenge was that of standardizing the container on a worldwide basis, so users around the globe would be working with the same object, and could handle containers from any source with assurance that the containers would fit their equipment. Into the mid-1960s, the tendency was for multiple types of containers to exist—each company, whether a shipping line, railroad or other innovator, designed its own container, one ideally suited to its own needs. The differences between container types were not great, but nonetheless enough to prevent interchange between users. Each system was therefore a closed system—a container ship designed to hold Sea-Land containers could not handle Matson containers, a railcar meant to carry a Flexi-Van container could not accommodate an Alaska Steam container, and so on. This was acceptable so long as containerization was a limited phenomenon only carried out by a few isolated users, but as it become widespread the inefficiencies were obvious. The various corporations could not agree on standards, nor could industry trade groups; the need for government and institutional intervention was obvious, however bitterly some in the private sector might oppose it.

---

[7] Edward A. Morrow, "3-Way Piggyback Introduced Here," *The New York Times,* August 10, 1960, p. 62; Levinson, *The Box*, p. 159.

[8] Norris, *Spatial Diffusion of Intermodal Rail Technologies*, pp. 163-165, 191; John G. Shott, *Progress in Piggyback and Containerization* (pamphlet) (Washington, D.C.: Public Affairs Institute, 1961), p. 17, also see images on pp. 36, 52.

[9] Levinson, *The Box,* p. 160.

The U.S. Federal Maritime Board began the first initiatives towards container standardization in 1958, and its role was soon taken over by the American Standards Association (the ASA, later to become the American National Standards Institute or ANSI), the nonprofit organization that is preeminent in establishing and maintaining standards in the U.S. With its powerful influence and widespread acceptance among businesspeople, bureaucrats and engineers, the decisions of the ASA were likely to be definitive. After vigorous debates, the ASA in 1961 announced standard container lengths of 10′, 20′, 30′ and 40′, and a standard width and height of 8′. U.S. trucking regulations of the time were crucial to this, as the maximum length for a trailer was 40′ and the maximum width 8′, if it were to travel on the roads of every state. The 8′ height was the product of various considerations, including how the vertical clearance on U.S. roads would relate to a container being hauled on a flatbed trailer. (The ASA also intended for containers to move on railroad flatcars, but the smaller allowable dimensions for trucking in comparison to rail made it the limiting factor.) In short, the dimensional qualities of the American trucking and road infrastructure at the dawn of the 1960s determined the size of this shipping container. Sea-Land and Matson objected to the new standards, which did not fit with the containers they were using, and though they gained some measure of relief they would in the long run gradually switch to the standard dimensions. It was the ASA's specified height that proved most controversial, as most of the shipping companies preferred a height of 8′-6″, since a container of that height was within U.S. road clearances if it were carried on a chassis appropriately designed for it.[10]

The International Organization for Standardization, better known as the ISO (not an acronym strictly speaking, but a sort of abbreviation), started its own effort to create a globally standardized container soon after the ASA standards were in place. This was an even greater challenge, as it was necessary to anticipate the issues containers might face under varied conditions in a multitude of countries. Although North America and Europe exerted the greatest influence, and were clearly most likely to adopt containerization swiftly, the ISO's objective was for the container to be able to function in the infrastructures of nations all around the world. ISO committee TC-104 handled this process over the course of the 1960s, with final agreement more or less being reached in 1967. Deciding on the container's size was the biggest challenge. The Europeans in general permitted slightly wider trailers on their roadways than Americans, and furthermore an 8′-wide container was not wide enough for two of their standard-size pallets to rest side-by-side. Naturally they campaigned for a wider container, but since most countries around the world adhered to a maximum trailer width very close to 8′ the Europeans had to give way on this point, and the ISO set a width of 8′. The multiple ASA standards for length of 10′, 20′, 30′ and 40′ were also accepted by the ISO; in the long run it would be the 40′ and 20′ lengths that came to be widely used, while the 10′ and 30′ options never gained traction and faded away. Height became a point of contention once again, as most shipping lines were ignoring the ASA's 8′ height and using 8′-6″ high containers instead. Generally the 8′-6″ height was workable in

---

[10] Levinson, *The Box*, pp. 127-137; Craig N. Murphy and JoAnne Yates, *The International Organization for Standardization (ISO): Global Governance Through Voluntary Consensus* (London: Routledge, 2009), pp. 56-57.

Europe, though a few railroad bridges were only high enough for the 8′ height. The ISO initially chose to adhere to the 8′ height, making it the standard. But many shipping lines and other container users continued to use 8′-6″ high containers, even as they gradually adopted the other ISO standards for the container. Consequently the ISO in 1969 reversed course and made the 8′-6″ height a standard as well, and it quickly became the dominant height while the 8′ dimension was essentially abandoned. The ISO also approved and made standard two "alternative" types of containers: one that duplicated containers used in some Soviet Bloc nations, and another similar to containers used on certain European railroads. These containers were of a smaller size and not in widespread use, and were eventually made obsolete by the main ISO standard.[11]

Figure 2.2: A typical 40′ ISO global shipping container

Source: Matt Hannes, *The Intermodal Container Web Page* (http://www.matts-place.com/intermodal/part1/images/nc/nyku6572194.jpg, accessed 9/21/09) (Note: There is no connection between this person and the dissertation author, in spite of their similar names.)

The new ISO standards, therefore, replicated the ASA sizes (and also used the corner castings set forth by the ASA, based on a design already in use by Sea-Land). However, the ISO did

[11] Murphy and Yates, *The International Organization for Standardization (ISO)*, pp. 54-62; Levinson, *The Box*, pp. 137-149; G. Van Den Burg, *Containerisation and Other Unit Transport* (rev. ed.) (London: Hutchinson Benham, 1975), pp. 78-84; Eric Rath, *Container Systems* (New York: John Wiley & Sons, 1973), pp. 49-51.

conclude that some improvements in strength were necessary, so the new ISO shipping container was not an exact copy of the ASA version.[12] Nevertheless it followed the ASA container closely, especially in terms of size—and the ASA container had in turn derived precisely from the American trucking system. So a key point should be stressed: the standard global shipping container in use today, numbering in the millions and traveling around the world and into nearly every country, reflects in an exact way the allowable dimensions (at least in terms of length and width) for a trailer on American highways in the early 1960s. It is a subtle yet revealing instance of the global influence of the U.S. in what is sometimes termed the "American Century."

When an invention evolves into the foundational component of an infrastructure it is far more than a technological accomplishment, as it becomes enmeshed in a complex and multifaceted system involving social practices, bureaucratic regimes, and organizational structures. This is especially true for the container—after all, there was no technical innovation involved in creating this generic steel box, and so it was primarily about standardization and cooperation, with all the bureaucratic, social and political factors that implies. While the idea was innovative, containers were used in the 1920s and precursors go back to the nineteenth century, so the concept itself evidently meant little until other necessary factors ripened in the 1950s and '60s. Where most inventions are created laboriously through some sort of scientific or technological breakthrough—often later molded into an inspiring narrative of a solitary inventor struck by inspiration and persisting through hard work—this was not what transpired with the shipping container. There simply was no technology to invent.

This is obviously not the case with many of the systems and devices underpinning globalization, which usually have involved fundamental technological and/or scientific advances. The internet is at present presumably the most obvious example, but of course numerous others can be identified. Such inventions and technologies do not directly bring about globalization in a purely deterministic sense, but they certainly make it possible—if not probable. Some are not so obvious. For example, the giant and fast-moving ships containers travel on have been made possible by the diesel engine, which represented a great advance over previous engine technologies. This enabled a tremendous and unprecedented movement of cargo over the world's oceans—not only by container ships, but also oil tankers and specialized bulk carriers.[13] It was a technological breakthrough, followed by constant improvements, that made all this feasible. With the container the matter is entirely different; the notion of invention, at least in the technological sense that one typically associates with "invention," is hardly relevant. Rather the main issues involve gaining cooperation between transport providers, creating the technical capacity around containers (such as cranes), adjusting the domestic infrastructure to carry

---

[12] Murphy and Yates, *The International Organization for Standardization (ISO)*, p. 58; Levinson, *The Box*, p. 148.
[13] Vaclav Smil, "The Two Prime Movers of Globalization: History and Impact of Diesel Engines and Gas Turbines," *Journal of Global History*, Vol. 2, Iss. 3 (November 2007), pp. 378-383. Also see Vaclav Smil, *Prime Movers of Globalization: The History and Impact of Diesel Engines and Gas Turbines* (Cambridge, MA: MIT Press, 2010).

containers (new railcars, trailer chassis, etc.), and transforming the shipping industry (both ships and ports) to handle containers. Standardization is a central part of these processes.

With the ISO standard finally in place assuring the worldwide uniformity and interchangeability of containers, their worldwide use started to pick up markedly in the late 1960s. It did take some time for the ISO container to become dominant, though, as Sea-Land and Matson, the two largest container users among the shipping companies, continued to use their own closed systems. Meanwhile in Europe it took some time for smaller containers to be phased out. On the other hand, many of the shipping lines and other innovators had already begun using the new standard in the early 1960s, as soon as (or even before) the ASA officially put it in place. Morris Forgash's aforementioned container service for global shipments that began in 1960, for example, used 20′ and 40′ containers compatible with the ASA standards under development at that time.[14]

Governments, global organizations and nonprofit institutions played crucial roles in standardizing the container; their presence was critical in boosting container use on a global level. The container would have achieved worldwide success and uniformity through a far longer, more protracted and painful process had it been left up to the private sector. The point is especially relevant because common narratives of the container's development tend to assign a heroic role to Malcom McLean, giving credit almost entirely to this corporate innovator. This facile interpretation fits a myth of free-market innovation, enshrined comfortably in neoliberal ideology. Many governments and nonprofits were in fact every bit as important as the private sector in establishing the container, and furthermore were equally innovative in its use. For example, Malcom McLean was only able to establish his original container service in 1956 thanks to the foresight of the Port of New York Authority (later the Port Authority of New York and New Jersey), which saw the concept's potential and agreed to construct a special container terminal at Newark. This case is exemplary, for it reveals that the public and private sectors each had a vital role to play, and that rather than being separate or opposed they were often intertwined.

The struggles of engineers and policy-makers to decide on a particular container standard, especially in terms of its size, strength and fittings, were very substantial, and spanned several years, first in the U.S. and then globally through the ISO. The ultimate result reflected conditions and needs from all over the world, but particularly revealed the input of First World nations and most especially the power of the U.S. There was nothing inevitable about the container's final form—it did not reflect an ideal solution, but rather a process of cooperation, compromise and contestation. Clearly it was an adequate solution, but in such a case there is no way to precisely define the perfect, logical solution. (The ISO's decision to create a standard that comprised multiple, modular sizes, i.e., the 10′, 20′, 30′ and 40′ lengths, was an acknowledgment of this, and a wise way to hedge their bets.) But once the standard was in place it acquired a massive

[14] Morrow, "3-Way Piggyback Introduced Here," p. 62.

technological momentum of its own. Nations and transportation providers around the world had no choice but to accept the container's size and other qualities as instituted by the ISO.

The standardization of the shipping container by the ISO was essential to its global success. For containerization to really take off at a worldwide level standardization was necessary, and it is no surprise that large-scale global container movement began in the late 1960s, the same period when the ISO was wrapping up its standardization process. In 1966 several shipping companies began carrying large volumes of containers on the North Atlantic routes between the U.S. and Europe. The first was Moore-McCormack Lines, which in February of that year placed 130 twenty-foot containers on the deck of a ship traveling between the U.S. and Europe, and announced that this would be done on a regular basis. This still does not qualify as a true container ship, however, for even though the containers were stacked on each other they rested only on the deck, and most of the ship's cargo was down below stored in breakbulk fashion.[15]

In the meantime the prominent shipping company United States Lines (generally known as U.S. Lines) was at work secretly converting four of its breakbulk ships into container ships, complete with cells for containers below deck. These ships were able to carry 206 twenty-foot containers, of which roughly half were carried in the cells below the deck and half on the deck, while they could handle some traditional cargo in addition. In March of 1966 one of these ships, the *American Racer*, embarked from New York to Europe, and the other three ships entered service soon after. Though sources are vague (and differ slightly) with regard to how much of their cargo was in containers versus breakbulk in these early voyages, these ships are classified as container ships because they had cells in their holds for carrying containers, and the *American Racer's* initial voyage is generally seen as the start of full-fledged international container shipping.[16] (Two earlier examples of the transnational use of container ships should be noted. First, as already mentioned, a few container ships were involved in coastal shipping between the U.S. and Canada in the 1950s and '60s. Second, the New York-based Grace Line in 1960 began a service to Venezuela using its own 17'-long containers and two container ships, but longshoremen in that nation refused to cooperate, hardly any containers were loaded or unloaded, and the company eventually gave up and sold the ships to Sea-Land.[17])

Sea-Land had also been making preparations, spurred on by Malcom McLean's eagerness. Unlike U.S. Lines, Sea-Land had no tradition of shipping to Europe, but it did have the most extensive experience with containers of any line. Indeed, rumors of Sea-Land's imminent container service between Europe and the U.S. was a factor motivating several other companies to prepare for containerization in the North Atlantic. In April of 1966 Sea-Land's *Fairland*,

---

[15] Arthur Donovan and Joseph Bonney, *The Box That Changed the World: Fifty Years of Container Shipping—An Illustrated History* (East Windsor, NJ: Commonwealth Business Media [The Journal of Commerce], 2006), p. 102.
[16] Brian J. Cudahy, *Box Boats: How Container Ships Changed the World* (New York: Fordham University Press, 2006), pp. 86-87; Donovan and Bonney, *The Box That Changed the World*, p. 102.
[17] Andrew Gibson, Interview by Arthur Donovan, Containerization Oral History Collection 1995-1998, Archives Center, National Museum of American History, April 28, 1998, pp. 38-39; *Marine Engineering/Log,* "Grace Initiates Seatainer Service," Vol. 65, No. 2 (February 1960), pp. 55-61.

converted from a conventional cargo ship into a container ship with a capacity of 226 containers, departed Elizabeth, New Jersey for Europe. This was the first all-container ship to cross the Atlantic, and marked the beginning of Sea-Land operations involving four ships.[18] European shipping companies lagged only slightly behind their American competitors, as a group of European carriers created the Atlantic Container Line (ACL), a joint venture, in 1966. (Such consortiums helped spread out the costs of container shipping, which were substantial—ships had to be converted or new ones built, cranes and other new equipment had to be installed either on ships or at ports, and port terminals needed to be redesigned.) During 1967 a host of other lines joined the fray and container shipping across the Atlantic became well established; in this and the following years it would achieve dramatic gains and make large inroads into the breakbulk business.[19]

Container service between North America and Asia was not far behind. In 1967 Sea-Land began working with the U.S. military to use container ships to bring supplies to the makeshift and badly congested ports of Vietnam; this rapidly grew into a booming business for the company and a valuable advance in logistics techniques for the military. Just a few months later in the same year Matson started the first commercial container ship service to Asia, hauling freight between Japan and the U.S. In 1968 the opportunistic McLean began carrying exports from Japan in containers as well, on ships that had to return across the Pacific from Vietnam anyway. Other shipping lines, both American and Japanese, quickly followed suit and adopted containerization during the late 1960s and early '70s. A bustling container trade between Asia and Europe also developed. Additional ports in Hong Kong, Singapore, the Philippines, Taiwan and South Korea started to receive container shipments, and before long Australia too was part of this Pacific network.[20] The export-oriented economies of East Asia would exploit the container with great effectiveness in the years to come.

Sea-Land and Matson continued for many years to use their own containers (35′ long for Sea-Land, 24′ long for Matson) in their global shipping networks. Hence their systems were closed and incompatible with the ISO container system. But even as those two corporations pursued their own plans—and complained bitterly about standardization—virtually every other shipping line entering into containerization went with the ISO standard in the late 1960s, and most assuredly in the 1970s. Since Sea-Land and Matson enjoyed a head start in containerization, for a period in the late 1960s and early '70s a significant proportion of global container shipping was carried out with nonstandard containers, but nevertheless the overall trend was most definitely for the ISO standards. The existence of these global standards gave shipping lines, ports and policy-makers the confidence to plan, budget and build for a future of container use. (Sea-Land and Matson would eventually change over to the ISO standards as well.)

---

[18] Levinson, *The Box*, pp. 164-165; Donovan and Bonney, *The Box That Changed the World*, p. 102; Cudahy, *Box Boats*, p. 87.

[19] Donovan and Bonney, *The Box That Changed the World*, pp. 102-105; Levinson, *The Box*, pp. 166-167.

[20] Levinson, *The Box*, pp. 180-181, 187-188; Donovan and Bonney, *The Box That Changed the World*, pp. 127-133.

Figure 2.3: A contemporary container ship in port

Source: Arthur Donovan and Joseph Bonney, *The Box That Changed the World: Fifty Years of Container Shipping—An Illustrated History* (East Windsor, NJ: Commonwealth Business Media [The Journal of Commerce], 2006), p. 161

Once containerization was solidly established, and growing rapidly, the next step was to tie the disparate transport modes more tightly together, in particular bringing land-based domestic journeys more closely into the overall scheme of container movement. The other logical step was to exploit advances in information technology to better track, coordinate and control containers throughout their global trajectories. During the late 1970s and '80s the American shipping line American President Lines (APL) became a leader by addressing both issues. APL was not one of the original innovators in containerization but the company quickly made up for lost time, especially after W. Bruce Seaton became its president in 1977. Seaton and his fellow executives and technocrats realized the container had begun to make distinctions among modes of transportation, and between national territories, less relevant, as this object moved across all transport modes and into all nations. APL worked hard, and quite successfully, to gain greater control over its containers as they moved domestically within national territories, and to set up a systems of information-driven logistics that truly functioned effectively at the global scale. Regulatory shifts also made this approach possible, as it became allowable for a shipping company to issue one single bill of lading that covered an entire container voyage, rather than just the waterborne segment.[21] The high level of coordination that APL instituted was revolutionary, and presaged today's tightly controlled supply chains. But APL's heightened involvement in land-based transport modes rarely extended to direct ownership or formal control, and in general this has remained the case in the decades since; actors in the various infrastructures focus on their core expertise, and work within the geographic scale they are embedded in, even while cooperating extensively and sharing information with each other.

Since the 1980s use of the shipping container has seen extraordinary growth that has been nearly constant aside from a few brief periods of stagnation during recessions. This is due to two factors. The first is the rapid and continuous growth in global trade, which obviously works to the benefit of the container. The second is the container's progressively larger share of oceangoing cargo movement, as breakbulk has nearly disappeared on major routes. Nearly all normal freight goods moving by ship now travel in containers; only bulk freight such as oil, liquefied natural gas, coal, ore, cement, gravel, certain minerals, grain and some other food products move in ships designed specifically for them. (It should be noted these bulk goods constitute a very substantial portion of ocean shipping, both in terms of volume and value. Automobiles imported to be sold are also generally carried on ships specially designed for that purpose.) Advances in information technology have augmented the capacity to coordinate and optimize container movements. Ships have become progressively larger, reaching massive sizes, so that a typical container ship today holds several thousand containers. Ports likewise have grown greatly in size and complexity, and are increasingly located in exurban areas so they can sprawl over vast expanses of land. Just-in-Time manufacturing techniques, depending on the perfectly timed movement of parts and supplies, are applied at a global scale, and major retailers now run their worldwide movement of goods with equal precision. The shipping container is a key object in the complex, precise and fast-paced supply chains that encompass the globe, as it helps make swift and reliable transnational transportation, over numerous infrastructures, a reality.

In addition to their dominant position in shipping over the ocean, containers have reached ever more deeply into domestic territories, moving along national infrastructures and exerting an impact upon them. Consequently containerization extends the reach of globalization deep and pervasively throughout national space. This topic, in the American context, is of course the subject of this dissertation. The container's impact on these land-based domestic transport networks should not be seen as secondary to, or merely deriving from, its role in ocean shipping, for the container is fundamentally designed to function in these multiple infrastructures—it is not an object intended for shipping that by happy chance also can be carried on land. Indeed, it is arguably most fundamentally linked to the truck, not only because its dimensions come out of trucking (as has been detailed) but also because most container journeys begin and end on a truck (that is to say, the origin and destination are served by truck).

[21] See Bruce Seaton, Interviews by Arthur Donovan and Andrew Gibson, June 19, 1997 and July 25, 1997, Containerization Oral History Collection 1995-1998, Archives Center, National Museum of American History, Washington, D.C.

The most powerful and pervasive global infrastructures do not merely link nations together but also penetrate far inside them so that a multitude of places gain a connection to the global. The global becomes embedded at the local, regional and national scale. I argue the shipping container is a remarkably pertinent example. The container is successful by riding upon the existing domestic infrastructures of trucking and railroads (and to some degree barge shipping on inland waterways) in addition to ocean shipping. The most basic and fundamental qualities of these national infrastructures generally need not be altered to accommodate the container. But other aspects of the domestic transport systems must be modified or augmented. In the case of the railroad, for instance, the track gauge and a host of other dimensions can remain the same—what must be developed is a railcar to carry the container. Normal flatcars can be used in the beginning if nothing else is available, but to carry containers in large quantities a railcar designed for that purpose is necessary. Such a railcar, customized for the container, can be regarded as an interface between the global infrastructure of containerization and the national infrastructure of the American rail network. The concept of an interface can be metaphorical, but this railcar also interfaces between the two systems in a very literal and physical fashion; it has connections and fittings, as well as the appropriate spatial size, to carry the container upon it, and meanwhile it has wheels and other equipment (such as inter-car connections) that fit with the national rail infrastructure. It works spatially with both the national railroad system and the global container system.

The container represents a transportation network that is global rather than national (or regional, such as NAFTA or the European Union) in scale. This seemingly simple object's ability to move in so many parts of the world is an extraordinary achievement. But, as already emphasized, the container achieves this success by working within the transport systems of nearly all nation-states. The container's simple stripped-down quality—just a steel box, with no wheels, special details or unusual attachments—makes it amenable to being carried or handled by many different types of equipment. The result is an emerging global unity that depends on existing infrastructures which can remain in all their variety. This is eminently sensible, for to create a brand-new unified transportation system at a global scale (leaving aside the issue of the oceans that separate nations), whether through building new infrastructure or altering existing infrastructure, would be patently impossible. The challenge would be not only in the physical nature of the infrastructure itself—such as harmonizing the track gauges or making all highway lanes the same width—but also the equipment that runs upon the infrastructure, and the practices, regulations and traditions that go along with it. The container provides a better and far more feasible alternative, as a way to achieve globalization that functions through the preexisting national infrastructures and modes of transportation. As will be discussed in chapter 3, one way to understand this duality of containerization, a system in its own right that works entirely through other infrastructures, is to see it as a "second-order" system or "internetwork."

While the container's original dimensions come out of U.S. infrastructure, the acceptance by the ISO of those dimensions would seem to indicate they were amenable to engineers and policy-makers representing many nations. But given the sheer number of nations involved, it was inevitable the container's size would conflict with standards in a few places. The issue arose most commonly with trucking, as a few countries did not permit 8′-wide loads on any of their roads, even the highways. Switzerland and Paraguay were two examples.[22] These nation-states were forced to give in (Switzerland did, and though information is lacking it is probable Paraguay did also) and alter their spatial constraints, at least on certain major roads. The difference was only a matter of an inch or two, so the change was primarily bureaucratic and regulatory—the roads did not need to be rebuilt. Modernizing export-oriented countries, such as those in East Asia, have built new infrastructure since the 1980s (if not earlier) with at least some awareness of the container and its dimensions. American infrastructure by contrast was obviously perfectly suited for the container, given that the container was developed with it in mind. Yet over time an ironic turnabout has taken place: the U.S. trucking and road system has become less ideal for the container, while the railroad system has been heavily modified to better accommodate it. The allowable dimensions for American trucks have expanded so greatly since the introduction of the container that today a truck hauling a standard global 40′ container is relatively inefficient. Meanwhile the double-stacking of containers on trains means that the vertical clearances of many U.S. rail lines have had to be raised, at great expense and effort. Subsequent chapters of the dissertation will describe and analyze these processes in detail.

This new global infrastructure, the network of container movement, utilizes the existing transport pathways of the nation-state, which are embedded in the national scale and possess their own character that relates to the history and geography of the U.S. Their meaning is altered slightly as containerization ties them more directly into a worldwide network, especially when the desire to accommodate the container leads to particular changes. A previously little-used railroad line may find itself of heightened importance due to container traffic, leading to extensive modifications such as the addition of a second track and improved signaling. A highway may be extended many additional miles so as to provide a link to a port city previously not seen as meriting such a connection. Specific nodes and bottlenecks along these routes are also important, especially when congestion, caused largely by container traffic, creates the need for them to be improved or reconstructed. The dissertation will explore numerous examples of such routes and nodes. This geographical scenario reveals that for the most part the container succeeds by using preexisting systems. Yet the way in which it does so is revealing, and the modifications that are made to those systems are of importance. It could be a trailer chassis that holds a container just a few inches lower than otherwise, allowing it to fit within vertical highway clearances—or it could be extensive work along a railroad line hundreds of miles long, to bring it to a higher standard for more efficient container movement. Either way, the American infrastructure is adjusted to better suit the container.

By its very workings, and in its historical development, the shipping container reveals something of the nature of globalization. The place of the nation-state in this ongoing process is

---

[22] Rath, *Container Systems*, p. 266; Tineke M. Egyedi, "The Standardized Container: Gateway Technologies in the System of Cargo Transportation," Paper for the Helsinki Workshop on Standardisation and Transportation, Helsinki, August 23-24, 1996, p. 12.

significant, as should already be evident. The new global network of containerization is not imposed fresh upon a slate wiped clean to receive the brave new world of globalization. Instead the container system is strung together out of national infrastructures, along with ocean-going shipping, to form a whole that is composed of disparate and place-specific components. This is somewhat different from the historical process of nation-building in which so many of our basic and most important infrastructures were forged. No matter how incremental the creation of a national infrastructure may have been, the final result was typically a unified system. Such unity at present being nearly impossible to achieve globally, the container network relies on a worldwide assemblage of these national systems, in tandem with ocean shipping, to create a system that in spite of its patchwork nature is surprisingly cohesive. Chapter 4 will deal with this topic, investigating the differing types of infrastructure at the national and global scales.

Containerization creates an unusual network, an infrastructure (if we can call it such) that, as already discussed, depends on other basic infrastructures in order to function. As the trucking, railroad and shipping systems are what actually move containers, the container network works by linking together these three modes of transportation, along with facilities and sites for the transfer of containers between the modes, into an overarching whole that possesses a certain degree of unity. This is a remarkable system that uses a rigidly standardized object, the shipping container itself, as the heart of a worldwide network of great flexibility. The result would seem to represent an unusual type of infrastructure, in terms of how it links together other more "basic" infrastructures, and also the way the container is the entity that carries out this linkage by fitting into these infrastructures. The container's ability to do so of course depends on its particular dimensions and other spatial and physical characteristics—containerization is a deeply material infrastructure. So the concept of containerization as an infrastructure is one that bears further examination, in light of what scholars have written about infrastructures, networks and technical systems. This is the subject of the next chapter.

Chapter 3 ~ Containerization as an Infrastructure

The network of shipping container movement constitutes, or at least can be understood as, an infrastructure. Containerization though does not fit easily into conventional notions of what we regard as infrastructure. Rather, as should be evident from the previous chapter, the shipping container succeeds by binding several infrastructural systems together—those of shipping (including both over the ocean and on inland waterways), trucking, and railroads. These infrastructures are in fact independent of each other, and the container certainly does not alter that. But containerization does form a new network—in a sense, an infrastructure—that is supported by those three modes of transportation, along with the facilities for container transfer between them. Since the container itself is a spatial and physical unit, along with the freight within it, that goes in a nearly seamless manner from origin to destination across multiple infrastructures and through various nations, its network of movement represents an infrastructural system in its own right. But if containerization's ability to create a cohesive, unified and global network out of three distinct modes of freight transportation makes it an infrastructure, it is an unusual one. This chapter considers what sort of infrastructure containerization really is, and what the scholarship on infrastructures and technical systems, within the field of science, technology and society (STS), can tell us about the container network.

A scholar who laid key foundations for the study of infrastructure, not merely as a technological phenomenon but with consideration of its social and political ramifications, was Thomas Hughes. Hughes did not merely seek to incorporate such factors, but to establish a comprehension of infrastructure in which the technological and the socio-political were integral. As he possessed the scholarly *bona fides* of a historian but also a high level of technological knowledge, Hughes was well positioned for this endeavor. (While Hughes rarely uses the word "infrastructure" as a conceptual category in his writings, generally preferring to speak of "systems" or "technological systems," clearly these terms are, in a general sense, synonymous with infrastructure.) The concept of the "large technical system," often known as an LTS, is associated with Hughes. He wrote most extensively about one such a system in his first and most influential book, the groundbreaking *Networks of Power*, published in 1983, which covered the historical development of electrical infrastructures in the late nineteenth and early twentieth centuries.[1] (Hughes actually did not use the term "large technical system" in this book. He began referring to the "large technological system" in the late 1980s, and it would seem he and other

[1] Thomas P. Hughes, *Networks of Power: Electrification in Western Society, 1880-1930* (Baltimore: The Johns Hopkins University Press, 1983).

scholars then swiftly switched to the "large technical system."[2]) In *Networks of Power* Hughes proposes a five-phase model, which will be outlined here, of how an LTS evolves from its invention into a full-fledged infrastructure.[3] While Hughes does not seem particularly insistent on this model in an exacting or detailed fashion—his description of it only occupies four pages in a lengthy book of 474 pages—it is nonetheless useful and has been followed and referenced by many others. (In a later article he would complicate matters by adjusting the model, adding, altering and/or subtracting some phases.[4] Other scholars have also tinkered with the model, and with the particular phases, while following its general gist.[5])

Hughes' first phase[6] is *invention and development*. Here an inventor comes up with a technological breakthrough, which then becomes the basis for the development of a full-blown system, overcoming many obstacles along the way. In some cases the inventor is able to maintain control of the technology and carry out implementation of the system, with the support of others like managers, engineers and financiers. A classic example, which Hughes explores in detail, is Thomas Edison, who was not merely an inventor but an avid system-builder. In other situations the invention is taken up by others more talented (or more motivated, or with superior access to funding) in system-building. At the end of this phase the system is still a very long way from being universal (i.e., from being an infrastructure), for it is particular to a specific location, group of users, purpose or setting. But its promise is evident, for it has been shown to work in a particular context. This first phase is the most glamorous stage of infrastructural development, marked as it is by exciting and groundbreaking technological breakthroughs that often stem from fundamental scientific advances. It is also generally characterized by arduous efforts at implementation to get the initial system off the ground and running, often in the teeth of fierce resistance and heavy obstacles. In popular histories and media accounts this first phase usually receives the bulk of the attention, and subsequent phases are likely to be ignored, or seen as inevitable and hence mundane. Those who seriously study infrastructure know better.

The second phase is *technology transfer*, wherein the system is put into place more widely. Having achieved success in its original setting, the technology of the system is now adopted and used by others, who may modify it slightly or even significantly for their own purposes. Each context will have its own preferences and needs, and this becomes especially evident when the

---

[2] It appears Hughes first wrote of "large technological systems" in: Thomas P. Hughes, "The Evolution of Large Technological Systems," in Wiebe E. Bijker, Thomas P. Hughes, and Trevor J. Pinch (eds.), *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology* (Cambridge, MA: MIT Press, 1987), pp. 51-82. Usage of the term "large technical system" seems to have effectively commenced with Renate Mayntz and Thomas P. Hughes (eds.), *The Development of Large Technical Systems* (Boulder, CO: Westview Press, 1988).

[3] Hughes, *Networks of Power*, pp. 14-17.

[4] Hughes, "The Evolution of Large Technological Systems," pp. 51-82.

[5] Paul N. Edwards, Steven J. Jackson, Geoffrey C. Bowker, and Cory P. Knobel, *Understanding Infrastructure: Dynamics, Tensions, and Design,* Report of a Workshop on "History & Theory of Infrastructure: Lessons for New Scientific Cyberinfrastructures," January 2007, pp. 8-11.

[6] These five phases are presented in Hughes, *Networks of Power,* pp. 14-17. In other writings Hughes modified the phases slightly, as did other scholars.

system moves outside its country of origin. In his original formulation Hughes assumes technology transfer happens geographically: a system might first be established in New York, and then re-created in Chicago, London, Paris, etc. (One may think of regions or nations rather than cities, but the geographic concept is the same.) For information-based systems though this dynamic could be non-geographic in nature—and that is especially the case in recent decades with computer networks, where the original setting is typically not geographic, but rather consists of a particular group of users or assemblage of institutions. In the phase of technology transfer, the new systems are likely to be separate from each other and from the original system. In this phase businesspeople, financiers, governments and corporations begin to take a substantial role in the systems, but the main emphasis is still on developing and implementing the technology.

Hughes' third phase is *system growth*. This blurs somewhat with the second phase of technology transfer, in that it is a period of multiple systems expanding, getting larger and acquiring more users. These numerous systems are more likely to become interconnected, or at least to share various practices and standards—though they may also be growing increasingly apart in some ways, and becoming more fixed as they grow more established. It is also a stage in which particularly troublesome technical problems are resolved; Hughes refers to these as reverse salients, and focuses on them because often they are key obstacles holding back systems otherwise ready to grow rapidly. Consequently a reverse salient attracts attention from engineers, scientists and technicians, until either it is successfully resolved or an alternate approach that bypasses the problem entirely is found. Aside from such reverse salients, in the phase of system growth technological issues become less important, and larger social, political and economic realities loom large. The importance of non-technological actors—businesspeople, financiers, governments, regulators and corporations—steadily grows. The engagement of users is also critical, as they become a critical variable and may engage with the system in unexpected ways.

The fourth phase is *momentum*. With technological challenges resolved and the practicality, usefulness, profitability and/or desirability of the system established, use at the widest scale ensues. Rapid growth arrives, as what was originally an experiment, then a luxury, is now perceived as a necessity, something to be put in place universally. The impetus feeds on itself and becomes unstoppable; the system is transformed into an infrastructure, with all that entails. The system by now is firmly established in both its technological and organizational aspects, and these factors propel it forward to gain more users and greater geographical span. As important as previous phases are, the phase of momentum is actually (in most cases) the period in which the majority of the system's users come on board. Technical obstacles are now no longer a barrier, though the character of the technology will always remain important. Consequently innovation—or at any rate, technological innovation—is no longer part of the story; businesspeople, governments and institutions take center stage, as do users. Politics and economics, along with social and cultural factors, are preeminent. Within the system itself, control now usually lies with managers rather than inventors or engineers.

Hughes is imprecise in terms of what to call his fifth phase, and in fact in later writings he left it out—as have other scholars. His description is also rather vague, and very brief (just one paragraph in *Networks of Power*[7]), but it seems to be a period when the system, now an infrastructure that is well established and universal, inevitably fluctuates within larger political, social and economic forces. No longer new or exciting in any way, the system is taken for granted in everyday life and what it provides is simply a mundane commodity. Whatever challenges (which again could be seen as reverse salients, according to Hughes) that arise are likely to be financial, bureaucratic and/or political, rather than technological. The system's large scale and universality becomes a factor in its own right, both as an advantage and drawback.

An additional phase has been added by scholars other than Hughes: postmodern splintering and decentralization.[8] In this stage the ideal of infrastructural unity and universality, which went hand-in-hand with modernity, is abandoned and the system is fractured into disparate subsystems of varying quality and price. Those who can pay get the best service, while those who cannot get little or nothing; it is an ominous neoliberal vision of people as consumers, not citizens, and of fragmentation as opposed to even the aspiration to unity. This phase is also characterized by a tendency toward decentralization and even self-organizing systems, fueled both by a more individualistic era and the new capabilities unleashed by digital communication technologies. The shift to decentralization can be a positive force, especially inasmuch as it allows for greater user involvement and innovation, but it also can mask the dismantling of infrastructural systems that previously served an entire citizenry. (It also must be kept in mind that in spite of the widespread current rhetoric about the virtue and inevitability of decentralized and bottom-up systems, many infrastructures are still tightly-organized and largely top-down—and must remain so in order to function properly.)

Perhaps one last phase is worth noting, though Hughes does not broach it in his original model: obsolescence and abandonment. Infrastructural systems often linger surprisingly long past their prime, but at a certain point a system is liable to be surpassed by new and better ways, and in particular by superior technologies. (Even when an infrastructure has been superseded, however, it may persist to a surprising extent in some cases, coexisting with its replacement. On occasion such an infrastructure, having lost its original function, morphs into something else. Passenger transportation by ship over the ocean gradually disappeared once air travel emerged, but the business of running cruise ships for vacationing subsequently developed. The once mighty telegraph company Western Union now survives as a money transfer operation.[9]) While in the most general sense some infrastructures are enduring, such as the network of roads and streets on which we travel, a particular infrastructural system built on specific technological capabilities is bound to fade someday. The system of animal-powered overland transport was superseded by the railroad and automobile, the telegraph was made outmoded by the telephone and fax, and so on. It is hard to conceive how some of our current systems will become obsolete,

[7] Hughes, *Networks of Power*, p. 17.
[8] Edwards, Jackson, Bowker, and Knobel, *Understanding Infrastructure*, p. 11.
[9] Paul Edwards pointed out the example of Western Union to me, in a comment in April 2013.

or what will replace them, but no doubt the railroad and automobile were equally hard to imagine in the eighteenth century. Such infrastructural abandonments are not necessarily only technological in nature, as political and social forces may also be factors.

Hughes' focus on the entire process of system-building helps him avoid devoting excessive attention to the moment of invention, the technological breakthrough that, although undeniably of vast importance, can be a distraction in the study of infrastructure. For Hughes it is the development of the system that matters most. Such a perspective is especially suited to containerization, for in the case of the container there was practically nothing—in the purely technological sense anyway—to invent. (There was also no clear-cut moment of invention, but rather a gradual evolution; it is almost impossible to identify the first shipping container.) Instead the breakthrough was in building and operating a containerized system of freight transportation. This is where the early innovators of containerization excelled, especially the entrepreneurial and driven Malcom McLean (often incorrectly called the inventor of the container). But as a corporate leader there was only so much McLean, or his counterparts at Matson and other container innovators, could do. After all he only had direct control of one company, Sea-Land. The larger process of worldwide infrastructure building had to be carried out collectively by governments, institutions and corporations, with the ISO's role probably the most crucial of all.

In addition to his five-phase model, Hughes emphasizes a few concepts in particular as integral to system-building. One is the reverse salient, which as already noted is an obstacle or problem that holds up progress in the development of an LTS. Hughes primarily thought of reverse salients as technological in nature, though he saw the concept as possibly encompassing other factors too. Because a reverse salient represents a significant obstacle to a system reaching a key level of functionality or completeness, extraordinary effort is often expended to solve it.[10] In the development of the shipping container network it would seem the most important reverse salient was the lack of a global standard for the container, and once that was overcome in the 1960s, thanks to the ISO, international container use could proceed unchecked and dramatic growth followed. This particular reverse salient was organizational rather than technological, but that is entirely fitting for the container which is not a technical innovation anyway. (There is another way to think of the reverse salient in terms of containerization, however. Perhaps the container itself was the solution to a reverse salient in the evolving postwar global network of freight transportation. By this logic, the growth of worldwide trade was running up against the bottleneck of breakbulk shipping methods, which represented a reverse salient that was solved by containerization.)

Another vital concept for Hughes, in his vision of system-building, is technological style. In essence he argues, in *Networks of Power,* that the way electrical systems were implemented in the United States, Britain and Germany reflected social, political and economic factors particular to those nations, as well as their histories and traditions. Hence the technology itself does not lead to

---

[10] Hughes, *Networks of Power*, pp. 14-15, 79-81; Hughes, "The Evolution of Large Technological Systems," pp. 73-76.

one inevitable, preferable solution, but rather the resulting infrastructures are socio-technical constructs. Hughes uses the term "technological style" to describe this process. By introducing the issue of style, traditionally applied to the arts, Hughes vividly (provocatively, perhaps) opens up the way one can comprehend an infrastructure. In opposition to reductionist ideas of technological progress, he sees a technological system or infrastructure as evolving in many possible ways, limited only by outright technological, scientific or material constraints.[11]

Hughes' attention to this issue of technological style is followed throughout *Networks of Power,* though he rarely explicitly refers to the concept. Perhaps more than anything else, it was this perspective that made the book so noteworthy on its appearance in the 1980s. By putting a focus on how technology is affected by social, cultural and political factors, Hughes points towards a view of technological history in which there is no inevitable way to implement technological solutions, where technology itself does not inherently possess or embody any ideal solution. He argues instead that how a corporation, society or government brings technology to bear will reflect many non-technical factors. (But Hughes does not take an extreme social constructivist stance, wherein technology is merely a tool to other ends; his understanding of technical and scientific details is impressive, and he gives the nature of the technology a central place in his narratives.) This position was not entirely new in the larger discipline of science, technology and society (STS), but it was valuable in opening the door to more thoughtful research on infrastructural systems. A whole field of scholarship revolving around large technical systems (LTSs) has emerged in the years since *Networks of Power.*

As this dissertation emphasizes, the shipping container gains its ubiquity largely because it can fit so well into the existing national transportation systems of trucking, railroads and inland waterways. The container typically moves along preexisting routes of movement, so while the infrastructure of containerization is new it depends on older domestic networks that possess their own qualities. These qualities reflect the history and character of their particular nation-state. Hence the notion of technological style, in the context of the national (just as Hughes used it, though presumably the idea could be used in other ways too), is quite appropriate for the container, which depends so heavily on these national infrastructures. This dissertation only focuses on the way the container has been used in one nation, the United States (with some coverage of Canada too), so it is not possible to do a comparative study of different countries. Rather, the dissertation intensively investigates how containerization in the U.S. has transpired in a fashion deeply affected by the American transport infrastructures of trucking, railroads, and inland waterways. While the container itself is universally standardized and obviously does not change in different contexts, the way containerization is carried out varies significantly from nation to nation. The process in the U.S. has followed a path that is distinctively American. This is due to the decisions American transportation providers and institutional bureaucrats have made,

---

[11] Hughes, *Networks of Power*, pp. 405-407; Hughes, "The Evolution of Large Technological Systems," pp. 68-70.

the preexisting characteristics of the domestic transport network, and the geographic qualities of the country.

Another important concept for Hughes is that of technological momentum, the process by which a system, or certain aspects of it, becomes locked in over time. This is somewhat comparable to the notion of path-dependency; in the beginning multiple options are available, but eventually one design, standard or technological method wins out. (Particularly famous are cases where the inferior competitor triumphs, as with VHS versus Betamax videocassettes, or the QWERTY versus Dvorak keyboard layout.) Hughes pursues a nuanced approach, rejecting technological determinism on the one hand and social constructivism on the other, as he takes into account the character of the technology itself while also examining social, political and economic factors and the particular historical process. He argues that society and politics may play a key role in the beginning, but once a particular technology acquires momentum then its system becomes an actor in its own right, and it gets harder to pursue alternatives.[12] This paradigm applies well to containerization—the initial design of the container was contingent on many factors of the time, but once established by the ISO it foreclosed other options and exerted great force in its own right.

In his original formulation of LTS development Hughes studied and described systems under the control of a particular individual or corporation. Later scholars extended his ideas to look at LTSs where power is coordinated and distributed among multiple participants—some corporate, some institutional or governmental.[13] Hughes himself also investigated such situations later in his scholarly career, primarily by focusing on systems built in the postwar era, and likewise stressed the collective nature of system-building for particularly complex and multifaceted projects.[14] (His use of the term "system" broadened in these later writings, to encompass situations that did not necessarily involve an infrastructure, but any sort of collective, well-organized and specific technological effort.) This way of viewing an LTS is better aligned with the container's history; in the development of containerization numerous participants and transportation providers across many nations occupied key roles. The largely anonymous engineers and policymakers participating in the ISO's deliberations were arguably the most important of all. (Yet their decisions were not entirely definitive, for widespread practices could counter them, as with the ultimate triumph of the 8'-6" dimension for container height despite the ISO's initial endorsement of 8'.) In containerization, system building has been a truly collective process.

---

[12] Thomas P. Hughes, "Technological Momentum," in: Merritt Roe Smith and Leo Marx (eds.)., *Does Technology Drive History? The Dilemma of Technological Determinism* (Cambridge, MA: MIT Press, 1994), pp. 101-114; Hughes, *Networks of Power*, pp. 15-17, 140-174.

[13] Erik Van Der Vleuten, "Understanding Network Societies: Two Decades of Large Technical System Studies," in: Erik Van Der Vleuten and Arne Kaijser (eds.), *Networking Europe: Transnational Infrastructures and the Shaping of Europe, 1850-2000* (Sagamore Beach, MA: Science History Publications/USA [Watson Publishing International], 2006), p. 305.

[14] See Thomas P. Hughes, *Rescuing Prometheus* (New York: Pantheon Books, 1998).

Indeed, many of the key figures in containerization are those who shepherded new standards and practices into fruition. Writing about a somewhat similar process in the realm of computer systems, Paul Edwards points out that such people or institutions can be termed "protocol builders," in contrast with Hughes' "system builders." Edwards adds: "Unlike the system builders, very few of the network builders nor the protocol builders have become well-known public figures, perhaps precisely because protocols are infrastructural, lying beneath the horizon of salient uses."[15] Protocols lack the glamour of new technological advances, hence they gain less recognition, and in addition crafting protocols is usually a collaborative process and so it is harder to identify a specific innovator. The container itself can be regarded as a protocol in the worldwide system of freight transportation. In the context of this dissertation and the specific topic of containerization, though, it is the container's dimensions, fittings, tolerances and other characteristics that constitute protocols.

Scholars following Hughes' lead have more deeply scrutinized the various types of infrastructure. Hughes uses the word "system" (or the phrase "large technical system") to identify an infrastructure, no matter how big or small, particular or universal it may be, but other writers choose to distinguish between a system and a network. A network, in their schema, was once a system or series of systems but has been enlarged beyond the bounds of any single system-builder into an infrastructure. Often the network evolves out of multiple systems that were formerly separate but gradually grew linked together. Such a network is subject to impacts from multiple causes and is not entirely under the control of one person or institution; as an infrastructure it becomes embedded in social, political and economic contexts. This inevitably pulls it away from the sort of centralized control or organization (though there may still be some measure of both) that a system is liable to have. As Paul Edwards remarks, "although infrastructures can be coordinated or regulated to some degree, it is difficult or impossible to design or manage them, in the sense of imposing (from above) a single vision, practice, or plan."[16]

A network, by this definition, is comparable to the later stages of the development of a system or LTS in Hughes' terminology; what Hughes calls the momentum phase would probably be the period in which several systems merge or become interconnected to form a larger, universal network. This distinction between a system and network was made by Paul David and Julie Ann Bunn in a 1988 article about the evolution of electric infrastructure—though they do not make the difference entirely explicit and their usage of the terms blurs on occasion.[17] (In the same article David and Bunn introduce the concept of the "gateway," an entity or device that mediates between or connects previously separate systems, allowing them to work together and hence to form a larger infrastructure. This idea is also highly relevant to the container and has been further

[15] Paul N. Edwards, "Y2K: Millennial Reflections on Computers as Infrastructure," *History and Technology*, Vol. 15, Iss. 1-2 (1998), pp. 12-13. (These page numbers for pdf version at http://pne.people.si.umich.edu/articles.html)

[16] Paul N. Edwards, *A Vast Machine: Computer Models, Climate Data, and the Politics of Global Warming* (Cambridge, MA: MIT Press, 2010), p. 12.

[17] Paul A. David and Julie Ann Bunn, "The Economics of Gateway Technologies and Network Evolution: Lessons from Electricity Supply History," *Information Economics and Policy*, Vol. 3, Iss. 2 (1988), pp. 170, 172.

developed by other scholars; it will be discussed in detail later in this chapter.) In the late 1990s Paul Edwards, a scholar focused on information and computer technology, extended David and Bunn's work in his article "Y2K: Millennial Reflections on Computers as Infrastructure" by more clearly defining the difference between a system and a network, and also introducing the additional category of an internetwork or web.[18]

Edwards is particularly focused on the internet and other computer-based communication technologies, but he seeks to bring these into a larger conceptual scheme encompassing all types of infrastructure. His division between a system and network is more specific than that of David and Bunn, and he stresses that the central control and system builders that characterize a system must give way in a network or internetwork to more distributed control, with a larger number of participants exerting sway in different ways and a far broader group of users. A network, not a system, can possess the universality that an infrastructure must have. An internetwork forms when the process is taken to the next level and a series of networks (or as Edwards puts it, a "network of networks"), though distinct in their actual technological functioning, become interlinked and work together to accomplish certain tasks.[19] This may or may not be regarded as an infrastructure. Identifying an internetwork is slightly more subjective than a system or network, but still fairly commonsensical; Edwards introduces and expands on the idea that the internet is an internetwork. He also notes that containerization can be viewed as binding the three separate infrastructures of shipping, trucking and railroads into an internetwork.[20] Another scholar using this division of system, network and internetwork is Greg Downey, whose 2001 article "Virtual Webs, Physical Technologies, and Hidden Workers: The Spaces of Labor in Information Internetworks" likewise is oriented to information infrastructures, but with an added interest in their physical manifestations and associated labor practices.[21]

In an internetwork very different infrastructures, consisting of fundamentally different types of technology, are connected. In the case of the shipping container, for instance, the truck, train and ship networks obviously remain, by their very nature, separate and distinct. This is quite different from the situation with a system and a network, where the presumption is that a network ties together multiple systems of the same basic type. For example, various system-builders could create a plethora of railroad systems, each using a different track gauge—as was the case in the U.S. into the late 1800s. The rail infrastructure that results is a fragmented collection of systems, lacking unity or cohesion at the larger scale. But once the track gauge is standardized at the national level (as eventually happened in the U.S. and most countries) then a true network results, and it is clearly one unified infrastructure, not a collection of systems or infrastructures that are merely interconnected. With an internetwork however the constitutive

---

[18] Edwards, "Y2K," pp. 7-29. (These page numbers for pdf version at http://pne.people.si.umich.edu/articles.html)
[19] Ibid., pp. 11-14.
[20] Ibid., p. 13.
[21] Greg Downey, "Virtual Webs, Physical Technologies, and Hidden Workers: The Spaces of Labor in Information Internetworks," *Technology and Culture,* Vol. 42, No. 2 (April 2001), pp. 209-235.

parts, the networks, retain their identities and roles as distinct (and perhaps very different) infrastructures. They may in fact serve numerous other purposes, apart from the particular internetwork that is our focus. This is assuredly the case in the container internetwork, since moving containers is only one of the tasks the trucking, railroad and shipping networks perform.

It should be noted that the terminology put forward in the preceding discussion is generally not followed in this dissertation, in which the terms "system" and "network" are used more or less interchangeably, and "internetwork" is hardly used at all. That is to say, a more normal usage of the words is followed in the dissertation. But the essential insight—that containerization works by connecting distinct infrastructures—runs throughout the dissertation and is vital to its arguments. So while the dissertation does not adhere to the system-network-internetwork terminology (which would be burdensome and awkward to maintain in such a long text), the paradigm is an important one to comprehend.

Another key concept relating to the network of container movement is the "second-order system." Such a system is one that functions by utilizing several more basic systems, termed "first-order systems" in this paradigm, which work together in a collective and highly organized manner for a specific purpose. Obviously this idea is somewhat similar to the internetwork, though it is applied in a slightly broader manner. The second-order system (which may also be thought of as a "second-order infrastructure" or "second-order network," as the terminology of the "system" is not crucial here) may be a traditional infrastructure. But usually the concept is used more broadly for an organized system, one not typically regarded as an infrastructure in its own right but which exploits multiple infrastructures or other networks (i.e., first-order systems) to achieve a particular end. Bureaucratic organizations, or other institutional or social entities, are generally integral to the way a second-order system works, for it is a construct rooted in both technology and people. Hence the concept of the second-order system is especially valuable because it brings in so many factors; drawing on this expansive framework helps one see the system as socio-technical in nature.

The idea of the second-order system apparently originated with Ingo Braun, a German sociologist, and was introduced by him in 1994.[22] Braun utilizes it to elucidate the European network of organ transplants, by necessity very tightly organized, that began to take shape in the late 1960s and has greatly developed since. But he also describes the concept of the second-order system broadly, as being possibly applicable to many cases and situations.[23] It seems the first to

---

[22] Erik Van Der Vleuten credits Braun with inventing the concept, in Erik Van Der Vleuten, "Infrastructures and Societal Change: A View from the Large Technical Systems Field," *Technology Analysis & Strategic Management*, Vol. 16, No. 3 (September 2004), pp. 404-405. He cites Ingo Braun, "Geflügelte Saurier: Zur Intersystemische Vernetzung Grosser Technische Netze," in: Ingo Braun and Bernward Joerges (eds.), *Technik Ohne Grenzen* (Frankfurt: Suhrkamp, 1994), pp. 446-500. An article by Braun and Joerges in English from the same year, also introducing the second-order system, is Ingo Braun and Bernward Joerges, "How to Recombine Large Technical Systems: The Case of European Organ Transplantation," in: Jane Summerton (ed.), *Changing Large Technical Systems* (Boulder, CO: Westview Press, 1994), pp. 25-51. The German article was apparently written first, since it is cited in the English article.

[23] Braun and Joerges, "How to Recombine Large Technical Systems," pp. 25-51.

point out that containerization constitutes a second-order system was Joachim Radkau, another German scholar writing at the same time.[24] Fortunately some accounts of the second-order paradigm have appeared in English (in particular an article by Braun and Bernward Joerges, and a brief discussion by Dutch scholar Erik Van Der Vleuten), and these form the basis for its use in this dissertation.[25]

A second-order system works with and builds upon what exists, the first-order systems already in place, rather than creating basic new systems. Yet the final result is something essentially new. Given that governments and societies in many developed countries are less and less capable or motivated to build new infrastructures, for a plethora of reasons, second-order systems offer a valuable way around growing limitations by improving efficiency through better interconnections and use of information technology. As Ingo Braun and Bernward Joerges point out, "much of today's large technical systems' expansion and transformation can be interpreted as superimposing second-order large technical systems on more or less stabilized classic infrastructural systems."[26] This is particularly the case with transportation systems, and hence the intermodal strategy (described extensively in chapter 12) has come to prominence—manifested in passenger transportation through various approaches, and in freight transportation primarily by the container. Indeed, Erik Van Der Vleuten points out that "as LTS [large technical systems] are currently running out of space for expansion (air, ground and underground are rapidly 'filled up'), their future development may take the shape of material interlacing of existing material networks to create new functions or uses."[27]

As already noted, the concept of the second-order system is similar to that of the internetwork, and both ideas have been applied to the global container network. But the frameworks are subtly different, at least in how they are presented. An internetwork is generally described as a series of networks linked together, which gains greater power and use through this multiplication of connections. It is often described as spanning "across" various networks. A second-order system is envisioned as a strategic use of infrastructures to form something broader, and phrases like "superimpose," "superstructure," or "on top of" are often used in its description. The idea of the second-order system also leaves a bit more latitude for imagination in conceiving what we regard as an infrastructure or system; Braun's case of the organ transplant network, for instance, would not typically be viewed as an infrastructure. An internetwork is a slightly tighter and more restrictive concept, at least in the way Edwards and other scholars use it.

Another concept similar to the second-order system and internetwork is the "meta-system," as used by Janet Abbate. Though Abbate uses the term only briefly (and her focus is on

---

[24] Van Der Vleuten credits Radkau with this; see Erik Van Der Vleuten, "Infrastructures and Societal Change," p. 405. He cites Joachim Radkau, "Zum Ewiger Wachstum Verdammt? Jugend und Alter Grosstechnischer Systeme," in: Braun and Joerges (eds.), *Technik Ohne Grenzen*, pp. 50-106.
[25] Van Der Vleuten, "Infrastructures and Societal Change," pp. 404-406; Braun and Joerges, "How to Recombine Large Technical Systems," pp. 27, 39-49.
[26] Braun and Joerges, "How to Recombine Large Technical Systems," p. 27.
[27] Van Der Vleuten, "Infrastructures and Societal Change," p. 405.

information technology), she explains that it refers to a system composed of a combination of previously separate networks that now converge or overlap, and hence comprise a somewhat unified whole still composed of separate and disparate parts.[28] While the freight transport modes were never entirely separate, as cargo has long been transferred between them, the container introduced an entirely new level of convergence that has amalgamated these infrastructures, even as they remain basically distinct, into a unified overarching system. Hence the concept of a meta-system is applicable to containerization. Abbate's description of the challenge of linking up these diverse infrastructures, as she notes the struggle to "reconcile differences between systems with entrenched technical methods, work practices, and organizational cultures,"[29] could easily be a description of the issues present in adopting the container in various contexts.

Concepts like the second-order system, internetwork and meta-system point to a key aspect of containerization: domestic national infrastructures can retain their own characteristics, and carry out their well-established roles, even as they now in addition constitute segments of a far bigger global network. Containerization does not represent an effort to build a new system from scratch, yet neither is it merely a group of infrastructures cobbled together that gains no greater unity from their interconnections. Rather it works within these existing infrastructures and simultaneously creates something larger and cohesive out of them. National, regional and local conditions can remain in all their variety, so long as they are able to move the container. It is not a top-down system but rather one of nuance, though crucially it does include one truly universal and standardized object, the container itself. Yet these national infrastructures cannot be entirely unaffected, for as container use becomes pervasive the domestic transport systems must adjust in many ways, some minor and others more fundamental, to accommodate it. In the process the global—represented by the container—turns into a driving force for change within the space of the nation-state. The bulk of this dissertation narrates how this has transpired in the American context. The process, however, is one where agency is exerted by local, regional and national actors, and where the existing qualities of American infrastructure, deriving from the character, history and geography of the U.S., are crucial in shaping how this globalization happens.

Clearly the container's success derives largely from being an object that bridges between different transport infrastructures. In this vein, the scholar Tineke Egyedi has referred to the container as an example of a "gateway" or "gateway technology." As should be evident by this point, the container's role as such a gateway is innately tied to its spatial characteristics, especially its dimensions. The container constitutes a spatial object, globally standardized, that interlocks with a plethora of national systems that possess their own diverse and varied spatial characteristics. These innumerable domestic infrastructures, in combination with ocean shipping, are able to link together to form a larger and impressively cohesive global network thanks to the container. (A gateway however need not be spatial—another example Egyedi discusses is XML, a

---

[28] Janet Abbate, "From Control to Coordination: New Governance Models for Information Networks and Other Large Technical Systems," in: Olivier Coutard (ed.), *The Governance of Large Technical Systems* (London: Routledge, 1999), pp. 116-117.
[29] Ibid., p. 116.

software standard for the World Wide Web.) As Egyedi explains, a seemingly inflexible object like the container actually provides for tremendous flexibility, once it has been standardized on a universal basis, because it only demands a few simple qualities of the things—truck chassis, railcar, container ship, crane, etc.—that it interfaces with.[30] We commonly envision standardization as inherently rigid and inflexible, but the reality is more complex. Some people in the freight industry over the years have expressed a similar understanding of the container's gateway role, and its inclusive simplicity, through the metaphorical idea of the container as a "common denominator" for the various infrastructures.[31]

In describing the container as a gateway technology, Egyedi draws upon the work of Paul David and Julie Bunn, who (as already noted) first used the term. But there is a difference between the two uses. David and Bunn present, as their primary example of a gateway technology, the rotary converter whose introduction in the 1890s allowed AC and DC electric systems to coexist for a few decades before AC became completely dominant.[32] As they describe it, a gateway makes it possible for two systems that are of the same basic type yet incompatible to work together. In such a scenario the two systems fulfill the same function, and it would be possible (perhaps desirable) to have just one unified system that does it, but for some reason (historical contingency, competing corporations, political factors, etc.) multiple systems have emerged. Hence a gateway serves a useful role, but would not be necessary if only the system were unified—in the case of electricity, if AC had simply triumphed from the start. The other examples David and Bunn give seem to confirm this interpretation of a gateway: a special plug that allows an electrical appliance from one nation to work in another nation where outlets have a different configuration; an adapter ring that permits a camera lens with a particular type of mount to attach to a camera with a different mounting; and a railcar with multiple wheels that can handle varying track gauges.[33] In each case the two incompatible systems are of the same type, and the incompatibility is not necessary in any fundamental sense—it would be possible to have a unified system that obviates the need for the gateway.

Egyedi on the other hand puts forward three possible types of gateway technologies, dedicated, generic and meta-generic, and defines them by their level of standardization. A

---

[30] Tineke M. Egyedi, "Infrastructure Flexibility Created by Standardized Gateways: The Cases of XML and the ISO Container," *Knowledge, Technology, and Policy,* Vol. 14, No. 3 (October 2001), pp. 41-54; Tineke M. Egyedi, "The Standardized Container: Gateway Technologies in the System of Cargo Transportation," Paper for the Helsinki Workshop on Standardisation and Transportation, Helsinki, August 23-24, 1996.
[31] For examples of this "common denominator" terminology, see: *Railway Age,* "Containers—Next Step in Freight?" Vol. 145, No. 21 (November 24, 1958), pp. 30, 35; Richard W. Black, "Flexibility in Unitized Cargo Handling for Ships in Military Operations," in: *Ship Design Implications of Recent Marine Cargo Handling Research,* Conference Proceedings, University of California, Berkeley, May 2-4, 1962, p. 4; Charles Cushing, Interview by Arthur Donovan and Andrew Gibson, May 8, 1995, Containerization Oral History Collection 1995-1998, Archives Center, National Museum of American History, Washington, D.C., p. 58; Les [Leslie] Harlander, Interview by Arthur Donovan and Andrew Gibson, June 19, 1997, Containerization Oral History Collection 1995-1998, Archives Center, National Museum of American History, Washington, D.C., p. 43.
[32] David and Bunn, "The Economics of Gateway Technologies and Network Evolution," pp. 173-191.
[33] Ibid., p. 170.

dedicated gateway, of which the AC/DC rotary converter is an example, has a low degree of standardization. She even claims that a dedicated gateway is typically "improvised" or "ad-hoc" in nature, and while these terms seem like exaggerated descriptions, they do hint at a certain specificity in a dedicated gateway, which meets a very particular purpose. Most if not all of David and Bunn's examples are dedicated gateways. A generic gateway possesses a medium degree of standardization; it is essentially standardized, and thus can connect innumerable subsystems rather than being limited to those of a specific nation, corporation, etc. The two cases Egyedi discusses at length, the shipping container and the internet standard XML, are both generic gateways. A meta-generic gateway has a high degree of standardization. This is a rather more slippery concept, but she refers to it as a standard at "the level of reference frameworks" that has "meta-generic properties," and cites the Open Systems Interconnection (OSI) Reference Model.[34] (Perhaps we can regard a meta-generic gateway as a collection of guidelines for how to set and standardize gateways.)

In her analysis of the container and XML, Egyedi applies the concept of the gateway to a mechanism or device that bridges between systems fundamentally different in nature. The container for instance differs from what David and Bunn discuss because it links systems that by their nature and function could not possibly be compatible. Railroads, trucking and shipping are entirely separate modes of transportation that could not possibly be merged into one technological system (unless one imagines a fanciful high-tech machine that can transform itself from one to another, *à la* Tom Swift or James Bond). It is not a matter of disparate standards or approaches existing for the same basic type of technological system, as in David and Bunn's examples. Rail, trucking and shipping are simply different infrastructures, and while the container binds them into one overarching network in a certain fashion, they remain separate in their essentials. Drawing on the system-network-internetwork terminology of Edwards and Downey, it would seem gateways like the container and XML are between networks and thus create internetworks, while David and Bunn's gateways are between systems and bring about networks. More generally, it appears a dedicated gateway helps form a system, while a generic gateway assists in creating a second-order system or internetwork. (Edwards also notes, albeit in passing, that a gateway can bind systems into networks, or networks into internetworks; he states that "gateway technologies and standards spark the formation of networks," and adds soon after that "in a later phase, new gateways may connect heterogeneous networks to one another."[35] His meaning is clearly that this connecting of heterogeneous networks constitutes the creation of an internetwork.)

Gateways are crucial in the development of global or transnational infrastructures. It is exceptionally hard to impose or create any sort of unity at the worldwide scale, due to the existence of nation-states that exert such power within their territorial domains. In addition the simple power of path dependence is tremendous; the existing national systems are firmly in place

[34] Egyedi, "Infrastructure Flexibility Created by Standardized Gateways," pp. 44-45; Egyedi, "The Standardized Container," p. 4.
[35] Edwards, *A Vast Machine*, p. 11.

and hard to alter. Infrastructural unity was generally only achieved inside nation-states with great difficulty and over long durations. To achieve it across the worldwide community of nations is, for the time being and in the foreseeable future, simply not possible. (There are a few exceptions. For instance, global air travel is highly unified, largely by necessity, with tight worldwide standards and even English as the universal language of air traffic control.) Instead gateways, links and interfaces must be put in place to make global networks possible. The apparent cohesion of these global systems, which are often in effect internetworks or second-order systems, belies their underlying fragmentation—they consist of multiple systems cobbled together, and it is gateways that make them possible. The shipping container is a perfect example of such a gateway.

Many national infrastructures also depend on gateways for certain functions—but globalization ups the ante. Consider global telephony. Each nation has its own distinct telephone system, with particular technical and bureaucratic characteristics. Some might be quite similar (the U.S. and Canada, which share the same area code scheme), while others may vary dramatically. The presence of cell phones, and various other innovations in recent years, further complicates matters. Yet it is possible (with a few exceptions and caveats) to call any number in the world from any other number in the world. It is an astonishing global infrastructure, resting on a whole host of technological and organizational link-ups (by now almost entirely taken for granted, except for those in the industry) that allow the assemblage of nation-states to interconnect their distinct systems. The internet is a more dramatic example. Just in the U.S., it depends on a variety of systems: phone lines, cable lines, fiber-optic networks, T1 connections, wireless systems like wi-fi, satellites, etc. Combine that with all the systems it must utilize in other nations, and the internet truly contains incredible diversity in the technology of its "pipes." In addition there are the servers and other devices, the software systems and protocols (including XML, discussed by Egyedi), and the bureaucracies and organizations. The remarkable final result is that (again, various caveats apply) one can send an email from one nation to another, or pull up any website from any location. A whole host of complex links and accommodations—technical, organizational and even social—make such a network possible. Concepts like the gateway, second-order system, and internetwork are of value in explaining how this happens.

One of the central arguments of the dissertation is that the way containerization is carried out is fundamentally dependent on national, regional and/or local context. A seemingly universal, worldwide infrastructure intersects with particular conditions at smaller scales, and these conditions ultimately are formative in the character of the overall network. The concept of "local universality" is useful in illuminating this. Introduced by Stefan Timmermans and Marc Berg, the idea of local universality illuminates how universal large-scale systems or infrastructures have local nuance—and how such local variations are not flaws or trivial details but rather are constitutive of the overall system. While Timmermans and Berg are specifically concerned with standardized medical procedures, the way they conceptualize the local versus the universal has relevance for discussions of the local and/or national versus the global with regard to the container:

> Local universality emphasizes that universality always rests on real-time work, and emerges from localized processes of negotiations and pre-existing institutional, infrastructural, and material relations. 'Universality', here, has become a non-transcendental term—no longer implying a rupture with the 'local', but transforming and emerging in and through it.[36]

So local and national actors do not simply obediently adhere to the standards and practices imposed on them by the ISO, or by overwhelming American influence. The global container network is built upon their actions and agency. While this would be true for any "universal" or "global" network, it is particularly the case for containerization since it is a second-order system that depends on the basic transport modes. So local and national practices—the railroad and trucking infrastructures—are inevitably crucial in how containerization can be implemented in specific places. The decisions of local and national actors, and the constraints of preexisting systems, are critical.

Scholars Susan Leigh Star and Karen Ruhleder present a somewhat similar case for understanding an infrastructural system as a conglomeration of users and scales, one that is woven together by its many and diverse users who interact with it in various ways. Such a network cannot be entirely imposed from the top down, because users relate to it in their own ways—or choose not to connect with it at all. In short, the user experience matters deeply; it is not just an inconvenience that arises at the end when the completed system must be tweaked to be more "user-friendly" or to mollify a few recalcitrant participants. Star and Ruhleder make these arguments in their 1996 article "Steps Toward an Ecology of Infrastructure: Design and Access for Large Information Spaces."[37] The article has been influential, largely because it introduced an extended multiple-point definition of infrastructure that has been widely referenced since. It is worth presenting here, in Star and Ruhleder's words:

- *Embeddedness*. Infrastructure is "sunk" into, inside of, other structures, social arrangements and technologies.
- *Transparency*. Infrastructure is transparent to use, in the sense that it does not have to be reinvented each time or assembled for each task, but invisibly supports those tasks.
- *Reach or scope*. This may be either spatial or temporal—infrastructure has reach beyond a single event or one-site practice.
- *Learned as part of membership*. The taken-for-grantedness of artifacts and organizational arrangements is a *sine qua non* of membership in a community of practice. Strangers and outsiders encounter infrastructure as a target object to be learned about. New participants acquire a naturalized familiarity with its objects as they become members.
- *Links with conventions of practice*. Infrastructure both shapes and is shaped by the conventions of a community of practice, e.g. the ways that cycles of day/night work are

---

[36] Stefan Timmermans and Marc Berg, "Standardization in Action: Achieving Local Universality Through Medical Protocols," *Social Studies of Science,* Vol. 27, No. 2 (April 1997), p. 275.
[37] Susan Leigh Star and Karen Ruhleder, "Steps Toward an Ecology of Infrastructure: Design and Access for Large Information Spaces," *Information Systems Research*, Vol. 7, No. 1 (March 1996), pp. 111-134.

affected by and affect electrical power rates and needs. Generations of typists have learned the QWERTY keyboard; its limitations are inherited by the computer keyboard and thence by the design of today's computer furniture.

- *Embodiment of standards*. Modified by scope and often by conflicting conventions, infrastructure takes on transparency by plugging into other infrastructures and tools in a standardized fashion.
- *Built on an installed base*. Infrastructure does not grow *de novo*; it wrestles with the "inertia of the installed base" and inherits strengths and limitations from that base. Optical fibers run along old railroad lines; new systems are designed for backward-compatibility; and failing to account for these constraints may be fatal or distorting to new development processes.
- *Becomes visible upon breakdown.* The normally invisible quality of working infrastructure becomes visible when it breaks: the server is down, the bridge washes out, there is a power blackout. Even when there are back-up mechanisms or procedures, their existence further highlights the now-visible infrastructure.[38]

This far-ranging definition encompasses many aspects of infrastructure, but clearly for Star and Ruhleder the role of the user is especially important. Hence local scale is crucial, since every user ultimately experiences the infrastructure as a local user. Yet Star and Ruhleder are not making a naïve argument about users superseding all other factors, or that the local is all that matters. Rather they argue that an infrastructure is fundamentally about both the global and the local. (They use the terms "global" and "local" to refer not so much to geographic scale, as this dissertation usually does, but to a universal system versus a particular user, yet the idea is analogous.) The quandary of infrastructure, Star and Ruhleder point out, lies in the "tension between local, customized, intimate and flexible use on the one hand, and the need for standards and continuity on the other."[39] Later they state, in a brief summary of the article's core argument, that: "*An infrastructure occurs when the tension between local and global is resolved.* That is, an infrastructure occurs when local practices are afforded by a larger-scale technology, which can then be used in a natural, ready-to-hand fashion."[40]

Star and Ruhleder add that "with the rise of decentralized technologies used across wide geographical distance, both the need for common standards and the need for situated, tailorable and flexible technologies grow stronger."[41] Although their focus is more oriented to information technology, this statement—aside from the reference to "decentralized technologies"—captures the situation of the container, as it represents a global and universal standard that is used in widely varying ways in different places and by different users. The container's status as part of a global infrastructure, rather than a national, regional or local one, only makes this point more crucial—to establish such a global network, both the universal standard and local flexibility must be present. While Star and Ruhleder could perhaps be more attentive to how power is manifested

[38] Ibid., p. 113.
[39] Ibid., p. 112.
[40] Ibid., p. 114.
[41] Ibid., p. 112.

in or through infrastructure (the same issue applies to Timmermans and Berg's work), their emphasis on the local and the user is a good counterweight to more conventional narratives of infrastructural development. This dissertation seeks to draw on such insights, though in the context of the container the local "user" is generally not a person but a corporation or institution acting at the local, regional or national scale. Alternatively, the local, regional or national scale itself can be understood as the "user" that intersects with the global scope of containerization.

One more salient aspect of the container infrastructure is the eminently physical character of containerization, and of the transportation infrastructures that undergird it. Indeed, this physical or material quality is inherent to any transport system, including both the objects in motion (cars, trains, etc.) and the routes they travel upon (roads, tracks, etc.). While virtually every infrastructure or network has at least some physical dimension, the extent of this materiality varies greatly. The network of telephony, for instance, is supported by a multitude of wires, cables, cell towers, underwater fiber-optic lines, communications satellites and switching stations. This is an important and extensive system of physical components that is integral to the functioning of telephony, but at the physical level does not possess quite the same heft, the same material and physical presence, as the system of roads, streets, highways, driveways and parking lots, along with the innumerable cars and trucks, that constitute our motor vehicle infrastructure. Infrastructures that involve knowledge and communication are, in general, less deeply material in their workings than most other infrastructures. Obviously exceptions exist—and no absolute dividing line should be drawn, as virtually every infrastructure has elements of both the physical and the informational—but the basic point is that some infrastructures have a greater physical manifestation than others. Those of transportation are examples of highly material infrastructures, but there are obviously many others. The water and sewer infrastructures for instance have a large physical presence. Electricity has an extensive though not hefty physicality in its distribution network (being somewhat like telephony in this regard), but possesses more material substance in the components that generate it, such as coal-burning plants, dams, nuclear power plants, solar arrays, wind farms, etc.

Obviously containerization is a very physical and spatial infrastructure, both in terms of the container itself and the cargo it holds within. As this dissertation demonstrates, this physical character, especially the container's exact dimensions and carrying capacity (in both volume and weight), are integral to how containerization functions. Furthermore the three transport modes the container depends on are equally physical. These material qualities have many ramifications for the container, especially in terms of its tendency, as will be emphasized throughout the dissertation, when traveling domestically (rather than over the ocean), to follow the established preexisting routes of transportation that are embedded in the space and workings of the nation-state. Transportation infrastructures have a hefty presence in the material world that makes them difficult to alter, and even in this era of the "information age" and "knowledge economy" such physical realities loom very large indeed.

The consistency of the container's spatial and material qualities, the same for every ISO (i.e., global) container everywhere, is fundamental to its success. There are many comparable examples, especially in the realm of infrastructure, of standardized dimensions that possess great importance and power. Sometimes these dimensions are arbitrary in nature, rather than stemming from technological imperatives. For instance, the standard gauge of 4'-8½" used by most of the world's railroads has no particular technical advantage, and a figure a few inches smaller or larger would work equally well. In other circumstances a dimension has a more logical rationale; obviously the standards for highway lane width were not set arbitrarily, but were the result of the width of cars and trucks already in use. (Those automotive dimensions in turn derive from the width of two human bodies seated side by side.)

The dimension or spatial attribute that is standardized gains importance through its presence in physical reality. I will use the term "spatial regime" to describe such a system of dimensional standards and/or physical practices, a series of interlocking spatial and dimensional attributes that compels conformity.[42] While the examples in this dissertation involve transport infrastructures, one can think of a spatial regime in many contexts. The required dimension of a water pipe, the expected height of a telephone pole, the mandated width of a doorway—these can all be regarded as specific instances of spatial regimes. Such a regime can be produced by government regulations, engineering standards, bureaucratic traditions, longstanding vernacular practices, and many other causes. These various factors will typically comprise some that are more technological and/or scientific in nature, and others that are more social and/or political. Sometimes the distinction can be hard to draw, or perhaps (as some social constructivists might argue) even irrelevant. In addition, the spatial regime should be viewed not as an entirely independent category, but rather as interwoven with other non-spatial aspects of a particular system or infrastructure. One key attribute of many spatial regimes is that once they are deeply embedded in a system it can be extremely hard to alter them; in this regard their materiality is important—a change must be implemented and carried out in the physical world.

Dimensional measurements and physical standards often appear to possess a bland technocratic aspect. Yet they can embody political, social and economic agendas. A classic example are the bridges on Robert Moses' Long Island parkways, built with a clearance too low for buses to pass through. This had the effect of restricting the reach of public transit—which Moses was notorious in his opposition to—and the mobility of the poor and minorities.[43] Historians still debate whether or not this was consciously intended by Moses and his engineers, but the result is the same regardless—the bias is inherent in the bridges themselves. A simple

---

[42] I came up with the concept of the "spatial regime" independently; the term has been used by other writers for various purposes. There is an entirely unrelated technical meaning of the term that applies to a particular type of environmental studies and geographic analysis. It has also been used on occasion by writers in a Foucaultian vein to describe connections between space and social or political control. The only use of the term that I have found with a meaning similar to mine is in Peter Trummer, "Spatial Regimes: Material Organization and Its Architectural Effects," *Hunch: the Berlage Institute Report,* No. 9 (Summer 2005), pp. 102-113. I came across this article after I had begun using the term.

[43] Langdon Winner, "Do Artifacts Have Politics?" *Daedalus*, Vol. 109, No. 1 (Winter 1980), pp. 121-136; Robert A. Caro, *The Power Broker: Robert Moses and the Fall of New York* (New York: Vintage Books, 1974), pp. 951-953.

dimensional measurement may possess all sorts of larger implications, far beyond the technical or scientific. (The example of Moses' bridges actually has particular resonance to the container, which—as will be described in later chapters—often bumps against its own problems of vertical clearance.) The container's spatial regime obviously does not possess as clear-cut an agenda as Moses' bridges, but the dissertation will point to some of its implications, and how they play out in particular situations.

Within a nation-state particular spatial regimes often hold across the entire national territory, and this is one factor making the unity of the nation-state so powerful and the borders between nations so significant. The slightest difference may have tremendous significance. For example, the rail gauge of Spain differs from the rest of Europe, and this discrepancy has long been an issue for movement between Spain and France. (But the new high-speed rail network in Spain uses standard gauge, like other European countries.) The subdivision of land can also be regarded as a spatial regime. A classic example is the grid imposed upon so much of the American Midwest through the Land Ordinance of 1785; later expansions of the U.S. also generally used grids for the platting of land. A spatial regime can be at the opposite scale, dealing in miniscule dimensions. In premodern Europe, for instance, there were variable techniques for specifying the size of many units—such as a bushel, a volume often contested between peasants and manorial lords—that varied between localities and over time. The centralized state faced the challenge, which it eventually surmounted, of bringing about a uniform spatial regime by standardizing such measurements. The development of long-distance trade and manufactured goods also played a part in this transition, but the role of the state was crucial.[44] Hence there is frequently a correspondence between a spatial regime and national identity.

The physical infrastructures of transportation, water and sewer provision, electric power, and oil pipelines, among others, can be regarded as "heavy" in terms of their relative immobility and sheer physical size. Even informational infrastructures depend on material components, as already noted—the internet relies on undersea cables, cell phone networks require cell towers, and so forth. Hence an infrastructure is likely to be a long-term presence in a territory, landscape or urban setting, difficult to alter in terms of time, effort and money. While people, goods, resources or information may move swiftly along it, the actual physical manifestation of an infrastructural system (a bridge, undersea cable, rail corridor, gas pipeline, highway, telephone pole, etc.) is typically fixed in place and very hard to change. It has a geographical and spatial inertia, and tends to organize things around itself rather than adjusting to change.[45] Therefore a spatial regime is a particular type of standard, one whose materiality and dimensionality is not incidental but of basic importance in the way it endures and how (or whether) it can be altered.

---

[44] James C. Scott, *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed* (New Haven, CT: Yale University Press, 1998), pp. 25-33.

[45] This important point is explored by Claude Prelorenzo, who emphasizes the durability and immobility of infrastructures and refers to "la ville lourde" (literally, *the heavy city*) as the result. His argument is primarily with reference to urban design. See Claude Prelorenzo, "L'Immobilité des Infrastructures," in: Claude Prelorenzo and Dominique Rouillard (eds.), *Le Temps des Infrastructures* (Paris: L'Harmattan, 2007), pp. 85-89.

This is all the more reason for new flows to travel along the corridors and nodes of systems already in place—as has been the case for containerization.

The rhetoric of globalization, and of the post-Fordist condition, often uses terms like "flexible," "light" and "nimble" to describe contemporary networks, or infrastructures likely to come in the near future. Such a vision no matter how appealing is largely an illusion. Logistics systems, for example, are indeed nimble and flexible in many ways—containers can be easily rerouted, held or sped up—and they are pervaded with information and communication in parallel with the movement of physical goods. But they also depend on massive components of infrastructure that have many inflexible qualities, being fixed in place and representing massive investments. The purely material and spatial realm continues to be of immense importance, and most infrastructures are far more heavy than light. Even information networks greatly depend, as already noted, on certain physical qualities. In addition, systems of information possess their own distinctive types of inertia and momentum, described by concepts like "data friction" and "computational friction."[46] Consider, for instance, how much time, resources and money go into a new version of a major piece of software. Further, the social, cultural and political aspects of an infrastructure usually embody tremendous inertia as well—people get accustomed to behaving in a certain way, and form social (or cultural, or political) frameworks structured around the infrastructure. Humans often find it hard to alter their ways, or may have a vested interest against change. The disadvantages of the QWERTY keyboard, for example, are well known, but it is hard to replace because it has become deeply entrenched in user habits. These sociopolitical dimensions are every bit as inherent to an infrastructure as its technological qualities.

One can regard this infrastructural inertia as a sort of heaviness, as already noted—once a system is in place it is difficult to change. (Another way to conceive of it is as path-dependence, or as Hughes' aforementioned concept of "momentum.") While information systems and social practices, as already noted, can embody great heaviness in their own right, it would seem the material, spatial world possesses a unique type of inertia due to its physicality. Things in physical existence, with size and bulk in actual space, resist transformations in an eminently tangible way. This dissertation—being, after all, an *architecture* dissertation—asserts that there is a special quality to physical, spatial and material infrastructures. As Hughes points out, "technological systems…are bureaucracies reinforced by technical, or physical, infrastructures which give them even greater rigidity and mass than the social bureaucracies…"[47] The task of reconfiguring such infrastructures, or altering their spatial regimes, is arduous in terms of money, effort and time. Transportation systems are a perfect example. This dissertation will describe a few instances where great efforts were successfully made to overhaul an infrastructural link or create a new one for the sake of accommodating the shipping container. These examples reveal the powerful impact of the container on American infrastructure, especially over the past two decades or so. But more often the dissertation will show how the presence and inertia—again, a very physical

---

[46] Edwards, *A Vast Machine*, pp. 83-85.
[47] Hughes, "Technological Momentum," p. 113.

and material heaviness—of preexisting infrastructure have caused containerization to be carried out within their constraints. In such cases the container brings about significant adjustment, but not wholesale change. Thanks to this infrastructural inertia, the history and character of the existing nation-state is central to how containerization unfolds within its borders.

In terms of the way the container network takes shape, two spatial and material aspects of the national infrastructure stand out. The first is the spatial regime of U.S. transportation, in particular the railroad and trucking systems (but also the inland waterways). This comprises factors like track gauge, lane width, vertical and horizontal clearance, allowable weight, and a host of other standards that possess some spatial or material quality. These derive from the evolution of the infrastructures, reflecting American history and practices including some social and cultural factors. The second spatial aspect is at the larger geographical scale, relating to the location of major hubs of movement and especially the corridors that connect them. These also reflect the vicissitudes of U.S. history, but in addition they stem from the inherent geographical character of the nation. Certain pathways through the landscape are ideally suited for particular transportation routes. Both of these spatial aspects will be described in great detail in the dissertation.

While this dissertation only deals with the U.S. (and to some extent Canada), the larger argument is applicable for all nations. The example of the U.S. is complicated slightly—and made more interesting—by the container's historical evolution, as it has a largely American origin. But the basic narrative could apply anywhere. The dissertation puts forward a thesis that parallels Hughes' ideas about technological style, arguing for the importance of comprehending national or local context in any account of technological adoption. The nature of containerization makes the point even more fitting; the container's dependence on using preexisting domestic transport systems means that inevitably national context will shape how containerization plays out. The worldwide container network is given form within the setting of the nation-state.

This issue of the national and/or local scale versus the global scale, of national infrastructure's place in global infrastructure, is dealt with in the next chapter. In an increasingly globalized world infrastructural networks are more likely to have a worldwide span, or to tie into global infrastructures in some fashion. The mythology of globalization still tends to promote a top-down vision of worldwide networks imposing a new *zeitgeist* upon nation-states and local settings, which can only react to these overarching changes. This vision of ongoing global changes is reflected not only in neoliberal tracts, where its presence is predictable, but also (albeit more subtly) in much of the serious scholarship dealing with globalization. The way containerization works, however, reveals a more nuanced dynamic of globalization, in which the character of national infrastructure plays a formative role in how global infrastructure operates. The next chapter investigates such issues in depth.

Chapter 4 ~ Globalizing the Infrastructure of the Nation-State

Perhaps the most important theme running through this dissertation is the way the ongoing creation of a global infrastructure—the worldwide system of containerization—is carried out within the territory of a nation-state, in this case the United States. A key issue to consider is how the development of this global infrastructure differs from the creation of the national infrastructures that were constructed in the recent past and endure today. Infrastructure has often been at the scale of the nation-state, for the era of truly widespread and encompassing infrastructural development, with a high level of organization and technology, occurred more or less in parallel with the development of the nation-state and the era of modernity. The railroads were the first such modern infrastructure, followed shortly by the telegraph and a host of other inventions and systems. Even before the railroad, however, the construction of roads and canals played an important part in nation-building in the late 1700s and the 1800s. All these networks represent examples of how infrastructure can be wielded to bind together a territorial space, turning it into a nation-state. Infrastructural connections helped define the territory of the nation, making it seem natural and inevitable—and continue to do so today. National infrastructures of transportation, power, communication and water (among others) transform abstract lines on a map into unified cohesive territories, and people into citizens. The nation-state is a construct—but one undergirded by, among other things, powerful physical systems. Indeed, "the nation-state has historically been…[infrastructure's] most common geographic scale, its principal financier, and in almost all cases the ultimate source of its governance."[1]

American history is in part a narrative of infrastructural expansion, and the early development of the United States was marked by efforts to create public works projects that would help stimulate—or at least keep up with—westward growth. Roads and inland waterways were the transport infrastructures of the day, and the young government, along with some of the states acting independently, worked to develop both. Historical details of this process are provided in chapter 6 (for roads) and chapter 10 (for inland waterways). Progress was punctured by periodic debates about the proper role of the federal government, or of government in general, but it was the exponents of a more centralized and active government (Alexander Hamilton in particular) whose vision for the most part won out over the long run. George Washington himself was a supporter of building both roads and canals. A key document promoting American nation-building through infrastructure was the "Gallatin Plan" of 1808, written up by Albert Gallatin,

---

[1] Steven J. Jackson, Paul N. Edwards, Geoffrey C. Bowker, and Cory P. Knobel, "Understanding Infrastructure: History, Heuristics, and Cyberinfrastructure Policy," *First Monday*, Vol. 12, No. 6 (June 2007) (http://firstmonday.org/ojs/index.php/fm/article/view/1904/1786, accessed 8/4/13)

President Jefferson's Secretary of the Treasury, which reveals the ambitions of the young nation both to bind itself more closely together and continue expanding westwards.[2] Thomas Calhoun, at this point in his career a strongly nationalistic Congressman, proclaimed in a similar spirit in 1816 to his fellow legislators: "Let us…bind the Republic together with a perfect system of roads and canals. Let us conquer space."[3]

Arriving on the scene in the mid-1800s, the railroad was one of the key infrastructures to support many of the modern nation-states during the nineteenth and early twentieth centuries. This was particularly true of the U.S., as will be discussed in chapter 5. Certainly those who lived in the glory days of this technology were keenly aware of its power to unify nations; an Argentine statesman proclaimed, during his nation's early burst of railroad building, that:

> [The railroad] will unify the Argentine republic better than any congress. A congress can declare a country one and indivisible; but without the iron road, which draws together a nation's far-flung extremes, the country will for ever remain divisible and divided in spite of all legislative mandates. Thus political unity must begin with territorial unity, and only the railroad can make a single area out of two places separated by 500 leagues.[4]

Such an attitude was particularly fitting for a young nation like Argentina or the U.S., whose period of nation-building took place largely during the railroad era and thus was driven by the railroad itself. But the more well-established European countries also seized on the railroad with alacrity, wishing to further unify and develop their national territories. The construction of a railroad bridge on the border between England and Scotland, for example, prompted a contemporary to describe it as "the last act of Union" between those two regions.[5]

Over the past few decades there has been a scholarly trend, alongside the "cultural turn" in the humanities and social sciences, to describe the creation of the national in social and cultural terms, and this has resulted in some noteworthy scholarship. Benedict Anderson in his influential book *Imagined Communities* emphasizes that the nation-state's development depended upon creating the concept of community, of nationality.[6] Another example of such thinking is Eugen Weber's highly regarded *Peasants into Frenchmen*.[7] But territorial space and physical systems also possess vast meaning and power, and so the identity of nation-states is embedded in such physical and spatial factors, not merely in cultural or social forces. (Weber incidentally is hardly ignorant of infrastructure's role; one of his chapters is titled "Roads, Roads, and Still More

---

[2] Robert Fishman, "1808 - 1908 - 2008: National Planning for America," Rockefeller Urban Summit, July 2007, pp. 1-6. (Paper commissioned by the Regional Plan Association)
[3] Adam J. White, "Infrastructure Policy: Lessons from American History," *The New Atlantis,* No. 35 (Spring 2012), p. 17.
[4] Nicholas Faith, *The World the Railways Made* (New York: Carroll & Graf Publishers, 1990), p. 65.
[5] Ibid., p. 60.
[6] Benedict Anderson, *Imagined Communities: Reflections on the Origin and Spread of Nationalism* (London: Verso, 1983).
[7] Eugen Weber, *Peasants into Frenchmen: The Modernization of Rural France, 1870-1914* (Stanford, CA: Stanford University Press, 1976).

Roads.") As Manu Goswami argues in *Producing India*, culture, infrastructure and territory work jointly to craft the identity and dimensions of the nation-state. Goswami's account of the role of the Indian railroads, initiated by the British but soon adopted by the Indians as both a symbol and tool of their evolving national unity, is particularly relevant.[8] The nation-state is "produced" and unified by a host of factors, including physical infrastructures, bureaucratic regimes like law and language, cultural identity and beliefs, educational norms, military forces, etc. The focus of this dissertation of course is on infrastructure, which is admittedly merely one of many factors, yet is (as Goswami argues) one whose importance should not be overlooked.

Though this dissertation concentrates on a type of infrastructure that is eminently physical, it should be noted that many key infrastructures are information-based, such as telephones, newspapers, magazines, fax machines, television and the internet. In addition there are particular bureaucratic regimes, and laws and shared practices, that can be considered an infrastructure of a conceptual sort. These are also central in the construction of national coherence. Michael Mann, in his discussion of the "infrastructural power" of the state, uses the word in this broad sense. He argues that infrastructure, both physical and organizational, is fundamental to the modern state's power. In this regard he notes that state power has grown over time, in tandem with advances in technology, literacy, bureaucracy, record-keeping, organization, etc.[9] Older states were commonly dictatorial, but limited in their infrastructural reach: "Great despotic power can be 'measured' most vividly in the ability of all these Red Queens to shout 'off with his head' and have their whim gratified without further ado—provided the person is at hand… [but] once you were out of sight of the Red Queen, she had difficulty in getting at you."[10] The modern state's power, Mann posits, is less arbitrary and more systematic (or rationalized, in any event), and is implemented through infrastructures both physical and conceptual.

James Scott's *Seeing Like a State* is a definitive account of how the state organizes the activities and people within it, and the techniques Scott describes are similar to those discussed by Mann under the broad rubric of "infrastructure." It is striking that many of Scott's examples are spatial in nature, such as the urban planning of Brasilia, the collectivization of agricultural land under Stalin, and the creation of the *ujamaa* towns in Tanzania. We can regard these methods of organizing space as infrastructural, and it is significant that (as Mann points out) they are characteristic of modern states—or states seeking to be modern. While Scott's case studies deal with disastrous state projects his insights about modern state practices are more broadly applicable, as Scott himself emphasizes. The state seeks to make its territory, people and economy "legible" (in Scott's terminology) so its bureaucrats can control, adjust and monitor what takes place while local knowledge possesses no advantage. Standards and information are also crucial

---

[8] Manu Goswami, *Producing India: From Colonial Economy to National Space* (Chicago: University of Chicago Press, 2004).
[9] Michael Mann, "The Autonomous Power of the State: Its Origins, Mechanisms and Results," in Neil Brenner, Bob Jessop, Martin Jones, and Gordon MacLeod (eds.), *State/Space: A Reader* (Malden, MA: Blackwell Publishing, 2003), pp. 54-55.
[10] Ibid., p. 54.

tools in this process—as with physical infrastructure, such systems play a key role in configuring the modern nation-state and enabling its powers.[11] Another scholar dealing with such issues is Timothy Mitchell; in his study of Egyptian modernizing efforts, *Colonising Egypt*, Mitchell ponders the implications of such efforts towards order in behavior, practices and spatial arrangements, including urban planning and architecture. For Mitchell, working in a more Foucaultian vein, these types of order possess a larger cultural significance; modernity was not merely achieved in a functional sense, but also experienced and understood in the cultural and social realm.[12]

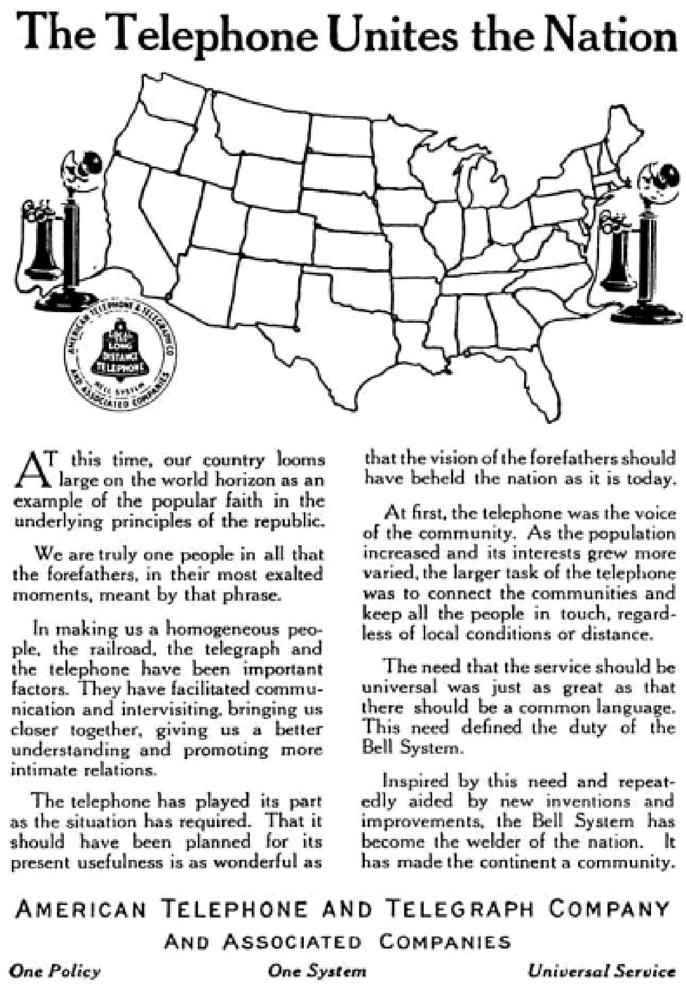

Figure 4.1: 1915 advertisement for AT&T

Source: Stephen Graham and Simon Marvin, *Splintering Urbanism: Networked Infrastructures, Technological Mobilities and the Urban Condition* (London: Routledge, 2001), p. 75

[11] James C. Scott, *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed* (New Haven, CT: Yale University Press, 1998).
[12] Timothy Mitchell, *Colonising Egypt* (Berkeley, CA: University of California Press, 1988).

Even infrastructures that at first blush seem more limited in scale frequently possess a national quality. Water and sewer systems in the U.S. are typically local or regional, for instance—they are not intertwined into a national network, but rather each one stands apart. The regulations, standards and practices of American water and sewer infrastructure, however, are largely national. An engineer working in one place could easily make the transition to another, as could a plumber. The measurements and dimensions of the equipment, the bureaucratic procedures, the engineering techniques, the affordances for health and safety—all these have a national aspect, despite some variations. One could make a similar point about electric power: it is not national in it scale, as the nation is divided up into a few giant regions for power generation and distribution, but in terms of its essential characteristics it possesses a national uniformity. Transportation infrastructure, even when built strictly for local purposes, also has this national quality. A town might be building a new intersection where two local roads meet, but the procedures of construction, the materials used, and the dimensions are likely to come out of nationally standardized regulations and practices. Furthermore those local roads ultimately tie into the national system, as one can follow a local road to an arterial, and an arterial to a highway.

In infrastructure's fundamental linkage to the modern nation-state, perhaps we can perceive a role for infrastructure that cuts even deeper, into the heart of modernity itself. One of the basic characteristics of modern life would seem to be the extraordinary prominence of technology in nearly every aspect of life. While the use of technology is obviously nothing new—since the dawn of history humanity has developed and applied technologies—what is novel in modernity is the way technology has become pervasive in human existence, and the extent to which people are entirely dependent upon it. These vital technologies are naturalized, taken for granted in the background, and people swiftly lose awareness of them over time. Gradually they are applied on a large scale and combined into systems that undergird, support and structure many aspects of modern life—at which point they are not merely technologies but infrastructures.[13] As such they also become linked to the laws, bureaucracies, classifications, standards, systems and formalized practices associated with modernity. As Paul Edwards puts it, "building infrastructures has been constitutive of the modern condition, in almost every conceivable sense."[14] He emphasizes that these infrastructural systems do not merely bring about or construct modernity, but also are shaped by it. No matter how modern life, and the modern nation-state, evolves, transforms or fragments, infrastructure seems sure to maintain its central role in modern (or postmodern) existence. Similar arguments are made by others; Bernward Joerges notes "the fundamental fact that modern, or if one prefers post-modern, societies irreversibly depend on the maintenance of

---

[13] Paul Edwards proffers this fundamental connection between modernity and infrastructure. See Paul N. Edwards, "Infrastructure and Modernity: Force, Time, and Social Organization in the History of Sociotechnical Systems," in: Thomas J. Misa, Philip Brey, and Andrew Feenberg (eds.), *Modernity and Technology* (Cambridge, MA: MIT Press, 2003), pp. 185-225.

[14] Ibid., p. 191.

these [infrastructures]."[15] Philip Brey opens an essay by simply stating that "technology made modernity possible," then adds the inevitable corrollary, further down the page, that "the converse also holds: technology is a creation of modernity."[16]

Standards are central to these infrastructures of modernity. Standardization is part of a process by which knowledge and/or action can be carried out over a large territory or group of people. One scholar notes that "without common standards all knowledge would be local knowledge,"[17] and this also applies to instrumental action. (Likewise all infrastructures would be locally bounded if not for standards.) Merchants operating over larger geographical spans began to develop common currencies, weights and measures even in the earliest days of modernity.[18] Standardization "was given an enormous boost by the grand universalizing project known as the Enlightenment,"[19] and in the wake of this epochal shift the eighteenth and nineteenth centuries saw the widespread implementation of standards and standardization, particularly in the West. It is no coincidence this transpired during roughly the same period, the era of modernity, that infrastructures were developing and expanding. In addition to the aspirational character of the Enlightenment, and the modernizing ambitions of government and science, the Industrial Revolution was also crucial in furthering standardization. Manufacturing made standards critical, as manufacturers used standardization and uniformity to assure the rapid production of goods at a consistent level of quality and sameness.[20]

One of the key actions that government often performs in order to create unity within its national territory is the setting of these uniform standards, protocols, systems and regulations. Many of these standards relate to infrastructure, and some are spatial, material and/or dimensional, often depending on great precision for their effectiveness. As described in chapter 3, these can be seen to constitute "spatial regimes." A classic example is railroad track gauge, the distance between rails. Here there can be no wiggle room or flexibility whatsoever, for a unified system must have the same track gauge throughout. Nearly every nation's rail network does in fact have this unity. This was not the case in the early days of the railroads, as different railroad companies built different tracks with their own gauges, as their engineers saw fit or as strategy demanded—sometimes the differing gauges were intentional, to prevent competitors from using the tracks. But over time the track gauges were made consistent, sometimes at great expense and effort, within national territories; in the U.S. this process was largely complete by the close of the

[15] Bernward Joerges, "Large Technical Systems: Concepts and Issues," in: Renate Mayntz and Thomas P. Hughes, *The Development of Large Technical Systems* (Boulder, CO: Westview Press, 1988), pp. 31-32.
[16] Philip Brey, "Theorizing Modernity and Technology," in: Misa, Brey, and Feenberg (eds.), *Modernity and Technology*, p. 33.
[17] Patrick Feng, "Studying Standardization: A Review of the Literature," Institute of Electrical and Electronics Engineers, IEEE 3rd Conference on Standardization and Innovation in Information Technology, Delft, The Netherlands, October 22-24, 2003, p. 101.
[18] Scott, *Seeing Like a State*, pp. 30-31.
[19] Lawrence Busch, *Standards: Recipes for Reality* (Cambridge, MA: MIT Press, 2011), p. 83.
[20] Feng, "Studying Standardization," p. 100.

nineteenth century.[21] Other standardized dimensions, such as for vertical and horizontal clearance, are also critical to successful railroad operations across the nation.

Likewise the Interstate highways depend on a consistent set of spatial dimensions and physical characteristics, such as for lane width, minimum turning radius, grade, drainage slope, and vertical clearance. (This uniformity also of course applies to normal American roads in a general sense; a person accustomed to driving in Pennsylvania will have little trouble doing so in Texas, due to a rough national uniformity in spatial layouts, signage, rules and other practices.) In comparison with the railroads, the highways were developed in a far more top-down and uniform way across the entire nation, and likewise the standards that govern them were put in place in a more wholesale fashion. Nevertheless a certain amount of adjustment did happen over time; early American highways like the Merritt Parkway, Taconic State Parkway, Arroyo Seco Parkway and Pennsylvania Turnpike represented initial efforts, and the lessons learned were applied on a nationwide basis with the Interstates.

The concept of the nation-state bases itself on the claim that a particular physical territory, a clearly demarcated expanse of geographic space, belongs to a certain group of people that is defined culturally and socially as being of a specific nationality. Further, and crucially, this territory is unified under one government that exerts exclusive and sole power within its borders. (The idea of exclusive national sovereignty, whereby each state is acknowledged to possess its own autonomy and to have legitimate power over its territory and people, is known as the "Westphalian system" or "Westphalian sovereignty.") Thus space and land are central to the nation-state's existence. All the land, people and resources within its territory are part and parcel of the nation-state, which is unified (or at least seeks to be unified) in terms of laws, transportation, culture, society and national identity. All these qualities, under the aegis of the nation-state, exist within the same enclosed geographic space—little wonder that expressions of patriotic identity often draw on the word "land," as in "homeland," "heartland," "motherland," and "fatherland." Space in this sense is not something that just receives the nation, but is actively implicated in state strategies and logics. The unity of the national is not merely carried out within a particular space, but through the effective use of that space; as Henri Lefebvre puts it, "the state tends to impose a rationality, its own, that has space as its privileged instrument."[22]

A powerful congruence exists here, wherein a multitude of political, economic and social characteristics are all unitary at the same scale, that of the nation-state, which is defined most fundamentally through its territory. The two key characteristics that must go hand in hand are government power (the state) and citizen identity (the nation). Peter J. Taylor emphasizes that the nation-state joins together these two factors through its territoriality:

---

[21] For a detailed account of this process see Douglas J. Puffert, "The Standardization of Track Gauge on North American Railways, 1830-1890," *The Journal of Economic History*, Vol. 60, No. 4 (December 2000), pp. 933-960.

[22] Henri Lefebvre (Neil Brenner and Stuart Elden, eds.), *State, Space, World: Selected Essays* (Minneapolis: University of Minnesota Press, 2009), p. 226.

> A given state does not just exist in space, it has sovereign power in a particular territory. Similarly, a nation is not an arbitrary spatial given, it has meaning only for a particular place, its homeland. It is this basic community of state and nation as both being constituted through place that has enabled them to be linked together as nation-state. The domination of political practice in the world by territoriality is a consequence of this territorial link between sovereign territory and national homeland.[23]

It should be kept in mind that the nation-state, and its territoriality, can be a limited prism through which to understand the world. This is the key point made by John Agnew's influential 1994 article that introduced the notion of the "territorial trap," in which he argues against a geographical view that assumes the nation-state is a rigid unit with complete sovereignty within its space and posits national territories and powers as given rather than constructed or contingent. The "trap" for Agnew is the tendency for scholars to invariably draw on the framework of the national, and the bounded territory it encompasses, as the default unit of analysis in political, social and/or economic studies. In raising such issues in the mid-1990s Agnew was perceptive, and ahead of his time, as he noted some emerging trends that pointed to a more transnational existence, one where the nation-state's basic territorial integrity remains yet it is opened up to a host of globalized dynamics, influences and networks.[24]

The nation-state's ability to unify so many aspects of human existence in a defined geographic space is so ingrained in our thinking that "it becomes difficult to remember that it is only one, relatively recent, historically contingent form of organizing space in the world."[25] Earlier systems of governance, power, economics, belief, society and culture were not marked by this convergence whereby nearly every sort of unity exists at the scale of the nation-state. In medieval Europe government and power worked at a series of scales, with the peasant living under a feudal lord who in turn was vassal to a monarch. Meanwhile religious belief was at another scale, with most of Europe sharing a common Roman Catholic faith centered on Rome. Saskia Sassen discusses some of the nuances of territorial space and its control during the Middle Ages:

> In Europe the Middle Ages was a period of complex interactions among particular forms of territorial fixity, the absence of exclusive territorial authority, the existence of multiple crisscrossing jurisdictions, and the embedding of rights in classes of people rather than in territorially exclusive units… The prevalent pattern in medieval times was one of crisscrossing jurisdictions, thus keeping territorial fixity from becoming exclusive territorial rule… There was a kind of

---

[23] Peter J. Taylor, "The State as Container: Territoriality in the Modern World-System," in: Brenner, Jessop, Jones, and MacLeod (eds.), *State/Space*, p. 101.
[24] John Agnew, "The Territorial Trap: The Geographical Assumptions of International Relations Theory," *Review of International Political Economy*, Vol. 1, No. 1 (Spring 1994), pp. 53-80.
[25] Akhil Gupta, "The Song of the Nonaligned World: Transnational Identities and the Reinscription of Space in Late Capitalism," *Cultural Anthropology [Space, Identity, and the Politics of Difference]*, Vol. 7, No. 1 (February 1992), p. 63.

> central authority during feudalism arising out of the church and the empire. But it was not based on territoriality—exclusive territorial authority. Their respective forms of authority could coexist with feudal jurisdictions, and with each other, albeit with frequent conflicts… Key actors controlled geographic spaces, such as the fiefs and the ecclesia, and in that regard we could describe the landscape as marked by scattered de facto mini-sovereignties in a vast system of often loose overlapping jurisdictions. But even where lords had jurisdiction over manors and lands granted to them, they lacked exclusive territorial authority.[26]

Sassen hypothesizes we may be entering a similar period today—similar in that we are starting to see certain "crisscrossing" and "overlapping" territorial arrangements, rather than the exclusive authority and unity of the nation-state over its space.[27] Yet she argues that it is actually the state itself that somewhat paradoxically puts into place many of the conditions of globalization.[28] In spite of the numerous multinational corporations and international institutions (such as NGOs) that possess newfound power, the nation-state is still preeminent and continues to play a crucial role in binding geographic space together, even if in the process it undermines its own power in certain ways. Hence the state helps create the new global existence; Sassen draws attention to "the ways in which the state participates in setting up the new frameworks through which globalization is furthered."[29]

This dissertation draws on and extends Sassen's insight, arguing that it is not merely the state that plays this key role in implementing globalization but also many actors embedded within the national scale, such as corporations, nonprofit organizations, industry trade groups, professional associations, and citizen advocates. With regard to the shipping container's presence in U.S. infrastructure it is evident that American corporations and trade groups, essentially acting within the confines of the national, have played a role every bit as important as government. The usual narrative of containerization stresses the importance of the shipping lines, businesses that are inherently actors at a transnational scale (though still based in locations within particular countries) who possess a global orientation. While their role certainly was significant, this dissertation will demonstrate that many of the key transformations to U.S. infrastructure associated with containerization have been carried out by corporations with a purely American identity, acting entirely inside the national territory.

From a larger historical viewpoint it is entirely fitting to emphasize the role of corporate actors, for capitalism, like the modern state, has been a powerful force in the homogenization of space and the development of infrastructural unity. Markets, commerce and corporations have unified and abstracted space and materiality in many forms, especially during the modern era. In *Nature's Metropolis*, William Cronon gives a masterful account, in the context of Chicago and the

---

[26] Saskia Sassen, *Territory, Authority, Rights: From Medieval to Global Assemblages* [updated ed.] (Princeton, NJ: Princeton University Press, 2008), pp. 32-33.
[27] Ibid., pp. 14-18, 224-248.
[28] Sassen, *Territory, Authority, Rights*, pp. 228-236; Saskia Sassen, *A Sociology of Globalization* (New York: W. W. Norton & Company, 2007), pp. 32-41.
[29] Sassen, *A Sociology of Globalization*, p. 34.

Midwest during the second half of the nineteenth century, of how capitalism and its institutions—with governmental involvement too, but to a decidedly lesser degree—homogenized and abstracted space and the material world, particularly the natural world.[30] Similar concerns appear in the work of James Scott, who states that:

> …large-scale capitalism is just as much an agency of homogenization, uniformity, grids, and heroic simplification as the state is, with the difference being that, for capitalists, simplification must pay. A market necessarily reduces quality to quantity via the price mechanism and promotes standardization; in markets, money talks, not people. Today, global capitalism is perhaps the most powerful force for homogenization…[31]

Such issues have been a particular concern of the geographer and theorist David Harvey, who uses the term "the spatial fix" to describe how capitalism is compelled to expand constantly over territory to develop new markets and exploit additional resources. Harvey further argues that capital dominates space at the expense of actors tethered to local places.[32] Early in his scholarly career Henri Lefebvre was also concerned with how capitalism "produces" space; later he turned his focus to how the nation-state does likewise. (Goswami borrows her terminology of "producing" India from Lefebvre.) Ultimately Lefebvre sees capitalism and the state as partners in the process; as Neil Brenner and Stuart Elden explain, "for Lefebvre, the homogenized, hierarchized, and fragmented spaces of capitalist modernity are produced not only through capitalist strategies…but just as crucially…through the variegated regulatory strategies of the state mode of production."[33] The state works in partnership with capitalism to control and exploit space.

Some other scholars, less theoretical than Lefebvre but more grounded in the particulars of their fields, concur with this viewpoint. The rise of capitalism was roughly contemporaneous with the development of the nation-state, and the two are linked in many ways. The most direct connection is that the market, private actors and corporations rely on the state to set the parameters of commerce and regulate its workings. More broadly, capitalism requires a force for order and stability, i.e., a government that enforces contracts, creates social stability, provides education, builds infrastructure, has a monopoly on the use of force, and does many other things the market cannot accomplish on its own.[34] This remains the case in our globalized present. As Ellen Meiksens Wood argues, "there is little evidence that today's 'global' capital is less in need national states than were earlier capitalist interests. Global capital, no less than 'national' capital,

---

[30] William Cronon, *Nature's Metropolis: Chicago and the Great West* (New York: W. W. Norton & Company, 1991).
[31] Scott, *Seeing Like a State*, p. 8.
[32] This set of concerns runs throughout Harvey's works. For a good sampling, see David Harvey, *Spaces of Capital: Towards a Critical Geography* (New York: Routledge [Taylor & Francis Group], 2001).
[33] Neil Brenner and Stuart Elden, Preface to an excerpt from Henri Lefebvre's "Space and the State," in: Lefebvre, *State, Space, World*, p. 223.
[34] Ellen Meiksins Wood, *The Origin of Capitalism: A Longer View* (London: Verso, 2002 [orig. 1999]), pp. 166-169, 177-179.

relies on nation states to maintain local conditions favourable to accumulation as well as to help it navigate the global economy…"[35] Later she adds that: "The economic imperatives of capitalism could be said to have created a global order more integrated than ever before…but to sustain this vast impersonal network requires close social and legal controls, such as those provided by the nation state."[36]

As Wood notes, it now appears that in certain respects the process of globalization is, for better or worse, generating a new kind of global unity. Many have written about this ongoing scalar shift. One of the more prevalent tropes is of a "flat world," as grandly announced in Thomas Friedman's superficial bestseller *The World is Flat*.[37] This presents a fundamentally misleading understanding of globalization, as though it were simply the historical process of the nation-state happening all over again at a larger scale. The opposing dystopian viewpoint is to see in the contemporary condition one of fragmentation and chaos, where the ravages of predatory capitalism and factional hatreds lead to disintegration. But this approach ignores what globalization has actually achieved thus far to interconnect the world. It is evident that a more accurate understanding lies between these two extreme and ideologically-driven positions, but difficult in practice to comprehend how globalization transpires. The example of the shipping container may be helpful.

Railroads and highways helped "produce" nation-states, as did countless other infrastructures, bureaucracies, organizations, procedures, codes, regulations and practices. Arbitrary spaces on a map, bounded by equally arbitrary lines that mark their borders, were given real unity and significance. The constructed nation-state was naturalized, and each nation-state came to seem inevitable. The currently emerging global spatial order is likewise produced, not natural, inevitable or innate, and clearly the container is one of the tools used to bring about this new global terrain. But there are some crucial differences, which one can tentatively identify, between the nation-building process and the presently unfolding dynamic of globalization.

The nation-state, ascendant during the era of modernity, generally sought to minimize or eliminate difference and impose a unity over its space and people. To return to the example of track gauge, the early American railroads operated with a variety of gauges, but a key part of the nation-building process was the gradual conversion to standard gauge throughout the network across the entire national territory. While these early railroad routes were not erased, they were converted wholesale to the uniformity of gauge necessary to establish a seamless domestic network. In countless other respects, including spatial dimensions, engineering details, and bureaucratic practices, the rail system gained a certain consistency, and new routes were built in accordance with this regime. The process involved not only governmental regulation, persuasion and coercion, but also the cooperation of the railroad companies who increasingly viewed this progress as synonymous with their self-interest. While generalization is risky, it is fair to say

[35] Ibid., p. 177.
[36] Ibid., p. 180.
[37] Thomas L. Friedman, *The World Is Flat: A Brief History of the Twenty-First Century* (New York: Farrar, Straus and Giroux, 2005).

most other national infrastructures followed a somewhat similar pattern. Those infrastructures that came later, such as the Interstate highways, in fact often had their uniformity imposed earlier in their development. One way or another, the nation-state (and/or the actors within it) was successful in crafting cohesive and uniform infrastructures.

National infrastructural unity was not a preordained, inevitable outcome. It took time to develop, beginning as fragmented systems before gradually, in halting steps, taking cohesive and unified shape at the national scale. It was constructed by various forces and actors, most importantly the governments of nation-states. Infrastructure helped create the modern nation-state, and the nation-state helped create modern infrastructure. The process to unity was not smooth, nor was it clearly planned from the start in most cases—in other words, it was historically contingent. Often national infrastructures were cobbled together out of diverse fragments, but these fragments eventually were molded into more unified and systematic networks, because the nation-state ultimately (though not initially) possessed the power to do so. Indeed, it was often the development of improved infrastructure in the first place that helped give the state this unifying power; thanks to modern infrastructure, the conditions were in place to allow the nation-state to develop and gain coherence over a large territory.

This evolution from fragmented systems to national infrastructural networks happened in various ways. In the case of the railroads, as already discussed, the plethora of early systems were essentially regional in nature, linking cities to nearby cities, or else cities to hinterlands. In many other cases the tendency was for infrastructure to develop first in major cities, and then expand outwards into towns and the countryside. Given that cities have typically been sites of technological innovation and development, and possess greater resources of funding and power, along with larger concentrations of people, this pattern is not surprising. In *Splintering Urbanism* Graham and Marvin basically posit such a paradigm, at least in the West; they see modern infrastructure beginning in cities like Haussmann's Paris, and later New York and Chicago, before expanding to cover entire nations, a process they view as exemplary of the modern infrastructural ideal.[38] This is a reasonably valid way to understand the development of many infrastructures, though it should be kept in mind that the hinterland around the city was often relevant from the start, at least for its resources. Modern water and sewer systems generally came to urban areas first, but the water itself was usually brought in from far off; likewise electricity developed in cities first, but generally depended on resources to power it (like coal) brought in from elsewhere. In addition, Graham and Marvin's viewpoint overlooks an earlier wave of infrastructural growth at the national scale in the mid- and late 1800s, in particular the railroad and telegraph.

In analyzing the process by which fragmented infrastructures coalesce into a more unified one that spans a nation-state, the categorization discussed in chapter 3 of the system and network is useful. In this conceptualization, a system is an infrastructure at an early stage of development,

---

[38] Stephen Graham and Simon Marvin, *Splintering Urbanism: Networked Infrastructures, Technological Mobilities and the Urban Condition* (London: Routledge, 2001), pp. 43-81.

when it is particular or localized and lacks breadth. Such a system often is the result of a new technology that makes the infrastructure possible, and hence represents a revolutionary innovation. Through technology transfer more systems of the same type are introduced in other places, resulting in numerous separate infrastructures, and as these gradually expand outwards their fragmentation becomes a problem. Eventually the diverse systems are unified into a national infrastructure, which at this point can be termed a network. (A network is not invariably national in scope, however—it is an agglomeration of systems, at no set scale—but for the purposes of this discussion let us assume this national extent.) This generally happens only through great difficulty, as a whole host of standards and procedures must be agreed upon, and furthermore power struggles inevitably emerge. The difference between a system and network is not merely one of scale, for a network, unlike a system, is deeply enmeshed in a multitude of political, social and economic factors. Where the system is an innovation that covers a limited sphere, the network covers most of the nation's population and/or territory, and becomes an essential underpinning of the workings of the nation-state. A system is typically controlled and run by a particular system-builder, but control of a network is more complex, as governments, corporations and users become entangled and each gain a certain measure of power. A network, in short, is a true infrastructure, part of the framework of modernity and the nation-state.

While a national infrastructure may originate as a loose group of limited and incompatible systems, the end result is usually a coherent and unified network. Uniform standards and practices are imposed on the fragmented systems, technologies are upgraded or retrofitted, connections are improved, and the infrastructural network becomes national, both reflecting and reinforcing the state's territorial, political and social unity. It remains to be seen whether a similar process will transpire at the global level, but this dissertation argues that it certainly has not happened yet and is unlikely to occur in the near future. Global infrastructures do exist—and containerization is merely one example—but they differ fundamentally from national infrastructures, because unity and cohesion are so hard to achieve given the persistence of the nation-state.

Thus far globalization has tended to establish itself by knitting together preexisting networks—and generating something on a larger scale out of them—rather than imposing uniform systems. The global dynamic is more adept at working with variations than eliminating them or superimposing new ones. (Perhaps one can regard the infrastructures of the nation-state in their uniformity as exemplars of modernity, while those of globalization, consisting of assemblages of disparate parts, are more typically postmodern.) Yet what makes a global network remarkable is that it achieves a measure of consistency and seamlessness nevertheless. The World Wide Web is probably the paradigmatic example, running over local and national networks yet to a large extent (though certainly not entirely) universally consistent in its appearance and workings. A shipping container is likewise the same everywhere, even as it moves through different national territories and infrastructures that retain their own particularities.

Many scholars have difficulty grasping such nuances; they may scorn the simplicities of Friedman's vision in *The World Is Flat,* yet their own work shares some of his basic assumptions. Neil Smith presents the idea of "scale bending," in relation to globalization, to describe how tightly global forces have tied the world together. In capturing the new worldwide scale of interconnections that link far-flung places ever more directly to each other, the concept is insightful and helpful. But Smith falters slightly when he draws a parallel with the creation of national scales, pointing out that "the earliest nation-states were the ultimate exercise in scale bending."[39] This is true as far as it goes, but obscures some key nuances; global scale bending differs from that of the national because it allows the differences of nation-states to coexist, even as it binds them more tightly together and allows local actors to jump scale. A similar issue clouds some of Keller Easterling's work on the shipping container. She comments that "today, perhaps, the spatial currency for the reorganization of commercial production and distribution is calibrated in part against the container and the new patterns of global trade that it both follows and helps to propagate," and continues by adding that the container is "a generic box capable of streamlining production according to a common format."[40] This is a reasonably accurate stance, yet such phrasing implies a top-down view of globalization, where the container as a global object decisively orders the spatial and material world around it. In this paradigm the past is conveniently ignored or seen as irrelevant, as are the specificities of national and local context, and we are presented with the new zeitgeist, the brave new world of globalization.

One widely held scholarly view of the ongoing spatial form of globalization emphasizes the emerging spatial divisions of "splintering" and "enclaves," which are largely carried out through infrastructure. The leading exponents of this view are Stephen Graham and Simon Marvin, primarily through their book *Splintering Urbanism*, and many other scholars now work through a similar paradigm.[41] The essential argument is that the modernity of the nation-state sought to establish uniformity and cohesiveness, while global dynamics today lead to fractured space and exclusions based on power and wealth. There are separate spaces and separate infrastructures, a hierarchy of intentional inclusion and exclusion. While elites are plugged into global circuits of knowledge and travel, thanks to their access to cutting-edge digital networks and superior transportation systems (such as air travel, high-speed rail, toll roads, etc.), the poor and working class must make do with second-rate systems. In developing countries the divisions are even starker, as the wealthy barricade themselves in secure enclaves served by the expected modern infrastructures of water, power, transportation and communications while the vast mass of the populace struggles to gain access to the most basic services. It is emblematic of a shift—to put it broadly—from the Fordism and modernism dominant until the 1970s to the Post-Fordism and postmodernism of today, and most of all it reflects the power of neoliberal ideology and the fading of social cohesion, the welfare state, and the ideal of the public good. Much of this

---

[39] Neil Smith, "Scale Bending and the Fate of the National," in Eric Sheppard and Robert B. McMaster (eds.), *Scale and Geographic Inquiry: Nature, Society, and Method* (Malden, MA: Blackwell Publishing, 2004), p. 202.
[40] Keller Easterling, "Interchange and Container: The New Orgman," *Perspecta,* Vol. 30 (1999), p. 120.
[41] Graham and Marvin, *Splintering Urbanism*.

“splintering” research examines infrastructure in the developing world, contrasting elite enclaves with slum conditions; Erik Swyngedouw for instance has written of the politics and distribution of water in poor countries.[42] In a First World context, Neil Brenner’s *New State Spaces* describes how certain cities in Europe are increasingly engaging with global commerce and flows while they lessen their ties to the actual nations where they are located.[43]

The “splintering” thesis has some applicability to containerization, for it is wealthy countries that have the best access to container networks of movement, and the best internal infrastructures to link themselves into this global trade. In the business of shipping and logistics it is a common complaint that in certain places it takes longer, and costs more, to move a container a few hundred miles inland than it does to move the same container several thousand miles across the ocean. A 2010 *New York Times* article about India’s congested railroads opens by declaring that “S.K. Sahai’s firm ships containers 2,400 nautical miles from Singapore to a port here [Mumbai] in four or five days. But it typically takes more than two weeks to make the next leg of the journey, 870 miles by rail to New Delhi.” The expense of the overland trip, the writer adds, is about three times more than the ocean voyage. The article goes on to comment that “as the world looks to India to compete with China as a major source of new global economic growth, this country’s weak transportation network is stalling progress.”[44] The ports themselves, key points where the shipping network meets the domestic infrastructure, likewise are crucial for a nation-state’s chances to be properly plugged into world freight commerce; Marc Levinson states that “a country cursed with outmoded or badly run ports is a country that faces great obstacles to finding a larger role in the world economy…it will receive the maritime equivalent of branchline service on a single-track railway.”[45] By the splintering argument, alterations to domestic infrastructure are merely part of an effort to link up the space of the national with that of the global, as national infrastructure is oriented to the imperatives of globalization. There is (so the argument would go) no longer an effort to build a unified national space, but rather a priority on creating links that connect points deep inside the national territory with the larger global networks. This is reminiscent of the condition of a colonized country, and raises the provocative idea that perhaps neoliberal globalization imposes a sort of colonial status on every nation.

To a certain extent this dissertation makes an argument similar to the splintering paradigm: containerization has caused American infrastructure to be more integrated into global networks, and in some ways subordinated to them. The splintering view is especially promising because it attempts to account for different scales, and considers how local, regional and/or national systems connect (or fail to connect) with the global infrastructure. Yet the splintering thesis suffers from some drawbacks, and is not entirely valid for the case of American containerization.

---

[42] Erik Swyngedouw, *Social Power and the Urbanization of Water: Flows of Power* (Oxford, UK: Oxford University Press, 2004).
[43] Neil Brenner, *New State Spaces: Urban Governance and the Rescaling of Statehood* (Oxford, UK: Oxford University Press, 2004).
[44] Vikas Bajaj, “India’s Clogged Rail Lines Stall Economic Progress,” *The New York Times*, June 15, 2010.
[45] Marc Levinson, *The Box: How the Shipping Container Made the World Smaller and the World Economy Bigger* (Princeton, NJ: Princeton University Press, 2006), p. 272.

The success of the container lies in its ability to move virtually throughout a nation's domestic infrastructure, not merely in certain fragments of the national territory. The reasonably successful nations, furthermore, have been quite limited in their progression into splintering; it is no coincidence that it is in the poorest countries where the splintering thesis is most applicable. A larger issue with the splintering argument is its emphasis on neoliberalism and the power of corporate and elite actors to the exclusion of all else. In this paradigm governments are merely carrying out the wishes of businesses, global capital and wealthy elites, and ordinary citizens are nearly powerless. The splintering thesis also tends to succumb to the fallacy noted earlier, of assuming globalization is a novel and inexorable force that has no connection to the past and renders existing conditions irrelevant. The agency of local or national actors, in the splintering schema, is severely limited. Many splintering scholars have undertaken thoughtful investigations of local conditions, and yet the underlying assumption almost invariably is that these localities can only respond to the all-powerful global.[46] (Though in fairness, this way of thinking has become common if not prevalent—it is hardly limited to splintering urbanism.) The example of the container demonstrates an interplay between different scales, rather than one being predominant. The global may dominate in some circumstances, but at other times it is reshaped by the local, regional or national. In addition the dynamic of globalization typically occurs within the structures already in place in nation-states. The flows of container movement, for instance, go through preexisting transport systems that were built as unified national infrastructures—and which still to a large degree play such a role, even as they now accommodate global cargoes also.

The way containerization exploits existing infrastructures is characteristic of a second-order system or internetwork, two very similar concepts explained in detail in chapter 3. A second-order system or internetwork is essentially one that uses existing systems to construct a brand-new and more complex network. The new network, i.e., the second-order system or internetwork, links these existing systems together into a broader infrastructure, one that gains a certain measure of seamlessness thanks to the effective interconnections it crafts between the systems. Previously separate infrastructures are bound together by a particular entity or device (such as the container), and/or by an information-based system that helps coordinate them. The remarkable result is that the container network is cohesive at the global scale, but only because it utilizes the independent and entirely separate national infrastructures that each possess their own distinctive qualities. The seeming impossibility of creating a worldwide infrastructure out of different—and often incompatible—domestic infrastructures is finessed by the approach of the second-order system or internetwork. Hence it is evident that the global container network depends on national transport systems, which are of great importance for that reason. Furthermore, this global network is formed in a fashion that is as much bottom-up as top-down, contrary to the assumptions of the splintering thesis which tends to posit that the global scale imposes itself on the national and local.

---

[46] For a brief critique of splintering urbanism that makes some of these points, see Olivier Coutard, "Placing Splintering Urbanism: Introduction," *Geoforum,* Vol. 39, Iss. 6 (November 2008), pp. 1815-1820. Several other articles in the same issue of *Geoforum* also criticize the splintering paradigm, or add nuance to it.

Paul Edwards advances the terminology of *infrastructural globalism* to describe the development of such world-spanning infrastructures, and while his particular focus is on the worldwide collection and analysis of meteorological data, the concept is broadly applicable.[47] Edwards stresses that a global network cannot be top-down or tightly controlled in its workings, inasmuch as so many participants in different nations are involved. Admittedly this point about the inevitability of shared control and broad participation applies to any infrastructure, at least to some degree, but it is especially the case for a global one. Edwards comments that an instance of infrastructural globalism is likely to be an internetwork, adding that it will be "a network of networks that behaves, at least for many relevant purposes, *as if* it were a single unified system."[48] This description certainly fits worldwide containerization. While an internetwork (or second-order system) is not necessarily global in nature, the concept is well suited to describing worldwide infrastructures that bind together a diverse array of separate national networks.

One characteristic of globalization, and of global infrastructures, is that entities at a variety of scales are increasingly able to interact with each other. The local can link up with the global on its own, without needing the prism of the state. Likewise the global can more and more easily penetrate into the local, bypassing or passing smoothly through national borders. The state loses its primacy as the only scale of action, the only scale able to interact with the global, for new innovations and practices like the internet and the container allow for the local to scale up more directly to the global (and for the global to scale down to the local). One strength of the "splintering" thesis is that it does capture how cities and regions within states are interacting directly with global flows and dynamics. Adherents of splintering are by no means the only ones to describe this dynamic. A similar metaphor is Neil Smith's concept, introduced earlier, of "scale bending." Writing of social and political concerns, not infrastructure, Smith's points are nonetheless fitting, as he notes that recent events "suggest intense 'scale bending' in the contemporary political and social economy. Entrenched assumptions about what kinds of social activities fit properly at which scales are being systematically challenged and upset."[49] The phrases "glocal" and "glocalization," which have become popular in discourses on globalization, capture a similar concept—that of the local directly linked to the global.

The extent of state weakness, as its boundaries are penetrated and its cohesion undermined by globalization, varies depending on the characteristic at stake. The prevalence of many economic global flows—the shipping container among them, but also worldwide flows of money, the outsourcing of jobs, the spread of business ideas, and the global scale at which many corporations operate—reveals the extent to which national economic identity has been punctured. Yet when it comes to society and politics the nation-state is more resilient. It actually

---

[47] The concept is mentioned frequently in Paul N. Edwards, *A Vast Machine: Computer Models, Climate Data, and the Politics of Global Warming* (Cambridge, MA: MIT Press, 2010). See pages 23-25 in particular. Also see Paul N. Edwards, "Meteorology as Infrastructural Globalism," in: John Krige and Kai-Henrik Barth (eds.), *Global Power Knowledge: Science and Technology in International Affairs* [*Osiris*, Vol. 21 (2006)] (Chicago: University of Chicago Press, 2006), pp. 229-250.
[48] Edwards, *A Vast Machine*, p. 229.
[49] Smith, "Scale Bending and the Fate of the National," p. 193.

seems to be experiencing something of a comeback, as shown by the greater border security of post-9/11 existence, problems and potential fragmentation in the European Union, backlashes against immigration, and a resurgence of nationalism in many places. Political power of course continues to be exercised almost entirely at the national scale (except when it is handled locally). The shipping container works primarily at the economic level, where globalization is strongest, and much of its success derives from this. Yet it cannot entirely avoid interacting in the social and political realms, where its power may be more limited.

The flows of container movement constantly intersect with situations at the national, regional and local scales. In an article about how Will County, Illinois, (roughly 35 miles southwest of Chicago) has adapted to the massive new intermodal terminals located there, along with giant distribution centers and the resulting increased traffic, Julie Cidell captures this interaction and some of the tensions associated with it, while undercutting facile "flat world" notions. She notes that "what appears to be one global economic system, extending through nodes and networks across featureless space, is actually located within multiple scales of government."[50] A key node on a global network is also a discrete place with its own history, conditions and conception of itself:

> …each municipality has unique characteristics that mediate the kind of development it gets: a restricted amount of land to work with, shaped by rivers, wetlands, freeways, and railroad tracks… They also have individual histories…of near-bankruptcy, legal disputes with neighbors, or rerouting federal highways to redirect traffic flow around their historic downtowns that shape city staff and elected officials' willingness to pursue particular paths of development.[51]

It is not only a matter of local governance (though that is Cidell's primary focus in her case study), but a whole host of these "unique characteristics" that matter deeply at the local level and do not merely modify or obstruct global infrastructure but play a formative role in its development.

More normative accounts of containerization unfortunately tend to miss this sort of dynamic, and assume local or national variations are problematic and should gradually fade away. Even if they acknowledge this will not happen in the foreseeable future, they persist in viewing variations as inefficiencies. A typical example is a 2004 article, quite knowledgeable in its details, by the Canadian geographers Robert McCalla, Brian Slack and Claude Comtois that describes the challenges of implementing consistent practices for land-based container movement, contrasting the increasing uniformity of container shipping over the ocean with the widely divergent approaches and situations in different nations and regions. The authors are careful not to predict an inevitable whittling away of these differences, instead stressing how firmly entrenched they

---

[50] Julie Cidell, "Distribution Centers Among the Rooftops: The Global Logistics Network Meets the Suburban Spatial Imaginary," *International Journal of Urban and Regional Research*, Vol. 35, No. 4 (July 2011), p. 846.
[51] Ibid., p. 847.

are, yet still refer to them as "constraints" and "impediments," clearly assuming that container logistics would be more efficient without them.[52] Such a viewpoint is so common that it may seem self-evident unless subjected to further examination. This dissertation proposes that instead of viewing national space and infrastructure, or local conditions, as an obstacle to the successful workings of the global container network, we understand them as foundational to it. At times it may even be the case that the local scale actually takes precedence, and the national and global may be merely constituted by a multiplicity of localities.[53] In any case, no scale should be seen *a priori* as dominant, and it is certainly an error to assume the global scale invariably takes precedence and can only be mediated by the local.

Perhaps scholars in the humanities and social sciences, attentive to the social and cultural dimension, are more attuned to how the local, national and global are interlaced and overlaid. In her perceptive and stimulating essay "A Global Sense of Place" Doreen Massey ponders such questions and argues that we must hold onto a sense of place, but stresses this does not imply a view of place as conservative and tradition-bound in opposition to the dynamism of cutting-edge globalization. Actors in particular places are linked into global networks, she demonstrates, and the two are not contradictory.[54] Michael Peter Smith makes similar points in his own work, explaining that the supposed dichotomy between the global and local does not hold up to closer examination, and that local actors do not merely partake of globalization but actively help construct it. Smith is especially insightful in his discussion of David Harvey and Manuel Castells. For all their apparent differences—Harvey is dedicated to a Marxist paradigm while Castells sees technology as formative—each is guilty of essentializing both the global and the local. They view the global as top-down, universal and well-nigh unstoppable, while the local is steeped in culture and tradition and can react to global forces but ultimately is unable to contest them. Smith contests such simplicities.[55]

Another helpful concept in comprehending such nuances within national territory and the built landscape is that of the "palimpsest" or "layered pasts," which has been used by some scholars to contest the assumption that national space is unchanging, and that the unity of this space is a natural condition. To view the territory of the nation-state (or any spatial unit) as a palimpsest is to argue for a long history whose relevance continues, comprising numerous factors predating the nation-state that possess enduring importance.[56] Extending the idea to the

---

[52] Robert J. McCalla, Brian Slack, and Claude Comtois, "Dealing with Globalisation at the Regional and Local Level: The Case of Contemporary Containerization," *The Canadian Geographer*, Vol. 48, No. 4 (December 2004), pp. 473-487.
[53] Robert A. Beauregard, "Theorizing the Global-Local Connection," in: Paul L. Knox and Peter J. Taylor (eds.), *World Cities in a World-System* (Cambridge, UK: Cambridge University Press, 1995), pp. 242-243.
[54] Doreen Massey, *Space, Place, and Gender* (Minneapolis, MN: University of Minnesota Press, 1994), pp. 146-156.
[55] Michael Peter Smith, "Power in Place: Retheorizing the Local and the Global," in: Jan Lin and Christopher Mele (eds.), *The Urban Sociology Reader* (London: Routledge, 2005), pp. 243-244. Also see Michael Peter Smith, *Transnational Urbanism: Locating Globalization* (Malden, MA: Blackwell, 2001).
[56] Daniel Cooper Alarcon, *The Aztec Palimpsest: Mexico in the Modern Imagination* (Tucson, AZ: University of Arizona Press, 1997); Carl Grundy-Warr, "Cross-Border Regionalism Through a 'South-East Asian' Looking-

contemporary case of global forces and the nation-state, one might argue the new wave of global networks is only the latest in this series of layers, and just as the nation-state did not entirely erase previous legacies, so globalization does not cover up earlier inscriptions but adds to them. These previous realities are not merely remnants to be vaguely perceived—though the metaphor of the palimpsest might imply this—but factors that possess their own agency. The national as a crucial scale endures to the present as a powerful and important entity, not as a sub-scale subsumed within the global and somehow secondary to it or powerless against it.[57]

The national, and for that matter the regional and the local, are by no means powerless in the face of global dynamics. Nations and cities can boost their presence in the global order through strategic initiative or simply random good fortune. (Likewise through incompetence or bad luck their status in the global system can be lowered.) They can alter or even redraw the lineaments of the global. They can also choose, to some extent, how deeply and in what ways they will enmesh themselves in globalization. Global power is exerted from particular places, by specific actors, and likewise global networks are constituted by national and local components. Admittedly the global can seem, to local residents or even national governments, like an overwhelming outside force. But this dissertation argues that on occasion local and national actors have reacted quite skillfully to the problems and opportunities posed by the container, and at times have even been proactive in shaping the development of containerization. Within the category of local and national actors, it should be noted, are not just governments but also institutions and corporations—anyone who acts primarily within a local or national framework.

As mentioned earlier, Saskia Sassen's recent work emphasizes the role that actors embedded within the scale of the state often play in carrying out globalization, and Neil Brenner describes how local governments are active in linking their cities and/or regions into the global dynamic. Such points fit well with the thrust of this dissertation, which investigates how various participants in the American transportation system have adopted the container and developed their own roles within larger global networks and supply chains. The general tendency has been for the complex and tightly organized global supply chains to be composed of multiple participants, all working in a coordinated fashion but nevertheless independent of each other.[58] Each transportation-oriented company is able to specialize in what it does best, in the context where it is most familiar. This is logical, since a U.S. trucking company (for example) can handle the American road portion of a container trip far better than a Korean shipping company or a German railroad. Yet though this allows participants to focus their activities within their own particular scales, such a situation does encourage them to gain a newfound awareness of the

---

Glass," *Space and Polity,* Vol. 6, No. 2 (August 2002), pp. 219-223; Daniel K. Richter, *Before the Revolution: America's Ancient Pasts* (Cambridge, MA: Belknap Press of Harvard University Press, 2011).

[57] For a cogent argument for the enduring importance of the national scale, see Becky Mansfield, "Beyond Rescaling: Reintegrating the `National' as a Dimension of Scalar Relations," *Progress in Human Geography*, Vol. 29, No. 4 (August 2005), pp. 458–473.

[58] John C. Taylor and George C. Jackson, "Conflict, Power, and Evolution in the Intermodal Transportation Industry's Channel of Distribution," *Transportation Journal,* Vol. 39, No. 3 (Spring 2000), pp. 13-15.

larger worldwide networks they are now enmeshed in. This can affect their strategy and behavior in diverse ways, and may even lead them to pursue contacts and partnerships abroad.

Today's global networks of containerized freight movement utilize the well-established pathways, often created with great effort, of the nation-state. Some of these national infrastructures were originally built for very different purposes, but no matter; today they serve both national and global agendas. Acknowledging the importance of the nation-state in the development of these global routes of container travel raises the role of history and geography. The nation-states are the result of a long historical process and are embedded in particular territories. Hence the form of globalization, and specifically the routes of container movement, follow a long and intricate heritage, with particularities that vary by place and circumstance. As Sassen points out, "as the national becomes a more complex site for the global, the specific and deep histories of a country become more, rather than less, significant and hence produce distinctive negotiations with the new endogenous and external global forces."[59] To comprehend the pathways of container movement, it is necessary to delve into the historical and geographic context of the nation-state.

Take, for example, the transportation routes that run east-west across upstate New York. The Appalachian Mountains, extending from north Georgia all the way to Maine, pose a great obstacle to movement in an east-west direction, but the Mohawk Valley, running west from Albany north of the Catskills and south of the Adirondacks, offers a passage through. The Native Americans of the region had long used it for travel. In the early 1800s the Erie Canal was built through it, helping New York City surpass its eastern urban rivals like Boston, Philadelphia and Baltimore. For water-based transportation of course the issue of topography is crucial, given the necessity of having a nearly flat route. By the same reasoning the corridor was also an inevitable path for a major railroad line—the logic of topography was compelling, as trains prefer to run on nearly level ground and tunnels are expensive to construct. Eventually this became a major route for the New York Central Railroad, carrying freight and passengers, and it remains a key rail corridor today. Later the highway would follow a similar path, with the New York State Thruway (Interstate 90) running more or less parallel to the railroad and canal. For the Mohawk Valley, and the area west of it all the way to Lake Erie, geography made the development of transport infrastructures along its path almost inevitable. The presence of cities that grew rapidly thanks to the Erie Canal (Albany, Utica, Syracuse, Rochester, Buffalo, etc.) further reinforced the logic of placing later generations of infrastructure along the route, for these cities in their own right required transport connections.[60] Today large quantities of containers travel by both train and truck through this corridor of transport infrastructures, which serves local, regional, national and now global purposes.

Similar narratives could be told elsewhere. Chicago owed its early growth to being at a location where portage between the Great Lakes watershed and Mississippi River watershed was

---

[59] Sassen, *Territory, Authority, Rights*, pp. 229-230.

[60] See Peirce Lewis, "The Landscapes of Mobility," in: Karl Raitz (ed.), *The National Road* (Baltimore: The Johns Hopkins University Press, 1996), p. 14.

as short as possible. Superb natural ports made it inevitable San Francisco and New York City would grow into major metropolises. The Central Valley of California, a natural north-south corridor surrounded on either side by mountains, attracted transport infrastructures of rail and road (and is expected to receive high-speed rail in the near future), along with a chain of cities running from Bakersfield to Sacramento. Sometimes geography is indeed destiny.

Yet contingency and agency are also crucial—the abstract logic of geography does not apply willy-nilly. While Chicago was founded for waterborne movement the city's great boom came thanks to the railroad, an infrastructure that had no compelling reason to make that location a hub as many other cities in the Midwest would have been equally suitable. The city's boosters and business leaders worked indefatigably to promote Chicago, and sheer historical accident (the initial failure of St. Louis to appreciate rail's importance, for instance) also played a part.[61] Los Angeles is an even more extreme case, as the entire history of the city and region is one of overcoming natural and geographical disadvantages—the most celebrated and notorious example being in the provision of water. While the history of water supply in Los Angeles is more well known, not to say controversial, the city's success with ocean shipping is no less remarkable. The region has no natural port whatsoever, in contrast to San Francisco to the north and San Diego close by to the south, yet over the years Los Angeles and adjacent Long Beach have constructed the largest and most successful port complex of the West Coast. Los Angeles also benefited greatly from being selected by the railroad companies to be the western terminus of the second transcontinental railroad, and much later of course it was very energetic in buildings its roads and highways for the automobile.[62] Such legacies live on today in many ways. (In particular, the Chicago and Los Angeles regions are now the two largest nodes of container movement in North America.)

So it is an error to assume today's "global flows" (such as containerization, the internet, etc.) constitute a placeless and inexorable logic that puts networks and nodes down on helpless spots on the map. Global networks are actively shaped by a plethora of local and national factors. It is equally important to understand that globalization possesses its own history and does not derive from some overarching zeitgeist too pervasive to be fully understood or for its origins to be unpacked. Yet such subtleties tend to be overlooked. Manuel Castells has been one of the foremost thinkers on the subject of global networks in recent decades, and his concept of the "space of flows," which describes how global infrastructures both physical and information-based intersect with space, has rightly been influential. Yet even he indulges in this type of rhetoric, claiming that "because function and power in our societies are organized in the space of flows, the structural domination of its logic essentially alters the meaning and dynamic of

[61] Chicago's rise is skillfully described in Cronon, *Nature's Metropolis*.

[62] For an account of how Los Angeles through its history has energetically built up its transportation infrastructure, with a particular focus on recent decades, see Steven P. Erie, *Globalizing L.A.: Trade, Infrastructure, and Regional Development* (Stanford, CA: Stanford University Press, 2004). For a somewhat similar narrative in a different context and time, see Mason B. Williams, *City of Ambition: FDR, La Guardia, and the Making of Modern New York* (New York: W. W. Norton, 2013).

places."[63] Such a statement essentializes global networks and puts local or national settings into a subservient position, as largely helpless. Castells goes on to refer to the space of flows as "ahistorical."[64] To the contrary, the current shape of globalization is deeply historical, being rooted in a historical process and influenced by specific places and events.

The shipping container is not something that appeared out of nowhere, or that developed through some pervasive global dynamic, but rather an object with a particular heritage stemming from the spatial regime of U.S. trucking and highways in the early 1960s. Likewise the global routes of commerce are formed (and over time constantly reshaped) by the conditions and histories of particular cities, regions and nations, as well as by actors working in those scales. This is a constant process, and one in which the local, regional and national can possess their own kind of agency. As Stephen Ramos points out, in the context of Dubai: "Much of the 'networked city' literature presupposes that with global connectivity, international flows will enter cities unidirectionally and reconfigure their spatial logics… [but] urban form, facilities, character, and policy can be precisely the decisive elements that attract global activities to a particular city."[65] Over the past few years some scholars, like Cidell and Ramos, have formulated arguments that critique the "splintering" (or "networked city," as Ramos puts it here) thesis, in particular its assumption of infrastructural globalization occurring in a top-down manner. Broader criticism of the splintering paradigm is not particularly new, for as already noted scholars in the social sciences like Massey and Smith have long been poking holes in it—or, more broadly, in the top-down view of globalization that splintering is in accord with. But writers like Cidell and Ramos are more specific in that they deal with infrastructure itself. Several articles in a themed issue of *Geoforum* in 2008 (the theme's title being *Placing Splintering Urbanism*) also contest many aspects of the splintering thesis, through detailed investigations of infrastructure in specific places. The articles vary in their tone and conclusions, but most argue for at least a more nuanced version of splintering and some reject it outright.[66]

This dissertation likewise seeks to advance a more nuanced approach, one that draws on the insights of the splintering paradigm while contesting some of its simplicities. The role of history is central in this effort, as the dissertation demonstrates that the ongoing development of the network of shipping container movement, in the American context, is shaped by the nation's infrastructural past—a past that endures in concrete form in today's transportation corridors. Geography is also relevant, as the topography and borders of the U.S., the pattern of its rivers and lakes, and the location of its major cities, have been (and continue to be) pivotal in the formation of its infrastructure. But most of all the dissertation argues that the development of global infrastructure, as illuminated by the example of containerization, differs in some key ways

---

[63] Manuel Castells, *The Rise of the Network Society* (2nd ed.) *[The Information Age: Economy, Society and Culture, Vol. 1]* (Oxford: Blackwell Publishers, 2000), p. 458.
[64] Ibid., p. 459.
[65] Stephen J. Ramos, *Dubai Amplified: The Engineering of a Port Geography* (Farnham, UK: Ashgate, 2010), p. 6.
[66] *Geoforum,* Vol. 39, Iss. 6 (November 2008). There are ten articles, and also an introduction by Olivier Coutard, who edited the themed issue.

from that of national infrastructure; the latter is cohesive and unified in a fundamental sense, while the former is an assemblage of disparate networks that nevertheless gains a measure of cohesion. The congruence of government, economics and society within the territory of the nation-state has not necessarily ended, but it certainly has been complicated by globalization, and so more flexible views of space, territory, scale and infrastructure are needed. The ideas of scholars like Sassen, Massey and Cidell, among others, can help us advance along these lines, as we recognize the power of the global, but also the agency of the national and local scales, in the continuing reconfiguration and globalization of infrastructure.

Chapter 5 ~ The Reluctant Railroads

This chapter will discuss the early history of containerization on American railroads, from the 1920s through the '50s, and the growing use of the globally standardized shipping container by these railroads in the 1960s and '70s. During these periods of time trains served to carry containers in moderate quantities on rail routes, but the container did not have a deep impact on the railroad industry. The rail network existed in its own right, a system with its longstanding history and practices and firmly embedded in the American landscape. As container movement was until the late 1970s a very small part of the railroad business, there was no need to make significant changes for the container's sake. Containerization still represented a fairly minor incursion into the territory and infrastructure of the U.S.; the infrastructural unity of the nation-state, set apart from the outside world, remained firmly in place. In the 1980s this would begin to change dramatically, as the container entered into the railroad network in greater numbers and became a key object about which the rail system oriented itself—that is the focus of chapter 7. But this chapter focuses on a period when the container for the most part had to fit into the existing rail infrastructure.

The railroad occupies a vital place in U.S. history, being the crucial infrastructure that tied the country together during dynamic years of growth, development and consolidation, particularly in the second half of the nineteenth century. From east to west across an entire continent, the railroad network converted a vast and lightly-settled frontier territory into a cohesive, interconnected and advanced nation. The consequences were technological, economic, political, social and cultural in nature. In numerous other countries the railroad played a similar role, binding territories together more tightly. But the American case is somewhat different, for in the U.S. the rise of the railroad coincided closely with the westward expansion, progress and development of the country itself. While in other nations rail helped unify a national space that was already well established, in the U.S. the railroad played a formative role in establishing that space in the first place. (This was by no means a unique situation, as a similar dynamic existed in many other newfound nations of North and South America. In colonial settings meanwhile the railroad was often a key instrument in establishing the territories of imperial control.) Writing about the place of both the river steamboat and the railroad in U.S. history, Wolfgang Schivelbusch comments that:

> The mechanized transportation system became, as it were, a producer of territories, in the same way that mechanized agriculture became a producer of goods. Since American history really began with the industrial revolution (all else being colonial pre-history), that revolution is a constituent part of American

> national and cultural identity to a far greater degree than it is in Europe. Steam power [the steamboat and railroad] was perceived as a guarantor of national unity…[1]

The railroad was the first infrastructure of modernity, transforming life in a multitude of ways. This was most evident of course in terms of transportation itself—the train was exponentially faster and more reliable than any previous mode of transport, and could carry far greater numbers of people and larger quantities of goods. The railroad was revolutionary in terms of technology, and in this it was linked to the Industrial Revolution, whose machinery created a break with the past in so many ways. No longer was civilization dependent on animal muscle power, wind, or water currents for its transportation. But the influence of rail ultimately went far beyond even this. The massive railroad companies are often regarded as the first modern corporations, their tremendous scale and tightly coordinated operations and bureaucracies necessitated by this new technology.[2] The growth of rail travel also made it necessary to standardize time—one of the most fundamental qualities of how we experience human existence—changing a plethora of local and informal times into broad and standardized time zones. There were other far-reaching social and cultural shifts as well.

For a railroad system to function successfully it is necessary there be a host of standards, many of them spatial in nature. Probably the most obvious is the distance between the tracks, known as the track gauge or rail gauge; as should be evident, a unified rail network must have a common track gauge throughout. Consequently this is a key dimension in the workings of railroads, and in the history of their development, with ramifications that are not merely technical but occasionally political. The most widespread track gauge is 4'-8½" and is fittingly known as standard gauge—this is used in the U.S. and indeed about 60% of the world's railroad routes.[3] Another important dimension is the loading gauge, which is the maximum height and width that are allowable for the train. This determines the clearances that must exist both vertically and horizontally for the train to move safely. The vertical clearance is especially crucial, as it determines the height of overpasses such as bridges, and the height of tunnels. It is usually extremely expensive and difficult to alter the vertical clearance on a rail line, especially one with many tunnels. The issue of vertical clearance became critical beginning in the 1980s for American railroads that sought to carry containers in a "double-stack" configuration, as will be discussed at length in chapter 7. There are many other dimensions and physical qualities that also must be standardized, or at least controlled and monitored: the minimum turning radius, length and weight of a railcar, details of connections between cars, etc. Of course there are also railroad standards that are not at all spatial in nature, such as the method of propulsion, the type of signaling, the braking technology, and so forth, but our main concern here is with the more

---

[1] Wolfgang Schivelbusch, *The Railway Journey: The Industrialization of Time and Space in the 19th Century* (Berkeley: The University of California Press, 1977), p. 91.
[2] Alfred D. Chandler, Jr., *The Visible Hand: The Managerial Revolution in American Business* (Cambridge, MA: The Belknap Press [Harvard University Press], 1977), pp. 81-187.
[3] Wikipedia, "Track gauge." (http://en.wikipedia.org/wiki/Track_gauge, accessed 6/28/11).

spatial aspects, which are so relevant to the container's presence in the rail system. Using the concept of the spatial regime introduced in chapter 3, one can regard the host of spatial factors and dimensions associated with a railroad system as such a spatial regime.

Figure 5.1: *Across the Continent ("Westward the Course of Empire Takes Its Way")*, Currier & Ives lithograph

Source: About.com, "19th Century History" (http://history1800s.about.com/od/steam locomotives/ig/19thcentloco/acrossthecontinent01.htm, accessed 4/15/13)

The nature of standardization varies depending on the dimension in question. When it comes to track gauge, clearly there is no room for flexibility—every rail corridor must accept the standard, or else the network is irretrievably fragmented. (Sometimes there are narrow gauge railroads on specialized routes, such as for mining, but these are isolated and now very rare.) The loading gauge is another matter; in this case absolute consistency is not needed, for a train that is set for one particular loading gauge can obviously travel on a line designed for any loading gauge larger than that one. In practice though there is a need for a standard minimum for the loading gauge, so that railcars of that size (or smaller) can be assured of traveling freely across the national network. Currently in the U.S. and Canada this minimum loading gauge is identified as AAR Plate B, and a train that meets its requirements for a height of 15′-1″ and width of 10′-8″, in addition to a few more technical considerations, can essentially move freely throughout the rail system. (However, AAR Plate C, with a 15′-6″ height and 10′-8″ width, now exists so widely that it is arguably the *de facto* standard.) Beyond this minimum there are significant variations, manifested in several other larger standards for loading gauge, and most of the major rail corridors in the U.S. meet one of these larger standards thus allowing bigger and more profitable railcars to pass through them.[4] (While the loading gauge is the maximum height and width of the trains, there is also a dimensional standard known as the structure gauge which is the minimum height and width of the clearances. Obviously the structure gauge must be slightly larger than the loading gauge, so as to provide an adequate margin of safety.)

In the beginning of the railroad era, during the early and mid-1800s, the assorted American railroad companies set their own particular spatial regimes, each choosing as it thought best. The most common track gauge was the 4′-8½″ standard gauge that originated in Britain, but it had plenty of competition. Tracks in the Southeast were generally at a gauge of 5′, though 5′-6″ was also used there, and the Erie Railroad in upstate New York used a 6′ gauge. Gauges of 4′-9″ and 4′-10″, bizarrely close to standard gauge, also existed. In the mid- and late 1800s there was a short-lived flurry of excitement among engineers over the supposed advantages of narrow gauge (i.e., under 4′), and so several narrow gauge lines were built, primarily in the West. Sometimes a railroad intentionally used a different gauge as those around it in the hope of wielding greater control over its traffic (though this strategy often backfired as the line became isolated). More commonly early railroad builders simply did not anticipate the need to link up with other lines, since they regarded their routes as local or regional in nature.[5] In addition, some people had an interest in keeping the network fragmented:

> In 1861, because of different gauges, eight changes of cars were necessary for a trip from Charleston to Philadelphia. Impediments to through traffic were caused not only by the absence of over-all planning but also by the presence of strong local economic interests. Tavern keepers, teamsters, and porters were happy that no single rail line entering either Richmond or Philadelphia made a direct physical connection with any other railroad entering the city.[6]

As early as the 1830s some foresighted engineers already were arguing for the use of one uniform gauge throughout a nation, and in 1846 Britain passed legislation mandating the use of standard gauge for most future construction. Others were less perceptive. In discussing the gauge of the projected first transcontinental railroad, several American senators in 1863 voiced doubts about the necessity of a standard gauge throughout the system, some even claiming that the periodic transfer of goods was advisable for safety.[7] Senator William Fessenden of Maine

---

[4] Wikipedia, "Loading gauge." (http://en.wikipedia.org/wiki/Loading_gauge, accessed 6/28/11); Christian Wolmar, *Blood, Iron, and Gold: How the Railroads Transformed the World* (New York: PublicAffairs [Perseus Books Group], 2010), p. 70.

[5] Douglas J. Puffert, "The Standardization of Track Gauge on North American Railways, 1830-1890," *The Journal of Economic History,* Vol. 60, No. 4 (December 2000), pp. 933-960; Derek Hayes, *Historical Atlas of the North American Railroad* (Berkeley, CA: University of California Press, 2010), pp. 112-115; Wolmar, *Blood, Iron, and Gold*, p. 89.

[6] John F. Stover, *American Railroads* (2nd ed.) (Chicago: University of Chicago Press, 1997), p. 45.

[7] William R. Siddall, "Railroad Gauges and Spatial Interaction," *Geographical Review,* Vol. 59, No. 1 (January 1969), pp. 30-31.

claimed that "the idea that the same cars will be run over this immense length of road and from one end of the country to another is not a very probable one."[8] But as the system grew ever more interconnected and sophisticated, and train trips got longer and faster, the need for standardization and unity in the track gauge became evident to all. Various awkward devices were introduced to allow railcars to move on multiple gauges, but none worked well—there was simply no substitute for having one consistent gauge. Given the expense of retrofitting, and the interests standing in the way, though, that was not easily accomplished. As of 1861 only about half of the nation's tracks were standard gauge. The triumph of the North in the Civil War helped pave the way to unity of gauges, and the use of standard gauge in the contruction of the first transcontinental railroad, completed in 1869, was an added impetus. By 1880 roughly 80% of the country's tracks were standard gauge, with only the Southeast remaining largely the exception. A watershed moment was the decision of several Southern railroads in 1886 to change to a 4'-9" gauge, which was consistent with the Pennsylvania Railroad and close enough to standard gauge to allow interchange. By about 1900 even this minor discrepancy had been eliminated, and virtually all trackage (except for a very few minor and isolated narrow-gauge railroads) was standard gauge.[9]

The unity of the national railroad infrastructure had essentially been cemented by 1890. The triumph of standard gauge while crucial was but a part of this larger process, which included not merely physical tracks and trains but also a host of institutional innovations like time zones, through tickets (for passengers), and through bills of lading (for freight). Throughout this evolution, various actors—governmental, corporate, and among the general public—sought either to advance or delay this unity, but also, and most importantly, to influence its eventual form. The qualities of national infrastructural unity ultimately reflected the desires of those who proved most powerful in the process. The decision setting the first transcontinental railroad's gauge serves as a good example. President Lincoln made the initial decision in 1862 to set the gauge at 5', consistent with that of railroads already existing in California, but the dominant eastern railroad companies immediately lobbied Congress for standard gauge instead. They argued quite logically for the value of a unified and seamless national system—but of course they wanted it on their own terms, with the gauge most of them were already using. The senators of the Northeast and Midwest were easily persuaded, outvoted those of California and Oregon, and passed legislation making the gauge 4'-8½", with the House of Representatives following suit soon after.[10] (Due to the ongoing Civil War, the South was not represented at all.) In this as in so many other ways, numerous interests and preferences became embedded in the eventual character of national infrastructural unity.

---

[8] Ibid., p. 31.
[9] Puffert, "The Standardization of Track Gauge on North American Railways, 1830-1890," pp. 933-960; Stover, *American Railroads*, pp. 143-144; Hayes, *Historical Atlas of the North American Railroad*, p. 128.
[10] George Rogers Taylor and Irene D. Neu, *The American Railroad Network, 1861-1890* (Urbana, IL: University of Illinois Press, 2003 [orig. 1956]), pp. 55-56.

In addition to the spatial and physical factors inherent in issues like track gauge and loading gauge, the interior dimensions of railcars are also important since they determine the quantity of goods carried. The railroad brought a new order to the packing and movement of goods, as each railcar and its contents became a spatial unit. William Cronon in *Nature's Metropolis* gives an example of this, while discussing the movement of grain: "Compared with other modes of transportation, railroad cars moved grain more quickly and in standardized carloads of medium size. With whole freight cars, for instance, carrying nothing but wheat, shippers and railroad managers soon came to think of grain shipments not as individual 'sacks' but as 'carloads' consisting of about 325 bushels each."[11] The principle obviously can apply to any cargo moving by train. In his book about the history of A&P, and the American chain store more generally, Marc Levinson repeatedly notes the advantages (for A&P and other chain stores, and also large wholesalers and jobbers) of being able to buy products by the train carload, rather than in smaller quantities as was the case for independent grocers.[12] The spatial capacity of the railcar, in short, became a standard in terms of volume (and hence quantity and weight for particular products), and therefore was a conceptual unit in its own right. A similar phenomenon would later happen with the truck trailer, and with the shipping container itself. Among the various types of railcars, the most important such standard was the boxcar, a versatile all-purpose enclosed car that carried all kinds of goods. (Boxcars are still widely used, but are no longer dominant as various more specialized railcars have become prevalent.) Railcars are also conceptual units from the viewpoint of railroad operations, as the cars can be moved back and forth between trains, and added to or removed from a train.

The paths of the railroad corridors, laid across the land, had a formative impact on American space and geography, and on the location of cities and towns. Even many cities that today are dominated by the automobile owe their original importance and early growth to the train—Atlanta and Los Angeles are examples. The rail pathways are integrally tied to topography and other features of the landscape, as a train is quite limited in the slope it can climb, far more so than an automobile. (There are exceptions such as cog railroads, but they are not widely used.) So the railroad builders selected reasonably flat corridors—valleys and flatlands were appealing while mountainous regions were avoided if at all possible. With land relatively cheap in the U.S. and labor relatively expensive (compared to Europe), American railroads were particularly motivated to avoid building trenches, tunnels, bridges or viaducts, instead routing the tracks long distances around topographic obstacles and bodies of water.[13] The rail corridor across upstate New York known as the "Water Level Route" is an exemplary instance of the way railroad builders sought out the most topographically convenient path. The Mohawk Valley to the west of Albany forms an accessible route through the Appalachian Mountains, and it was

[11] William Cronon, *Nature's Metropolis: Chicago and the Great West* (New York: W. W. Norton & Company, 1991), p. 110.
[12] Marc Levinson, *The Great A&P and the Struggle for Small Business in America* (New York: Hill and Wang, 2011), pp. 81, 84, 161.
[13] Schivelbusch, *The Railway Journey*, pp. 96-98.

fully exploited by the New York Central Railroad for this purpose, ultimately becoming part of a main line (the Water Level Route) between New York and Chicago. In the Southwest the U.S. government even purchased land from Mexico (the Gadsden Purchase of 1853) in order to make possible a route through southern Arizona and New Mexico that avoided mountains to the north. Crossing rivers could also be an issue; railroads would go long distances to find the easiest crossing, or delay building a bridge and instead depend on ferries to move their passengers and goods across the water.

But sometimes the railroads made choices unrelated to such factors. The lines looked to choose the most profitable routes—or those where they could be persuaded or induced to come. Cities and towns were often desperate for a rail connection, realizing their economic future depended upon it, and accordingly offered all sorts of incentives. In their novel *The Gilded Age* Mark Twain and Charles Dudley Warner give a memorably comical account, exaggerated yet broadly accurate in spirit, of such a case.[14] Sergio Leone's film *Once Upon a Time in the West* also gives a glimpse of the conflicts (albeit playing out more violently than was usual) that could surround the siting of a railroad station. Major cities were at least assured of receiving some service, but sought to have a few competing lines instead of just one monopolistic provider. The strategies and considerations of the corporate railroad barons could be quixotic. When in the 1870s the powerful Southern Pacific Railroad was building routes into Southern California from both the north and east, the logical terminus was San Diego, the city with the best natural harbor in the region. But Southern Pacific had extensive real estate interests along the shores of the San Francisco Bay area, and the company's executives feared the value of their holdings there would be diminished if San Diego were to grow into a West Coast rival to San Francisco. So instead they chose to end their routes in a city of relatively little importance at the time: Los Angeles. Not inclined to generosity, however, the railroad imposed steep conditions on the city in return for this valuable access.[15] Thanks to these new connections Los Angeles rapidly grew, quickly outstripping San Diego.

A metropolis that was enterprising—or simply lucky—could outrace its competitors, and one such case was Chicago. Founded in the early 1800s due to its location at the most convenient portage from the Great Lakes to the Illinois River (that river giving access to the entire Mississippi River watershed), the young city grew thanks to its location at this point in the water-based transportation system. But it lagged far behind some of the other major water-based cities of the Midwest, such as St. Louis and Cincinnati, that had come to prominence earlier. It was the arrival of the railroad that boosted Chicago beyond these competitors and into the dominant city of the Midwest. While St. Louis confidently enjoyed its seemingly unassailable position just south of the confluence of the Mississippi, Missouri and Illinois rivers, and remained focused on

[14] Mark Twain and Charles Dudley Warner, *The Gilded Age: A Tale of Today* (New York: Modern Library [Random House], 2006 [orig. 1873]). See chapters 27 and 28.
[15] Steven P. Erie, *Globalizing L.A.: Trade, Infrastructure, and Regional Development* (Stanford, CA: Stanford University Press, 2004), pp. 49, 52.

waterborne transportation, Chicago embraced the new railroad technology.[16] Multiple railroad companies came to serve the city, and as some ran east and some west but none in both directions, Chicago grew entrenched as a giant hub for the movement of both goods and passengers. Geography had little to do with Chicago's success in attracting the railroads, for it had no inherent advantage in this regard over other Midwestern locations. Rather it was the city's initiative, along with the decisions of railroad executives in New York City and elsewhere, that proved crucial.

In the early days of American history infrastructure often played a role that was more oriented to the rest of the world—and especially to Britain—than to unifying the young nation. This was quite logical when America was a mere colony of the British, but continued to a large degree into the early 1800s as the vast resources of the young and underdeveloped nation were largely funneled to Europe. The routes of railroads and inland waterways tended to run from the interior to the coast for this purpose. As the century wore on and the U.S. gained greater unity and a stronger identity—as well as a manufacturing base and large cities—the situation changed and infrastructure acquired a more unifying national aspect. During the construction of the first transcontinental railroad in the 1860s the widespread expectation was that it would serve primarily to expand American trade with Asia, but instead it generated growth in the western U.S., and promoted commerce throughout the nation. (The idea of Asian trade with the U.S., or passing through the U.S., goes far back in American history, to the earliest days of Western expansion and even the search for the Northwest Passage.[17]) One figure in the railroad industry, writing roughly 20 years after the completion of the transcontinental railroad, admitted that "we connected it rather with the notion of transcontinental communication and trade with China and Japan than with internal development, or what railroad men call local traffic." He added that hopes of Asian commerce "have fallen far short of fulfillment," while "the enormous development of local business has surpassed anything we could have ever dreamed of."[18] The American railroad network ultimately stitched the country together, encouraging development throughout and serving as a unifying force. (This vision of trade with Asia coursing through the nation's western railroad lines did eventually come true, however, as chapter 7 will describe, and containerization had a lot to do with it.)

Yet even as the railroads increasingly knit the nation together in the second half of the nineteenth century, much of the optimistic rhetoric of unity by rail faded. During the early 1800s the new technology was seen to embody the promise of national unity in multiple ways: economic development, cultural uplift, enhanced communication, social ties, military security, territorial expansion, etc. Encomiums to rail's importance came from railroad entrepreneurs, predictably enough, but also from civic leaders, citizens groups, and journalists and writers. But

---

[16] Cronon, *Nature's Metropolis*, pp. 296-303.
[17] John Warfield Simpson, *Visions of Paradise: Glimpses of Our Landscape's Legacy* (Berkeley, CA: University of California Press, 1999), pp. 89-90.
[18] Stephen E. Ambrose, *Nothing Like It in the World: The Men Who Built the Transcontinental Railroad, 1863-1869* (New York: Simon & Schuster, 2000), pp. 370-371.

from about 1850 onwards the major railroad companies, growing ever larger and wealthier, felt more inclined to assert their own self-interest, while the public attitude towards the railroads grew negative. Dreams of unity and universal advancement took a back seat to ruinous competition on some occasions, and monopolistic behavior at other times and places. The larger companies were now extraordinarily powerful, well organized and far-flung, and their actions reflected this new reality.[19] Consequently popular resentment was widespread. Yet in the midst of the constant controversy and strife, the railroad companies during the second half of the century continued to grow rapidly, and to build links among themselves. Standardized practices and interchange techniques, along with stations serving multiple lines, made the rail system more unified. One crucial part of this process, as already described, was the imposition of standard gauge throughout the national network.

During the nineteenth century American railroads were crucial in supporting the nation's military operations, of fundamental importance in the nation-building project. The railroad's military role is best known in the context of the Civil War, where it helped revolutionize warfare and gave the North a key advantage. But rail was equally relevant to the conflicts against Native Americans associated with westward expansion. The army and western railroad companies found themselves in a symbiotic relationship, with the railroads depending on soldiers to protect their lines, encampments and construction crews, while the military needed rail to move soldiers, equipment and supplies quickly over large territories. Civil engineering was taught at West Point, and many of the leading railroad engineers and builders had a military background.[20] While the military justification for the building of the Interstate highways in the twentieth century would become well known, the railroads arguably were more integrally connected with the American military.

American railroad companies have a long, albeit sporadic, history of pursuing intermodalism in the movement of freight—that is to say, applying strategies that involve using more than one transport mode to carry goods, with an easy transfer of cargo between the modes. Most often railroads have pursued these coordinated intermodal schemes with trucking firms. The benefit of coordination is that each mode concentrates on what it does best: the railroad carries the cargo economically a long distance over a fixed route, while more flexible trucks pick up the cargo at its origin and drop it off at its destination. There were, and still are, essentially two ways to carry this out. The most obvious method is to carry entire truck trailers on train flatcars, a practice widely known as "piggyback" and more technically called trailer-on-flatcar or TOFC. The other method is to utilize a solidly-built and weatherproof giant box—that is to say, a shipping container—that is interchanged between trucks and trains, with the container typically large

---

[19] James A. Ward, *Railroads and the Character of America, 1820-1887* (Knoxville, TN: University of Tennessee Press, 1986), pp. 128-150.

[20] For an extensive account of American railroads and the military, see Robert G. Angevine, *The Railroad and the State: War, Politics, and Technology in Nineteenth-Century America* (Stanford, CA: Stanford University Press, 2004).

enough to be analogous to a trailer without wheels. This practice is termed container-on-flatcar or COFC.

Early versions of both piggyback and COFC appeared long before the motor vehicle. In both the U.S. and Europe in the nineteenth century there were piggyback-like operations in which horse-drawn wagons were carried by train, with the wagon strapped onto a flatcar (and the horses carried in a boxcar or fresh horses provided at the other end). One widely referenced American example is a railroad that moved wagons with farm produce from Long Island to New York City.[21] (With perishable food as the cargo evidently speed was of the essence, and so it made sense to avoid the delay of loading and unloading the goods at both ends of the rail journey.) Circus wagons sometimes traveled by train as well, and the technique used to load them, involving ramps, came to be known as "circus loading." (The practice continued for a time after circuses switched from wagons to motorized trucks, as shown in the Cecil B. DeMille film *The Greatest Show on Earth*.)

Likewise there were examples of containerization in the nineteenth century, in which containers were transferred between train and wagon, or in some cases between train and ship or barge. A variety of containers were created and used for this purpose in Britain and the U.S., though generally with limited success. As far back as the 1830s, railroad companies such as the Liverpool and Manchester Railway in Britain and the Camden and Amboy Railroad in the U.S. used containers in an intermodal fashion. Some manufacturers and shippers of particular products, such as ice, strawberries and bread, also invented and used large crates, boxes and/or chests that somewhat resembled containers in their use. Various inventors also patented container designs, though they typically went unrealized. While all of these early containers were small (by later standards) and arguably more comparable to oversize crates and boxes, they were large enough, and able to hold a sufficient weight, that cranes or other lifting devices were necessary to move them (though some were built with rollers and could be pushed from one mode of transport to another). They were sufficiently durable and weatherproof to be placed atop rail flatcars and wagons, rather than being put inside boxcars or covered wagons. Furthermore they were not abandoned after a journey, but remained in use.[22] All these are key characteristics of the shipping container, and so these early containers can at least be regarded as its precursors.

During the late 1800s and early 1900s an interesting use of rail freight arose in North America that—though not intermodal, strictly speaking—could be regarded as a precursor to today's "Just-In-Time" containerized global supply chains. These were the "silk trains" that brought silk, an extremely valuable cargo at the time, from the West Coast ports of Vancouver, Seattle and San Francisco to the factories of New York City and northern New Jersey. The raw silk arrived on the fastest ships from Japan and China, and due to its value it was imperative to bring it as quickly as

---

[21] David P. Morgan, "The Paraphernalia of Piggyback," *Trains*, Vol. 20, No. 8 (June 1960), p. 38; David J. DeBoer, *Piggyback and Containers: A History of Rail Intermodal on America's Steel Highway* (San Marino, CA: Golden West Books, 1992), p. 13.

[22] John H. White, Jr., "The Magic Box: Genesis of the Container," *Railroad History,* No. 158 (Spring 1988), pp. 75-78.

possible to the locations where it was processed and used in manufacturing. Any delay meant money was lost; as with a supply chain today, the longer the cargo is in transit the larger the gap between payment at each end and the lower the profit. Not only did each mode of transportation carry the silk as swiftly as possible, but the entire worldwide journey was carefully coordinated—somewhat like the modern movement of containers.[23] (When American railroads began to carry containers from West Coast ports to the Midwest and East in "landbridge" trips in the late 1960s and '70s, in fact, some of them promoted their efforts by drawing a historical comparison with the silk trains.[24]) The American and Canadian railroads made every effort to get the silk across the continent without the slightest delay, and a romance grew up around these speeding trains, which carried armed guards and received top priority on their lines. The most widely recounted anecdote concerns when Prince George, the fourth son of King George V, in 1926 was traveling along with various other important passengers by a special Canadian Pacific Railway express train from Vancouver to Halifax, where he was to board a ship back to Britain. The prince had arrived from Asia on a ship that also carried silk, and it took a few hours to load the silk on its own train which thus left Vancouver slightly later than the prince's train. But the silk train was the faster of the two, and somewhere in the Canadian Rockies the train carrying the prince was ordered to pull aside and halt at a siding so the silk train could pass it by![25]

The rise of the automobile during the early decades of the twentieth century brought an end to the supremacy the railroads had enjoyed. The car gave Americans a freedom and flexibility they relished, allowing them to explore the wide-open spaces of their nation, and to transform the way they lived as suburban development pushed outward from the old urban cores. The success of the motor vehicle was also reflected in the growth of trucking at the expense of rail-borne freight. The truck had a capacity to travel door to door that trains lacked, being able to reach any location so long as it was served by a road. Railroad tracks formed an extensive web over the nation's territory but could not possible compete with the breadth of roads, which rapidly improved as they were paved and modernized. Trucking allowed factories and warehouses to disperse over the landscape; no longer was it necessary to be located along a rail line, or to use a horse-drawn wagon to bring goods to the nearest rail depot. For these and other reasons, American railroads commenced a slow decline from about 1920 onwards. Nevertheless they remained of great importance during the 1920s and '30s, especially in long-distance travel and freight shipping. Motor vehicles generally could not compete in such long-distance movement, given the relatively primitive state of automotive technology and the lack of good highways, while air travel was still in its early days.

So in the 1920s and '30s the railroad companies still possessed great power and importance, but increasingly were forced to reckon with competition from the automobile. In the freight

---

[23] See Alan Vanterpool, *Silk Trains of North America* [pdf on the web] (Edmonton, Canada: Alberta Pioneer Railway Association, 2010), especially pp. 13, 26-30.
[24] George H. Kronberg [Vice-President—Traffic, The Milwaukee Road], "Stacy Street, the Milwaukee Road Link Between the Orient and the Midwest," *Traffic World,* Vol. 146, No. 13 (June 28, 1971), p. 31.
[25] Vanterpool, *Silk Trains of North America*, p. 108.

business a particular challenge for the train was that generally it could not offer the direct service trucks now provided. Some major warehouses, factories and other industrial uses were along rail lines or had their own spur lines, but most shipments needed a local provider of transportation to handle the distance between a freight depot and the source or destination of the journey. Traditionally this had been done by horse-drawn wagons, often known as drays. Trucks replaced them in the 1910s and '20s, for the most part, and then gradually began to offer freight shipping over longer distances. (This evolution is covered in greater detail in chapter 6.) In addition to this door-to-door capability, using a truck for the entire trip meant freight did not have to be unloaded and reloaded when it was taken on and off the train. So although the truck was still markedly less efficient than the train over long distances, it did possess certain advantages. Using the intermodal philosophy, with piggyback or containers, could combine the best of both worlds—the efficiency, capacity and speed of the train, and the flexibility and reach of the truck. It also obviated the issue of transferring cargo between transport modes, since instead the trailer or container was simply shifted. Given the occasional movement of wagons and containers by rail in the days before the automobile, it is not surprising similar practices sprang up once trucking became widespread. Despite the natural rivalry between the nascent trucking industry and the well-established railroads, the logic of cooperation through an intermodal approach was strong. While there were some in each industry who opposed it, being reluctant to share any of their business with the other, nevertheless during the 1920s and '30s many container and piggyback operations began.

A container innovator named Benjamin Fitch emerged in 1917 in Cincinnati, where the movement of freight between different rail terminals was a problem. Fitch's solution was a new container, larger than previous models, that could be loaded onto a truck that was basically similar to a flatbed truck, consisting of the motor, cab and chassis but no enclosed body to hold goods within. The container, once placed on the truck and attached securely, essentially became this enclosure containing cargo (and in fact was called a "demountable body"). Judging from photographs, these containers were (very roughly speaking) about six feet high and wide and fifteen feet long. As with a contemporary shipping container, the container essentially took up the entire volumetric cargo space available for a truck of the time. This containerized system was not intermodal, though, for the containers were only meant to travel by truck; the objective was to get the most efficient possible use of the few (expensive) trucks by having several (relatively cheap) containers available. Trucks carrying containers could constantly shuttle back and forth between the terminals while other containers were being loaded and unloaded—when a container was lifted off a truck by crane, another loaded container was ready to be put on the truck. The operation commenced in 1917 with one truck and nine containers and quickly expanded in subsequent years, though it would remain limited to the Cincinnati area.[26]

Fitch also found that a few railroads were interested in the intermodal use of containers. In 1921 the Cincinnati, Lawrenceburg and Aurora Electric Street Railroad began using his containers

[26] White, "The Magic Box," pp. 78-79.

on its 25-mile route, and transferring them to and from trucks. Later in the decade the Cincinnati and Lake Erie Railroad (also an electric railroad, incidentally) adopted a similar container operation advanced by Fitch that ranged much further geographically, as the railroad installed cranes to handle containers at terminals in Cincinnati, Dayton and Toledo, with trucks even carrying the containers into Michigan and Kentucky. The Cincinnati, Lawrenceburg and Aurora failed in 1930 and the Cincinnati and Lake Erie followed it into oblivion in 1939, but the undeterred Fitch continued on, developing a container system for carrying milk that was used from the late 1930s to the early '50s. In the early 1930s he also designed a container with dimensions of 8′ x 8′ x 20′ for the Pennsylvania Railroad that saw modest use.[27]

Fitch's container innovations were fairly minor operations, but in the early 1920s one of the nation's biggest railroads, the New York Central Railroad, chose to enter into containerization. The man most responsible for this strategy was the president of the railroad, Alfred H. Smith (not to be confused with Alfred "Al" E. Smith, four-time governor of New York State), who involved himself closely with the development and use of containers until his death in 1924.[28] The container's primary purpose was to carry out LCL (less-than-carload) services in a more efficient and profitable way; LCL had long been a problem for the railroad companies, and by the 1920s truckers were taking much of the business. Containers were seen as a means to carry these relatively small shipments in a safe and secure manner, and also to transfer them easily to and from trucks that would make local pickup and delivery. So the system was fully intermodal, although in actual practice containers on occasion were loaded or unloaded at a rail depot rather than moving by truck.

The New York Central's containers were smaller than those Fitch had put into use, being 7′-2½″ wide, 9′-3½″ long and 8′-2½″ high. (Some other sizes were also built, for more specialized purposes.) Hence two or three containers could be carried on a flatbed truck, or on a truck's flatbed trailer, though probably in some cases only one was actually hauled. Evidently the container's dimensions were not oriented to the truck (as was the case with Fitch's container and later with the postwar container), but to the ideal volume for LCL cargo. The container was of steel construction, weighed 2,600 pounds, and could hold 7,000 pounds of freight. When traveling by rail the containers were carried in low side gondola cars whose walls, along with various attachments, kept them in place. The New York Central initiated the operation in 1921, and soon founded the L.C.L. Corporation to take charge of the containers. Over the 1920s the business expanded as several other railroads—especially those that interchanged with the New York Central—began using the containers, as did many freight forwarders and consolidators. While the container was most commonly used for general merchandise, it also found a niche in carrying mail shipments. Special containers were designed for certain types of bulk goods like bricks, cement, lime and coal, as well as milk, produce and meat. Originally transfers between

[27] Ibid., pp. 79-81, 88.
[28] Ibid., pp. 82-84.

modes were done by crane, but later versions of the container had short legs attached so they could be handled by lift trucks. By the mid-1930s nearly 4,000 containers were in use.[29]

The New York Central's great rival, the Pennsylvania Railroad, was taking note of these events, and started using containers of its own in 1928. In the following year the Pennsylvania Railroad created the Keystone Container Car Company to manage its containers, and by the mid-1930s over 3,000 containers were circulating through its system. These containers had almost the same capacity as those of the New York Central, but the dimensions and fittings differed slightly and so the two systems were incompatible. The Pennsylvania Railroad's containers were held on flatcars rather than gondola cars, and in fact generally only moved by train, rarely being transferred to trucks. At depots they were loaded and unloaded more or less as a boxcar would be. So the system actually was not intermodal—its goal was essentially to convert a railcar into a series of modules amenable to LCL cargo and protected from damage or theft. However, the containers were shifted between flatcars in the course of being routed to their destinations. This was perhaps the most interesting aspect of the operation: containers were routed through a central hub, a terminal in Enola, Pennsylvania, where each was switched from its incoming train to the appropriate outgoing train to its destination.[30] (The workings of this facility are described more thoroughly in chapter 9.)

The New York Central and Pennsylvania Railroad were the most important users of containers in this period, but others also adopted and used containers of roughly comparable size. The future of containerization however did not lie with these small containers, but rather with larger units of the type pioneered by Benjamin Fitch, containers of a design and size tied principally to the truck. Essentially such a container was like a truck body with the wheels, cab and engine stripped away. The spatial character of trucking during this period determined that this type of container would be about fifteen to twenty feet long. In addition to the intermodal containerized systems created by Fitch in the 1920s and '30s that have already been described, during the 1930s there were several other efforts to put containers of this size into use. In the early 1930s a trucker named Eugene Cassavant created two 18′-long containers for shipping by rail between New York and Worcester, Massachusetts. 20′-long containers designed by William Kellett for Acme Fast Freight were introduced and used in the mid-1930s by a few railroad companies. A similar container about 16′ long was introduced in 1932 by the Mt. Vernon Car Company, and in 1936 a 20′-long container known as the Cedarstrom freight handling device was demonstrated. The Security Storage Company began using containers of a similar size for

---

[29] William T. Hoops, "The L. C. L. Merchandise Container," *Railway Age,* Vol. 84, No. 8 (February 25, 1928), pp. 499-502; Homer H. Shannon, "Between the Package and the Box Car," *Traffic World,* Vol. 45, No. 23 (June 7, 1930), pp. 1514-1515; White, "The Magic Box," pp. 82-86; Lewis C. Sorrell, "The Container Car," *Traffic World,* Vol. 44, No. 15 (October 12, 1929), p. 895.

[30] Shannon, "Between the Package and the Box Car," pp. 1513-1515; White, "The Magic Box," pp. 86-88.

international shipments (traveling by ship, train and truck) of household goods, such as for diplomats on the move. But none of these operations gathered significant momentum.[31]

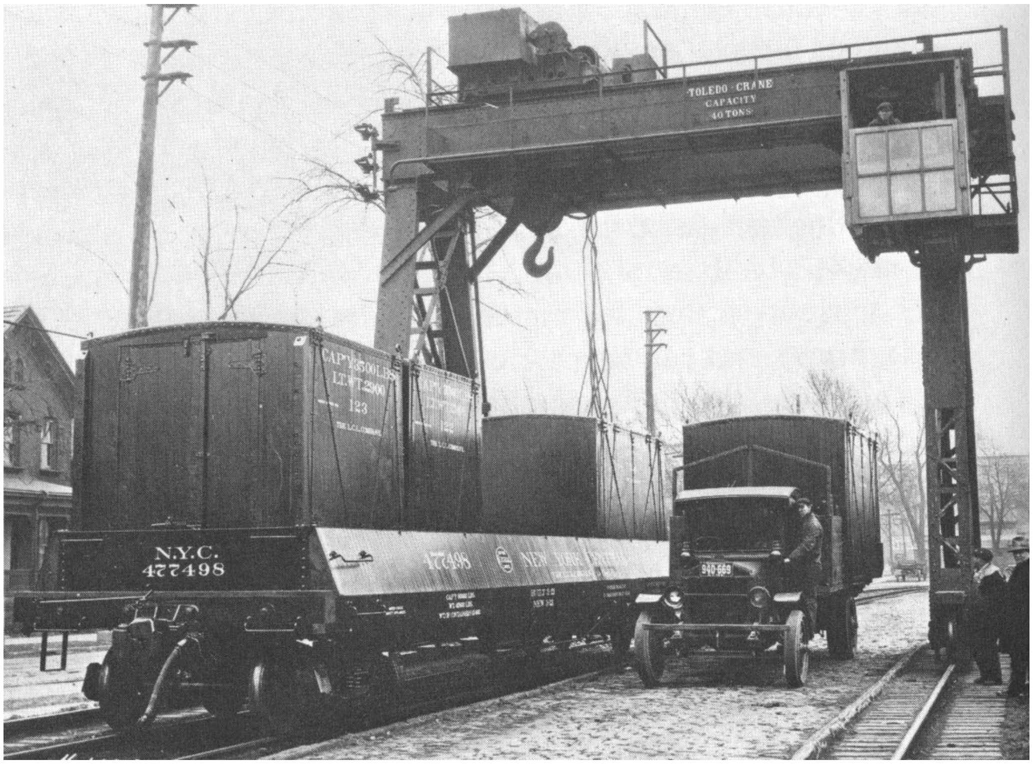

Figure 5.2: Containers being transferred between train and truck in the 1920s

Source: David J. DeBoer, *Piggyback and Containers: A History of Rail Intermodal on America's Steel Highway* (San Marino, CA: Golden West Books, 1992), p. 14

Meanwhile over the course of the 1920s and '30s there was a rising awareness of the need to better coordinate the nation's various modes of freight transport, especially railroads and trucking. A report by the U.S. Chamber of Commerce, published in 1923, argued for greater cooperation, and specifically made the point that railroads should be allowed to discontinue some services, while truckers should restrict themselves to offering short hauls. A government report, issued by the ICC (Interstate Commerce Commission) in the early 1930s, came to similar conclusions about the need for better coordination, though it argued for a more regulatory approach. The unregulated status of trucking, as opposed to the heavy and complex regulations imposed on the railroads, was a frequent subject of debate, particularly inasmuch as the truckers were steadily gaining market share. (Federal regulation of trucking finally began in 1935.) In addition, trucks moved over roads built by the government, while the railroads had to maintain their lines. Some railroad companies saw the need for coordination, and unsurprisingly preferred

[31] White, "The Magic Box," pp. 90-91; Frank B. Norris, *Spatial Diffusion of Intermodal Rail Technologies,* PhD Dissertation, University of Washington (Geography), 1994, pp. 55-56.

to control the trucking aspect of freight movement also; thus by the close of 1929 there were 55 railroads operating trucks as well as trains.[32] Trucking companies, though often flourishing, were generally small and lacked the capital to consider buying a railroad, and in any event hoped to cut out the railroads completely and provide door-to-door service on their own.

In 1931 the ICC, notwithstanding its rhetorical support for coordinated transportation, issued a ruling blocking rail carriers from using lower rates for container cargo. Instead the price had to be set on the basis of the particular goods carried, as was generally the case in the established regulatory structure of railroad rates. This prevented railroads from charging a fixed rate for a container, i.e., setting a price depending only on the weight and/or mileage traveled rather than the goods themselves. The logic of the ICC's ruling actually applied to both containerization and piggyback, and it had a restrictive effect on each since it seemingly eliminated their advantage over normal boxcars. As the 1930s wore on container use diminished for additional reasons. The Great Depression hurt the railroads particularly, as they saw more and more of their business go to truckers. The logical next step was to use bigger containers, but while some efforts were made in this direction (as already noted) the wholesale changes needed were too expensive.[33] In the late 1930s and '40s meanwhile a new and interrelated pair of technologies, the forklift and pallet, began to make freight interchange faster and easier, reducing the need for small containers that were only slightly larger than a pallet anyway. The American armed forces in World War II exploited forklifts and pallets very effectively, helping make their use widespread.[34]

Another reason for the decline in containerization was the growth of the other type of train-truck intermodalism: piggyback. As already noted, a form of piggyback had been practiced occasionally prior to the motor vehicle, with wagons riding on flatcars. The first American example of piggyback service for trucking came in 1926, when truck trailers 16' long were hauled on rail flatcars by the Chicago North Shore and Milwaukee Railroad.[35] By this point in time some of the larger trucks (by the standards of the time) were composed of a tractor and a trailer, making piggyback more feasible. (In piggyback operations typically the train only carries the trailer, with another tractor—and another driver—arranged to pick up the trailer once it arrives at the end of its rail trip.) A few other railroad lines initiated piggyback services in the late 1920s. The aforementioned ICC ruling served to temporarily dampen interest in the early 1930s, but several rail carriers introduced piggyback in the later years of the decade. The two that proved

[32] Stephen B. Goddard, *Getting There: The Epic Struggle Between Road and Rail in the American Century* (New York: BasicBooks [HarperCollins Publishers], 1994), pp. 141-142; Norris, *Spatial Diffusion of Intermodal Rail Technologies*, pp. 51-52.

[33] Josephine Ayre, "History and Regulation of Trailer-on-Flatcar Movement," *Highway Research Record*, No. 153 (1967), pp. 2-4; Norris, *Spatial Diffusion of Intermodal Rail Technologies*, pp. 43-48.

[34] Herbert A. Tonne, "How the Fork-Lift Helps Materials Handling," *The Journal of Business Education*, Vol. 24, Iss. 4 (1948), pp. 19, 31; Shane Hamilton, *Trucking Country: The Road to America's Wal-Mart Economy* (Princeton, NJ: Princeton University Press, 2008), pp. 120-121.

[35] The most well-informed sources are in agreement on the first American piggyback operation of trucks being in 1926. See: Brian Solomon, *Intermodal Railroading* (St. Paul, MN: Voyageur Press [MBI Publishing], 2007), pp. 27-29; DeBoer, *Piggyback and Containers*, pp. 17-18; Norris, *Spatial Diffusion of Intermodal Rail Technologies*, p. 41. Some other sources give later dates (even as late as the 1950s), but they are incorrect.

most committed to it were the Chicago Great Western Railway and the New York, New Haven and Hartford Railroad (widely known as "the New Haven"), which would both run piggyback operations successfully for over 30 years. Yet many railroad lines held back, fearful that cooperating with truckers in this fashion would ultimately benefit the trucking industry more than the railroads.[36]

World War II interrupted the course of events. The militarization of the nation generated an explosion in traffic for the railroads while restrictions on gasoline hampered trucking. With the nation moving goods and people at an unparalleled rate to support the war effort, the railroad companies (which were not nationalized on this occasion, as they had been in World War I) were pushed to the utmost and played a vital role. They also enjoyed substantial profits during the war years. With little need to cooperate with trucks, by the late 1940s the railroads' interest in piggyback and containerization had nearly vanished, with only a few exceptions. The rising use of forklifts and pallets, as already noted, may have also motivated the railroads to abandon their intermodal innovations. But the railroads' central role during the war proved to be their last hurrah, for once the fighting ended Americans returned to their cars with renewed passion, a trend supported by postwar economic growth. Trucking likewise boomed. The development of modern divided limited-access highways, which began as early as the 1920s and picked up speed in the 1950s due to the creation of the Interstate highway system, further ensured the power and ubiquity of motor vehicle transport for both people and freight. Another blow to the railroads was the rise of air travel for the general public after World War II, which ended the importance of the train for long-distance passenger journeys. The railroad industry began to suffer more deeply than it ever had previously.[37] The logic of intermodalism, and the need to work with trucking companies, was once again evident.

Consequently piggyback reemerged in the 1950s. The New Haven had been important in maintaining the viability of the practice through the years; a journalist writing about piggyback in 1953 stated that "the New Haven unquestionably leads the field."[38] Other lines were increasingly motivated to join in. The Chicago and Eastern Illinois Railroad commenced piggyback operations in 1950, and both the Union Pacific Railroad and Southern Pacific started services in 1953. A major participant was the Pennsylvania Railroad, whose new president James Symes was a proponent of piggyback, and in the mid-1950s the company entered the business by establishing its own service known as TrucTrain, and also through working with the Railer-Trailer Company to bring in additional trailer traffic.[39] Another factor in favor of piggyback was regulatory, for in the "Twenty Questions Case" brought by the New Haven in 1954 the ICC essentially reversed its rate ruling of 1931 and clarified several additional points. The new ruling

---

[36] Norris, *Spatial Diffusion of Intermodal Rail Technologies,* pp. 41, 57-58, 62.

[37] Stover, *American Railroads*, pp. 184-191, 218-221.

[38] Theodore Brand, "Toting Trucks by Rails Has Bright Future: But Plan's Growth May Be Gradual," *Chicago Daily Tribune,* December 20, 1953, p. 7.

[39] Herrymon Maurer, "New Signals for the Pennsy," *Fortune*, November 1955, pp. 114, 116; Nancy Ford, "Piggy-Back Spreads Out," *Modern Railroads*, Vol. 10, No. 12 (December 1955), pp. 65, 69.

applied to intermodalism in general and thus was to the advantage of both piggyback and containerization, but the immediate impact was greater for the former.[40]

Another crucial change in piggyback came in the mid-1950s when railroad lines began to interchange their railcars carrying trailers. Given that intermodal rail operations are most economic over longer distances, the logic of moving trailers beyond a single carrier's region was evident, but until 1954 this was not done. Instead each railroad handled its own piggyback service, and did not cooperate with others in any sort of joint networks. In 1954 and 1955 this situation was altered as numerous companies established interline agreements, greatly expanding the geographical scope of piggyback.[41] This was made easier in subsequent years by more standardized methods and equipment; whereas previously each railroad had its own type of flatcar for carrying trailers, and its own particular way of attaching the trailer to the flatcar, now some consistency began to emerge. The arrival of flatcars designed and built specially for trailers was important in this—previously piggyback was generally carried out using standard flatcars that were modified, often awkwardly, for the purpose. In 1953 General Motors introduced a 75′-long flatcar intended for piggyback and capable of holding two 35′-long trailers—over the years the standard trailer size had expanded greatly, and by this time a 35′ trailer was typical throughout most of the country. (The topic of trailer and truck dimensions is covered in more detail in chapter 6.) By the end of the decade 40′ trailers were in wide use, and so 85′ flatcars for piggyback, again able to carry two trailers, were created by builders like Pullman Standard and General American Transportation and put into service. Flatcars of more ordinary length, usually 50′ or 60′ long and capable of holding just one trailer, also remained common. In 1955 a number of railroads jointly formed the Trailer Train Company, which functioned to build and lease piggyback flatcars to the railroad lines.[42]

Thanks to such trends and innovations, piggyback expanded rapidly in the mid- and late 1950s as the railroad companies found it profitable. In 1955 there were 32 railroads operating piggyback services, with a total of about 168,000 carloadings, and by 1959 the numbers had grown to 50 railroads and roughly 415,000 carloadings.[43] Still a tiny fraction of long-distance trucking, these figures were nonetheless substantial, especially for a railroad industry suffering in so many other respects and generally in decline. The number of piggyback facilities (i.e., where trailers were transferred between trains and trucks, often in or next to rail yards) rose dramatically as the piggyback network grew more extensive. Yet some railroad lines were still resistant, fearing that cooperating with truckers would only further weaken them. The trucking industry likewise was generally doubtful about piggyback, though many trucking firms participated in it. So even as the business boomed there remained plentiful reluctance on both

---

[40] Ayre, "History and Regulation of Trailer-on-Flatcar Movement," pp. 12-13; John C. Spychalski and Evelyn Thomchick, "Drivers of Intermodal Rail Freight Growth in North America," *European Journal of Transport and Infrastructure Research [EJTIR],* Vol. 9, Iss. 1 (March 2009), p. 69.

[41] Ford, "Piggy-Back Spreads Out," pp. 61-72; Brand, "Toting Trucks by Rails Has Bright Future," pp. 7, 9.

[42] Morgan, "The Paraphernalia of Piggyback," pp. 37-45; David P. Morgan, "What Price Piggyback?" *Trains*, Vol. 20, No. 7 (May 1960), p. 30.

[43] Morgan, "What Price Piggyback?" p. 30.

sides. Some railroads used trucking subsidiaries (as they had done in the 1920s and '30s) to keep their piggyback operations "in-house," while others sought to work with existing trucking companies.

While piggyback advanced over the course of the 1950s the shipping container also returned to the railroads, though to a more modest extent. The small containers of the 1920s and '30s were no longer practical or efficient, and so the new breed of containers measured about 8′ in width and height and between 20′ and 40′ in length, making them comparable in size to the truck trailers of the period. The first example of this new era of containerization may have been the service operated by the Illinois Central Railroad in 1948 and 1949, using 20′-long containers. A wave of interest emerged in the mid- and late 1950s as numerous other railroads across North America began container use. The Missouri Pacific Railroad was the first of these, debuting its service, which it termed a "demountable body system," in 1956, and later in the same year the Texas and Pacific Railway (a carrier controlled by the Missouri Pacific) started a similar service. Near the end of 1956 the Chicago, Rock Island and Pacific Railroad launched its "Convert-a-Frate" containerization scheme. In 1960 the Baltimore and Ohio Railroad, partly motivated by low clearances on one of its major corridors that made piggyback impossible, adopted the same container system as the Missouri Pacific and Texas and Pacific. (Because a container does not have wheels below it as a trailer does, a flatcar with containers on it has a lower profile than a flatcar carrying trailers.) The Baltimore and Ohio was able to interchange with those two carriers in St. Louis, and so the system could, at least in theory, move a container all the way between El Paso and the East Coast. The Southern Railway also faced clearance issues that precluded piggyback, and so it too joined the ranks of container users in the early 1960s.[44]

The most successful of these innovators was the powerful New York Central, which introduced its Flexi-Van system in 1958. Flexi-Van containers, 36′ or 40′ long, were moved between train and truck by a system that used a combination of sliding and rotation; a container ideally could be transferred in three or four minutes. Specialized railcars and devices for the truck had to be purpose-built for this system, however. (Incidentally, when the New York Central was planning for the Flexi-Van, and trying to decide on a container design, one of the options considered and rejected was the new container that had been introduced by Malcom McLean's Sea-Land in 1956.) As with the Baltimore and Ohio and the Southern Railway, a motivation propelling the New York Central to use containers was the existence of clearances too low for piggyback. Initially the Flexi-Van system was successful, and it grew during the late 1950s and early '60s; by early 1960 about 3,000 containers were being transported per month. Flexi-Van containers were used in sufficient quantities that certain trains called "Supervans" carried only

[44] Norris, *Spatial Diffusion of Intermodal Rail Technologies,* pp. 76, 118-122; Peter S. Douglas, "Year of Decision Ahead for the 20-Foot Container," *Traffic World,* Vol. 128, No. 11 (December 10, 1966), p. 64; Eric Rath, *Container Systems* (New York: John Wiley & Sons, 1973), pp. 32-33; Marc Levinson, *The Box: How the Shipping Container Made the World Smaller and the World Economy Bigger* (Princeton, NJ: Princeton University Press, 2006), pp. 155-156.

the containers.[45] These unit trains streamlined operations, and were a precursor to today's stacktrains composed entirely of containers.

Figure 5.3: Flexi-Van container being moved between truck and railcar

Source: Arthur Donovan and Joseph Bonney, *The Box That Changed the World: Fifty Years of Container Shipping—An Illustrated History* (East Windsor, NJ: Commonwealth Business Media [The Journal of Commerce], 2006), p. 38

Several railroads partnered with the New York Central to carry Flexi-Vans, creating an extensive network of movement. In addition to this domestic success, the Flexi-Van was used in international shipping to Europe and Japan during the 1960s; this was experimental in the beginning, but eventually was done on a regular basis. These operations allowed American railroads carrying Flexi-Vans to offer more convenient service to points abroad. A number of shipping lines carried the containers, though they did so not with true container ships but rather using traditional breakbulk ships with a few containers placed on the deck.[46] For a brief time it seemed possible the Flexi-Van could become the universal container, standardized for all users across all modes of transportation, that far-sighted industry observers and government officials

[45] Solomon, *Intermodal Railroading*, pp. 66-69; *Modern Railroads,* "NYC Introduces New Flexi-Van," Vol. 12, No. 9 (September 1957), p. 160; *Modern Railroads,* "Flexi-Van—NYC's New Piggyback," Vol. 12, No. 5 (May 1957), p. 137.

[46] John G. Shott, *Progress in Piggyback and Containerization* (pamphlet) (Washington, D.C.: Public Affairs Institute, 1961), p. 17, also see images on pp. 36, 52; *Railway Age,* "Containerization: Always a Bridesmaid?" Vol. 161, No. 23 (December 12, 1966), pp. 20, 23.

realized was needed. But piggyback continued to expand rapidly during the 1960s, and as it gained widespread use the Flexi-Van lost momentum. The problem was compounded by its somewhat awkward method of transferring containers between truck and train—in theory it only took a few minutes, but in practice (especially in bad weather) there could be issues. In the meantime it was the shipping industry that was taking the lead in designing and using containers. After the New York Central merged with the Pennsylvania Railroad to form the new Penn Central in 1968, Flexi-Van operations were phased out. The Penn Central's bankruptcy in 1970 was another blow, and by the mid-1970s the Flexi-Van was essentially defunct.[47]

The container systems created by the railroads in the 1950s and early '60s featured a variety of mechanisms, devices and procedures for holding containers in place; sometimes the container was carried in a gondola railcar, in other cases on a specially modified flatcar (as with Flexi-Van), and occasionally on a normal flatcar. Likewise the means of transfer between truck and train was a challenge the rail carriers met in different ways. Some used overhead cranes, generally mounted on wheels or tracks—this was regarded as a "mechanized" system—while others had a system of sliding the container across, which sometimes involved rotating it as well (as with the Flexi-Van setup). Compared to piggyback, with its slow and laborious practice of circus loading (though occasionally trailers were transferred with cranes), the transfer of containers between railcars and trucks was quicker. There were drawbacks, however: a mechanized terminal was very expensive, and sliding methods proved awkward at times. Circus loading was cumbersome but it was also a tried-and-true system, and there were plenty of terminals and rail yards set up for it.

An especially ambitious, though little-known, example of a container system introduced by a railroad was that of the White Pass and Yukon Corporation of Canada. This company, primarily a railroad though it engaged in other activities too, had long carried freight between Whitehorse in the Yukon and the port of Skagway, Alaska, and typically depended on shipping lines to make the connection between Skagway and Vancouver. In the early 1950s the company, in particular its president Frank Brown, began to see the logic of containerization. Like many Canadian transportation companies the White Pass and Yukon was willing to diversify, and so in 1955 it introduced a full-blown network of container movement by train, truck and ship, using small containers of 8' x 8' x 7' size. Railroad flatcars were used, with special equipment to hold the containers in place, and specialized trailer chassis were introduced for the truckers. Most impressively, the White Pass and Yukon commissioned its own ship in 1955 to make the connection between Skagway and Vancouver: designed to carry 168 of these containers in addition to other cargo, the *Clifford J. Rogers* was one of the first container ships ever (as noted in chapter 2). By the end of 1955 the company had in place a remarkable container system that covered all three modes of transportation.[48] (According to one source White Pass and Yukon

[47] Solomon, *Intermodal Railroading*, pp. 69-70.
[48] *Canadian Transportation,* "The Ms. Clifford J. Rogers," Vol. 59, Iss. 1 (January 1956), pp. 48-49, 51; *Canadian Transportation,* "The Year in 1954 for White Pass and Yukon," Vol. 58, Iss. 8 (August 1955), pp. 425-427;

containers also traveled by riverboat or barge on the Yukon River.[49]) It was a pioneering accomplishment, but it seems to have had limited impact and gained little recognition at the time.

The Pacific Northwest during this period was a hotbed of container innovation, and another railroad that participated in the early use of containers interchanged with ships was the Alaska Railroad. In its containerized operation the railroad worked with the Alaska Steamship Company (widely known as "Alaska Steam"), which ran between Seattle and several Alaska ports. In 1951 Alaska Steam started using 30′-long containers in a service with the trucking company Ocean Van Lines, and then in 1953 terminated that arrangement and began cooperating with the Alaska Railroad instead. This joint operation expanded to carrying 24′-long containers (which were termed "cargo vans") in 1956, and in the meantime the railroad also introduced piggyback service.[50] The system was successful for quite some time, and in 1959 an army general described it as "the best example of integrated transportation in the United States."[51] (The Alaska Railroad incidentally was owned and operated by the federal government at this time—a reminder that government is as likely to innovate as private enterprise.) The early success of containerization in the Pacific Northwest probably stemmed from two factors. For one thing, labor in Alaska and the Yukon was scarce and expensive, making mechanization an appealing substitute. In addition, the operations of railroad companies like the Alaska Railroad and White Pass and Yukon were intrinsically tied to coastal shipping, as train and ship worked together to bring goods in from the wider world, and also to carry resources out.

These examples of railroad lines hauling containers that also moved over water were limited in significance. The shipping of the Pacific Northwest was not large in scale, and the region was a somewhat special case. The Flexi-Van was sometimes carried on ships in global trade, as already noted, but not to a truly substantial extent. A few other containers, of widely varying sizes and characteristics, were interchanged between ship and train, but such practices were occasional rather than systematic. In general the railroad companies that pursued containerization concentrated on domestic journeys within the U.S. and/or Canada. Hence the containers of the railroads were unlikely to evolve into a global standard; instead it would be the shipping lines that introduced and developed containers that ultimately led to the worldwide standardization of the container. Into the mid-1950s, however, shipping was not demonstrating much initiative either, for it was an industry firmly rooted in tradition and few of its members grasped the advantages containerization offered. Furthermore, large investments would be necessary to reconfigure both ports and ships to handle containers, and there were longshoremen's unions to deal with.

Frank B. Norris, "Cargoes North: Containerization and Alaska's Postwar Shipping Crisis," *Alaska History*, Vol. 7, No. 1 (Spring 1992), pp. 22-24.

[49] Richard Saunders, Jr., *Main Lines: Rebirth of the North American Railroads, 1970-2002* (DeKalb, IL: Northern Illinois University Press, 2003), p. 124.

[50] Norris, "Cargoes North," pp. 19-22; Edwin M. Fitch, *The Alaska Railroad* (New York: Frederick A. Praeger, Publishers [Praeger Library of U.S. Government Departments and Agencies], 1967), pp. 124-126.

[51] Fitch, *The Alaska Railroad*, pp. 127-128.

This changed forever in 1956, when container shipping received a key boost with the establishment of a coastal shipping service known as Sea-Land, under the leadership of former trucking executive Malcom McLean. Using converted tanker ships that carried containers attached to the deck, Sea-Land moved freight between the port of Newark (at that time a minor port) and a few ports in the Southeast and the Gulf of Mexico. As described in chapter 2, McLean's initiative was a watershed moment when container shipping over the ocean began to take hold and acquire momentum, though few realized it at the time. In 1957 Sea-Land introduced true container ships (actually converted freighters), built to carry 35′ containers stacked in their holds. In 1958 the Matson Navigation Company, a major shipping line between Hawaii and the West Coast, began putting 24′ containers on the deck of its traditional breakbulk ships, and by 1960 Matson was also operating container ships. The efficiency of carrying containers over the ocean was swiftly apparent, the primary advantage being not in the ocean journey itself but the interchange with the land-based transport modes of rail and trucking, as well as the speed of loading and unloading at ports. By the early 1960s it was evident to some that containerization might well be the wave of the future.

Despite McLean's background in trucking he was not opposed to doing business with the railroads. Before entering the shipping industry, his objective had simply been to move freight more easily between the Southeast, where his trucking company was headquartered and most of its business was, and the Northeast. With Interstate highways still on the drawing boards, long-distance trucking was an arduous business. Interested in the possibility of piggyback, he initially considered working with the railroads, and it was the refusal of executives of the Southern Railway in the early 1950s to consider this idea that may have led him to pursue the option of coastal shipping instead. (It is possible clearance issues were a factor in the Southern Railway's rejection of McLean, for as noted earlier many of their lines had clearances too low for piggyback.) Once he entered into shipping, McLean chose to move his containers by truck for the relatively short inland trips to and from the ports.[52] Matson also used trucks primarily for the land-based portion of container trips, but did draw on the railroads occasionally: in Hawaii its containers moved on the narrow-gauge Oahu Railway (albeit a very short distance), and in the continental U.S. a few containers traveled by rail to and from California ports. An operation between California and Chicago provided an opportunity for Matson, the Santa Fe, and Pullman-Standard to test a hydraulic cushion frame mounted on a regular flatcar holding containers, so as to verify that the frame's cushioning would reduce jostling and damage.[53]

By the late 1950s and early '60s there were several American railroads using containers, as already described, but most of the railroads interested in an intermodal approach had concluded

---

[52] Arthur Donovan and Joseph Bonney, *The Box That Changed the World: Fifty Years of Container Shipping—An Illustrated History* (East Windsor, NJ: Commonwealth Business Media [The Journal of Commerce], 2006), pp. 24-25, 27-28.

[53] Brian J. Cudahy, *Box Boats: How Container Ships Changed the World* (New York: Fordham University Press, 2006), pp. 68-69; J. E. Gutridge, "Technical Advances in the Railroad Industry Leading to Integrated Transportation," in: *Ship Design Implications of Recent Marine Cargo Handling Research,* Conference Proceedings, University of California, Berkeley, May 2-4, 1962, pp. 5-6.

piggyback was more useful for their purposes. The dynamic was entirely different in the shipping industry, where the logic of being able to stack containers was compelling. McLean originally did consider carrying trailers on his ships (a practice widely known as roll-on/roll-off or "RO-RO" and sometimes facetiously termed "fishyback" at the time), but trailers cannot be stacked and their undercarriages (i.e., the wheels) represent wasted space, so he went with containers instead. With the railroads generally neglecting the container, truckers predictably seized the bulk of the land-based container moves that a few shipping lines were now making available. Some observers saw the need for the railroads to capture a slice of this burgeoning business. A trade journal warned in 1960 that: "Some ship lines talk of landing as many as 1,000 vans [containers] a week at New York port alone in the not-too-distant future; if they do, some land carrier [railroad] is either going to get set for inland moves or else sit by and watch the business go to contract or private trucks."[54]

Indeed, it was ocean shipping that would bring large quantities of containers into the American freight transportation system, and potentially to the railroads. More specifically it was international shipping that would play the key role, not the coastal shipping that Sea-Land was originally engaged in, or Matson's commerce with Hawaii. The role of global trade, and of containers standardized at a global scale, was to be crucial. Factors internal to the U.S. were not sufficient (at least at this point in time) to bring about widespread container use, for the railroads and truckers had generally concluded that piggyback was more efficient and profitable. As of the 1950s and early '60s, there was no compelling reason for rail carriers to move into containerization (with the exception of those dealing with clearance restrictions that prevented piggyback). What eventually altered this situation was the rapid growth in container use by the shipping lines, and the need for those containers to travel inland, over the domestic transport system. So it was this global object the shipping container—albeit invented in the U.S., then slightly altered into a global standard by the ISO—that would enter into and change the national railroad infrastructure.

In 1966 container ships entered service between the U.S. and Europe, with U.S. Lines being the first shipping company with operations and Sea-Land following very soon after. Other shipping lines, both American and European, joined in quickly. (These events are described in greater detail in chapter 2.) Within about a decade, the marine trade in non-bulk goods (i.e., anything other than bulk cargo like oil, grain, coal, etc.) between North America and Europe was dominated by containers. It was a remarkable change that created opportunities for rail, as Marc Levinson explains:

> The surge in transatlantic container traffic, coming at a time when American factories were running hard to meet the demands of a wartime economy, offered a golden opportunity for U.S. railroads to regain their place at the heart of the domestic transportation system. Their business in conventionally packaged export cargo was dying. Thousands of containers were passing through New

[54] *Railway Age*, "Containers: The Right Track?" Vol. 148, No. 22 (May 30, 1960), p. 49.

> Jersey and Baltimore every week, many of them going to or from factories in the industrial heartland of the upper Midwest. This huge scale offered no advantage to truckers, because, no matter how many boxes [containers] were being handled, one truck could pull only one 40-foot box. Scale could bring real savings aboard trains, giving the railroads a way to recover some of the export traffic they were losing.[55]

Yet, as Levinson goes on to describe, the U.S. railroads were reluctant to grab a share of the action, and some were actively hostile. Many had heavily invested in piggyback, and it would be difficult and expensive for them to set up container systems. The New York Central was still using its Flexi-Van containers, and did not wish to switch to a different, incompatible container. In early 1967 the Whirlpool Corporation sought to have the New York Central carry refrigerators in containers from Indiana to New Jersey, where they would be loaded onto ships. When the railroad pushed to use boxcars instead, recommending the containers be loaded at the port, Whirlpool simply chose to move the containers by truck. Likewise when Matson attempted to have containers (filled with canned Hawaiian pineapples) transported by rail from the West Coast all the way to the East, the railroads shot the idea down because the rate between Chicago and New Jersey would have been lower than their normal rate for canned goods. Perhaps the most ambitious proposal was put forth by Malcom McLean in 1966. He offered to build rail yards in Chicago and St. Louis, as well as at Sea-Land's port in Elizabeth, New Jersey, and proposed creating special railcars that would allow containers to be stacked one atop the other, with the railroads running trains composed entirely of these cars from Chicago and St. Louis to New Jersey. The railroad companies turned down the idea.[56] (As usual McLean was ahead of his time; chapter 7 will discuss the development of such "stacktrains" in the 1980s.)

While American railroad companies remained timid in their approach to the container, the state-owned European railroads proved more forward-thinking and entrepreneurial. Many were already using containers to a limited degree. The United Kingdom was particularly in the lead, since from the mid-1960s British Rail had been running its "Freightliner" container unit trains for domestic freight. Not surprisingly, British Rail was eager to work with Sea-Land to carry containers to and from the new container port at Felixstowe. Meanwhile railroads in France and Germany offered competitive flat rates to carry containers from ports to points far inland. In 1967 a group of European railroads set up Intercontainer, a company that would coordinate the movement of containers long distances by rail, generally through multiple countries, both for containers only moving within Europe and those involved in ocean journeys as well.[57] Some feared that clearances would be an issue for containers riding upon railcars on certain European lines, but in general this was not the case. It did prove to be an occasional problem, though: a key

---

[55] Levinson, *The Box*, p. 167.
[56] Ibid., pp. 168-170.
[57] J. R. Whittaker, *Containerization* [2nd ed.] (Washington, D.C.: Hemisphere Publishing [John Wiley & Sons], 1975), pp. 66-77; G. Van Den Burg, *Containerisation and Other Unit Transport* [rev. ed.] (London: Hutchinson Benham, 1975), pp. 168-176; Levinson, *The Box*, p. 168.

rail line leading to the German port of Bremerhaven passed under a bridge that was too low, and so Sea-Land and the city agreed to split the cost of raising the bridge.[58] In Asia on the other hand the railroads were generally less capable of handling containers. Container service across the Pacific to Asia began in 1967 and took off rapidly, but extending container movement into the domestic space of Asian countries was typically accomplished with trucks.

Despite their growing use of piggyback, and other tentative efforts at modernization and adaptation, the economic situation of American railroads steadily worsened in the 1950s and '60s. In addition to the devastating competition they faced from cars and trucks, the railroad companies grappled with their own internal issues. They had become massive and sluggish entities, and their once-innovative character had stagnated. Hamstrung by bloated bureaucracies, giant labor forces, and byzantine government regulations, the railroads could not reverse their downward trajectory. They received little sympathy from the government or the general public, who well recalled their greed, abuses of power, and monopolistic practices of earlier days. The government subsidized the motor vehicle by building roads and highways (and by granting tax breaks for home mortgages, fueling suburban auto-centric growth) while the railroads had to maintain their own lines. Similar issues were evident in other parts of the world, but to a lesser degree. Europeans were not so powerfully motivated to pursue the individuality of the car and suburbia, since in comparison to Americans they possessed greater social homogeneity and exhibited more loyalty to their cities. Furthermore the denser cities of Europe made automobile use less practical, while the vast American territory provided ample room to suburbanize. The inhabitants of less wealthy countries simply could not afford automobiles, so they stuck with rail (while also using buses). In addition, many countries had nationalized their railroads, and this motivated governments to support and improve them. So most nations took a balanced approach, adopting the automobile but retaining a strong role for the railroads and also for public transit. While the previous dominance of the railroad was reduced nearly everywhere, its crisis in the U.S. was exceptional.

The decline of the U.S. rail industry was relentless, marked by a steady drumbeat of route abandonments, bankruptcies and consolidations. In the late 1960s matters finally came to a head. The two greatest American railroad companies had long been the Pennsylvania Railroad and New York Central Railroad, fierce competitors through the bulk of their existence. Both were now in crisis and so they merged in 1968 to form the Penn Central Transportation Company, but it did no better, declaring bankruptcy in 1970. This was at the time the largest corporate bankruptcy in U.S. history, and it shocked the nation. Several other railroads followed suit. The provision of passenger service was particularly affected as railroads across the country moved to give it up, leading to the creation of Amtrak by the federal government in 1971. The freight business of the Penn Central, along with several other failed eastern railroads, would eventually be folded into the government-supported Conrail in 1976. The decade of the 1970s would be one

[58] John Boylston, Interview by Arthur Donovan, Containerization Oral History Collection 1995-1998, Archives Center, National Museum of American History, December 7, 1998, pp. 15-16.

of survival and regrouping for the railroads. The one niche where they remained successful was in the transport of bulk goods like coal, iron ore and grain, which were too heavy to be economically carried by truck, but this was not a particularly profitable business.[59]

In spite of these traumas the railroad business continued to evolve. During the late 1960s a new concept, one that reflected the increasing globalization of container journeys, was introduced and began to attract attention in the North American railroad industry. This was the idea of "landbridge" rail, in which containers traveling from Asia to Europe would move by ship over the two oceans and by rail overland across North America. In theory this allowed shipping lines to concentrate on the ocean they served best, the Pacific or Atlantic, rather than having to travel the whole distance and go through the Panama Canal. It also cut down on the distance and time involved, since the canal is a substantial detour to the south. The rail portion of the route represents a sort of bridge over land—hence the term "landbridge." (The concept of landbridge is applicable in other contexts. The most prominent is a rail network running across the vastness of Russia from East Asia to Europe, used to carry containers since the 1970s.) One particularly appealing aspect of landbridge was that it might draw off much of the container cargo traveling between Asia and Europe through the Suez Canal. (Ironically, the Russian landbridge was also aimed at this cargo.) Another advantage of landbridge was that it did not require mechanized terminals (i.e., with cranes or other devices to move containers on and off trains) at points along rail routes within the U.S., but only at ports.

As a strategy for freight movement landbridge is integrally tied to containerization, and would not be feasible without it. It is the container that allows these shifts in mode—from ship to train and back to ship—to be carried out smoothly and quickly. Without intermodalism the expense and time of unpacking and repacking cargo would make landbridge prohibitive. What is perhaps most interesting about landbridge is how clearly it globalizes the infrastructure of the nation-state, for it is explicitly evident that the rail trip across the nation-state (either the U.S. or Canada) is just one segment of a longer, international journey. Through landbridge, as one trade journal in the early 1970s described it, "railroads become an integral part of the world's sea lanes."[60] The infrastructure of the nation-state loses its internal cohesion, in a sense, and its borders appear less meaningful; the vast landmass of North America becomes merely a portion of a route that has an origin and destination in other continents.

Some of the major North American railroads began to plan seriously for landbridge, and made contact with possible shippers in Japan. Union Pacific even opened a sales office in Tokyo. Two major landbridge schemes were put forth by railroads within the U.S. The Santa Fe and Penn Central proposed in 1968 to carry containers between California and New York on an accelerated five-day schedule. Soon after, Union Pacific and the Norfolk and Western Railway came up with a plan to carry containers from a West Coast port to Hampton Roads, Virginia. Other railroads rushed to propose their own routes, even though nobody had actually begun

---

[59] Stover, *American Railroads*, pp. 226-242.

[60] Robert D. Bartley, "TOFC and COFC: There's Big New Growth Ahead for Both," *Railway Age,* Vol. 174, No. 20 (October 29, 1973), p. 28.

landbridge service. This little bubble of optimism soon burst, for by mid-1969 it was clear demand was insufficient to implement landbridge successfully. The U.S. rail system was too fragmented, and the process of transferring containers at ports was not so seamless, especially from a bureaucratic standpoint, as originally expected. In Canada on the other hand landbridge was implemented sooner, in large part because that country had two railroad carriers in Canadian National and Canadian Pacific that extended from coast to coast and even had a tradition of involvement in marine shipping. In 1967 Canadian National opened a landbridge route running from Vancouver to Halifax.[61]

At least one shipping line had ambitious ideas for landbridge. Having pioneered container movement to Hawaii in 1958 and Japan in 1967, Matson was ready to think in larger terms. The company's president, Stanley Powell, Jr., made plans to move containers by sea, train and truck in a network that would span Asia, North America and Europe, all under Matson's control. Such ambitions of course included landbridge service. Matson attempted to buy U.S. Lines, one of the largest Atlantic shipping companies, and also U.S. Freight, a major freight forwarder actively involved with the railroads under its president Morris Forgash, an enthusiastic proponent of containerization. Neither purchase transpired, but Matson did buy Acme Fast Freight, another forwarder. Powell's vision was far ahead of his time, and if successful could have given Matson an extraordinary global network, but he lacked the full support of the directors of Alexander & Baldwin, Matson's parent company. In addition the business suffered some setbacks in these early years, especially since the Japanese lines entered into containerization far more quickly than anticipated. Alexander & Baldwin got cold feet and replaced Powell in 1970, and Matson pulled out of international shipping in 1971, keeping only its traditional routes connecting Hawaii with the West Coast.[62]

In 1972 landbridge service finally began in the U.S., as the shipping company Seatrain (which had its own distinctive intermodal heritage, having once made a business of carrying railroad cars on ships) introduced a landbridge, operated by the Santa Fe and other railroads, for container traffic between Japan and Europe.[63] Other carriers began landbridge arrangements gradually over the 1970s.[64] But the concept never became a major factor in container shipping, and instead certain offshoots of landbridge became more significant. These were minibridge and microbridge. Minibridge is a system in which containers arriving by ship are carried over the entire span of land (i.e., from coast to coast) by train to a rail terminal serving a port facility, but

---

[61] Norris, *Spatial Diffusion of Intermodal Rail Technologies,* pp. 193-197; Saunders, *Main Lines*, p. 129.
[62] Robert J. Pfeiffer and Stanley Powell, Jr., Interview by Arthur Donovan and Andrew Gibson, June 18, 1997, Containerization Oral History Collection 1995-1998, Archives Center, National Museum of American History, Washington, D.C., pp. 4-5, 16, 18-23; William L. Worden, *Cargoes: Matson's First Century in the Pacific* (Honolulu, HI: University Press of Hawaii, 1981), pp. 150-153; Fred A. Stindt, *Matson's Century of Ships* (Modesto, CA: Fred A. Stindt, 1982), pp. 171-172.
[63] Arthur C. Novacek, *One Step Ahead* (Charlotte, NC: Pure Heart Press [Main Street Rag Publishing Company], 2006), pp. 115-118; Solomon, *Intermodal Railroading*, pp. 79-80.
[64] Larry Kramer, "Use of Landbridge Cuts Containerized Cargo Travel Time," *The Washington Post,* August 20, 1978, p. H2.

then are not transferred to another ship but instead are placed on trucks for travel to their final destination. Microbridge is similar, also involving both ship and train, but here the containers do not travel all the way to a port, but instead end their rail journey somewhere in the interior of the landmass, where they are transferred to truck for final delivery. Minibridge and microbridge journeys may also go in the reverse order from what has been described, i.e., they can start with a train route that is followed by shipping.

Where landbridge generally cannot compete with the ease and simplicity of an all-water route, minibridge and microbridge are more logically suited to the normal routes of global trade. (Microbridge in particular describes such a typical practice—a container journey partly by water and partly by land—that the term is hardly used today.) This was already evident by 1969 to P. Laurin Cowling, an executive at the Chicago, Milwaukee, St. Paul and Pacific Railroad, better known as the "Milwaukee Road," who argued that a combined rail-ship operation could not compete on price with a container ship making the whole trip on its own. Instead he saw a promising future for minibridge and microbridge (which he referred to as "little landbridge"), where trains hauled containers from the West Coast into the central and eastern regions of the U.S., in the process supplying some areas that had previously been within the hinterlands of eastern ports. As Cowling noted, the Milwaukee Road in 1969 was already running this type of service successfully.[65]

During the 1970s it was minibridge that became popular. It had started as early as 1968, when Japanese carriers delivering cargo to East Coast ports began sending the containers to ports on the West Coast (that had less expensive labor costs), from which they were carried by train all the way to eastern ports, where the mechanized equipment was in place to move them from train to truck. The scheme had the advantage of fitting smoothly into preexisting patterns—the delivery was being made to the appropriate port, merely by train rather than ship. But eastern ports valued the business of shipping far more than a mere train terminating at or near the port, and objected strongly. Indeed, the practice made it possible not just to substitute one port for another, but one entire coast for another, and that proved especially relevant in late 1968 when a dockworkers strike impacted eastern ports. In 1971 a minibridge system commenced between the West Coast and Europe, when the Lykes Brothers shipping company and Southern Pacific collaborated on service between San Jose, California, and Antwerp, making the transfer from railroad to ship at Galveston, Texas. Several other minibridge arrangements between the West Coast and Europe were put in place in the following years.[66]

The lack of a standardized approach to containerization had long plagued the railroads. During the 1950s and '60s carriers used a variety of container sizes and fittings, which proved hard to interchange amongst themselves and did not fit with the new containers introduced by the shipping companies. By the late 1960s most shipping lines were using the recently agreed-upon ASA/ISO standard for their containers (except Sea-Land and Matson, who continued with

---

[65] *Railway Age*, "'BIG LANDBRIDGE' Versus 'LITTLE LANDBRIDGE," Vol. 166, No. 19 (May 26, 1969), p. 23.

[66] Norris, *Spatial Diffusion of Intermodal Rail Technologies*, pp. 199-200.

their original containers), but the railroads were slow to get on board. The Southern Railway did choose to use the ASA container design, but it had the advantage of entering containerization later than the others, when the ASA standard was in place.[67] The railroads in the 1950s and '60s had also utilized a variety of different flatcar designs to carry containers —usually standard flatcars, modified flatcars, or designs similar to flatcars in some way, although occasionally gondola cars were used. Virtually none of these flatcars were actually designed solely for container use (except for the railcar that carried Flexi-Vans for the New York Central), though some built with piggyback in mind were also provided with the flexibility to haul containers too.[68] The variation among carriers was not a major problem when domestic containers only moved on particular rail lines—each company could have its own closed system. But as containers moved longer distances on multiple lines, and in greater quantities, the need was clear for a better and more standardized system of railcar design.

Gradually the situation began to change. The shipping lines were bringing in a growing quantity of containers, more and more of which met the new ISO specifications as the diverse and incompatible container systems began to fade away. This too made it logical to establish standard railcars, to be used all across the country, for carrying containers. Hence in the mid-1960s the Trailer Train Company, originally founded in the 1950s in order to build and lease railcars for piggyback operation (as described earlier), began to focus on the need to accommodate containers too. Trailer Train requested prototypes from four railcar builders for a new flatcar that could carry both trailers and containers, and in 1967 it was introduced and went on to become successful.[69] Other railcars designed for containers in this era were also usually "all-purpose" cars capable of holding either trailers or containers. In the early 1970s Pullman-Standard developed a railcar called the Land Bridger meant solely to carry containers, but found it difficult to interest any railroads in such a specialized device and eventually modified it to carry trailers also.[70]

The success of the new Trailer Train railcar marked an interesting moment at which the domestic infrastructure of the nation was adjusted to suit the new global object, the shipping container. Though there had been several previous railcars designed to handle containers, that of the Flexi-Van system being the most notable, they were primarily meant to carry domestic containers moving on domestic itineraries. When a railcar is created with the purpose of holding the global ISO container (even if it also can carry trailers) then the national railroad system has been modified to accommodate a global agenda. Yet the basic qualities of the infrastructure remain the same. In the case of the railroad, these basic qualities include elements such as the track gauge, loading gauge, signaling system and method of propulsion. It is very difficult, expensive and time-consuming to change such deeply embedded and fundamental characteristics of an infrastructure, and the container does not make it necessary. Rather, the

---

[67] Ibid., p. 189.

[68] Gutridge, "Technical Advances in the Railroad Industry Leading to Integrated Transportation," pp. 6-7.

[69] *Railway Age,* "Containerization: Always a Bridesmaid?" p. 35; Norris, *Spatial Diffusion of Intermodal Rail Technologies*, p. 201.

[70] DeBoer, *Piggyback and Containers*, pp. 105-106, 122-123.

container's success rests on its ability to work within existing infrastructures, for it is a singularly flexible and adaptable object in spite of its standardized rigidity. So this early change to the railroad system was not dramatic in nature, but still of some significance. (More fundamental alterations would come later, as described in chapter 7.)

The global container infrastructure and national railroad infrastructure are able to maintain their basic fundamental qualities, and the railcar customized to carry containers plays a key role, acting as a sort of interface between them. The concept of the interface is actually played out quite literally by the railcar, as it physically makes contact with and fits into both the train tracks of the national system and the container of the global system. Essentially it mediates between the two infrastructures. On the one hand, the railcar's wheels rest upon the domestic rails, its dimensions work within domestic limitations, and its structural capacities are within domestic expectations. On the other hand, the railcar has the fittings, shape and structural ability to securely hold the container, an object of global dimensions and characteristics, and to allow it to be taken on and off the car easily. Thanks to the railcar serving as an interface, the basic qualities of both the domestic infrastructure and global infrastructure can remain intact.

The shipping container is a critical component in a network of global freight transportation, one that relies on many technologies and devices yet ultimately revolves around the container. The concept of the "gateway technology," used by several scholars of science and technology (as described in chapter 3), helps elucidate how and why the container is central to this network, despite being a seemingly ordinary and unsophisticated object in its own right. Yet it is not enough to put the emphasis solely on the container, for it can only work with infrastructure that is able to carry it, and the basic freight transport modes of trucking, railroads and shipping cannot do so without some modifications. (The greatest overhaul in the design of a transport device, for the purpose of hauling the container, was undoubtedly directed at ships. The shift from a ship carrying freight in breakbulk fashion to one carrying containers represented a significant transformation, and occupies a leading role in most histories of containerization. But for this dissertation, in line with its focus on domestic transportation, the modifications to the truck and train are more relevant.) These alterations, carried out for the purpose of making container movement feasible or more efficient, have been crucial in the development of the containerized system. The resulting devices—the railcar for containers just described, and the trailer chassis that allows trucks to haul containers—can be understood (as already noted with regard to the railcar) as interfaces between the container and the domestic transportation network. (The trailer chassis, similar to a flatbed trailer, will be described at length in chapters 6 and 8.) While they seem banal and unimpressive—much like the container, for that matter—these interfaces are of great importance, being every bit as essential in the working of the overall network as the container itself. A gateway requires an interface to function properly in each infrastructure it utilizes, and the gateway and interface are equally essential to the operation. The gateway and interface, in short, are both integral to the process by which several systems are linked together into a larger system.

A major obstacle to railroad container service—perhaps bigger than the challenge of better railcars—was the issue of terminal mechanization. A few railroads chose to shift containers by sliding them (including rotating, in the case of the Flexi-Van), but this generally did not work well. The ideal solution was some sort of crane or other lifting device (such as an oversized forklift-type machine), but that was expensive and rarely implemented. The lack of mechanized terminals had long been a drawback to containers, from the railroads' point of view. To some degree this was the cause of the preference for piggyback over the container during most of the 1950s and '60s, for the circus loading approach of piggyback was at least cheap and convenient, though awkward and slow, and the ramps for circus loading were in place by the late 1950s at numerous terminals and rail yards. At ports, on the other hand, cranes were usually available to transfer containers to and from railcars. (In practice containers rarely move directly between a ship and train, but rather a truck serves as intermediary. A crane or similar device would be available at the port to move the container between the truck and train.) The ports were large capital-intensive operations, emphasizing speed and efficiency, and could easily afford this expense. But once the train moved inland it was a lot harder to find a mechanized facility. For this reason much of the containerized rail traffic of the 1970s was oriented to minibridge, in which a port facility with its cranes was at each end of the journey. (For microbridge service it was not so easy. Piggyback being so entrenched and widely-used, an unusual solution was sometimes used: the container simply remained in place on a trailer chassis, and the chassis along with the container on it was circus loaded on the train and carried the same way a trailer would be in piggyback operation. Clearly this was inefficient—and the practice did not become pervasive—but it did at least work within the existing system.)

Minibridge, and to a lesser extent landbridge, gradually gained ground, and by the mid-1970s was well-established and being implemented on several different rail routes. A few unit trains were also operating in minibridge and landbridge service, indicating that a critical mass of container demand had been reached.[71] The movement of containers within North America was rising rapidly, fueled by their success in global trade, and their land-based journeys were getting longer, extending beyond traditional port hinterlands. This was significant, for the longer the journey the more efficient a train is compared to a truck. Gradually the American railroads were getting into the container business in a serious way. The growth in container transfers at the Burlington Northern Railroad's South Seattle intermodal terminal, serving the port of Seattle, demonstrates the trend. In 1969 this terminal (at that time operated by the Northern Pacific Railroad) received roughly 150 containers per month, and by 1972 the figure had risen to about 1,500.[72]

The Canadian railroads moved more quickly into carrying containers. As mentioned earlier, these companies had long been involved in diverse transportation ventures such as shipping, trucking and even air travel, and hence were inherently more receptive to coordinating multiple

---

[71] Norris, *Spatial Diffusion of Intermodal Rail Technologies*, p. 200.
[72] Solomon, *Intermodal Railroading*, p. 81.

transport modes. This was particularly the case for Canadian Pacific, which by the early 1970s was operating a trucking business in Canada and container ships on the ocean in addition to its railroad business. The company even ran its own port terminal at Wolfe's Cove, Quebec, building a road to connect the port to the highway and extending its railroad tracks to the docks as well. Such an approach, combining different transport modes and controlling the entire journey of freight, had obvious advantages in a containerized operation. Yet it also led Canadian Pacific to regard its network as a closed one, and into the mid-1970s the company persisted in using its own unique containers (of which there were 17 types) rather than adopting the ISO standards.[73]

By the late 1970s the presence of the container in the American railroad network was significant, but still minor in the larger scheme of things. The container for the most part was fitted into a preexisting system of domestic movement at the scale of the nation-state. The links to railroad service at several ports had been improved, and containerized global freight was flowing over the national border with a remarkable new seamlessness. But the force of globalization, in the shape of the container, was yet to transform the railroad industry, which continued in its normal practices while adding the container as a new cargo to carry. The space and infrastructure of the nation-state maintained a separate, distinct quality, and the global infrastructure generally did not overlap. But the container would bring about significant alterations to the American railroads in the near future, with the advent of double-stack railcars and the reshaping and expansion of many rail corridors. This process would start in the late 1970s and continue into the present, and is the subject of chapter 7. The next chapter is chapter 6, however, which examines the early impact of the container on American trucking.

[73] Whittaker, *Containerization*, pp. 52-54, 214-223.

Chapter 6 ~ Trucking Gets on Board

This chapter describes the early history of the use of the shipping container in American trucking, until roughly the late 1970s, a narrative that encompasses not only the trucks themselves but also the roads and highways they move along. While the term "railroad" is generally taken to comprise the entire system of train, track, signaling and integral equipment, in road transportation a sharper distinction exists between the vehicle itself and the route it travels upon. But of course the two are still linked. Hence this chapter will discuss the development of the American road network into an infrastructure capable of supporting heavy automobile traffic, ultimately including the Interstate highways and the vast trucking business that thrives thanks to them. In the context of containerization this is particularly fitting because the modern American highways, i.e., the Interstate system, were built in roughly the same period that the container grew to become a major cargo to be carried in the domestic infrastructure.

Surely the automobile is the most important mode of transportation of our time. Railroads are still essential, while air travel has been revolutionary, but on a routine day-to-day basis the motor vehicle is doubtless the key transport device used in the contemporary world. This is true both for passenger travel, with the car and bus, and for the movement of freight, with trucks of various types. In tandem with this transportation revolution has been a dramatic improvement in the quality of roads, and in particular the development of the smooth and durable paved roads that the motor vehicle depends on for its rapid movement. A host of other changes to the road network have also been necessary, such as traffic signals, new signage, and lane markings, in addition to extensive regulations and bureaucracies. Furthermore the development of a new type of road specially designed for high-speed travel over long distances, the divided limited-access highway, has been crucial.

Given the importance of the motor vehicle in our era, it is no surprise the shipping container has been so tightly connected to it. The container's dimensions are historically embedded in the spatial qualities of American trucking. The container must fit three modes of transportation: ships, trucks and trains. Of the three, it is the truck—or to be more precise, the truck trailer—that imposes the tightest spatial limits on the possible dimensions of the container. Hence the spatial regime of trucking is the determining factor for the size of the container. In its very form, its length, width and height, the container is a modular volume that directly derives from the American tractor-trailer. The truck is a crucial component of containerization in another way, for the beginning and end of each container journey is usually accomplished by truck. No matter how great a distance a container moves by ship and/or railroad, a truck is generally needed at both the origin and destination, for it is by road that most cargo starts its journey and reaches its ultimate destination. The container is ultimately designed for the motor vehicle, and its success is linked to the dominant role of trucking in the movement of goods today. Yet ironically containers are associated principally with ships and ports, both in the mind of the public and in the bulk of the scholarship on containerization. When a container is carried by truck it tends to be nearly invisible, an object seen yet not really perceived, as the assembly appears much like a normal tractor-trailer to the untrained eye.

A further irony is that trucking is probably the transport mode least impacted by the container. While containerization caused dramatic changes to the shipping industry and the ports, and powerfully affected the American railroad industry, its impact on trucking while significant has not been transformative to a comparable degree. Yet if the business of trucking has not been altered to quite the same extent as the railroads, it has nevertheless seen important changes. And if container movement by truck draws little notice or interest, that fact hardly denies its importance—infrastructure is often at its most significant when it stays in the background, structuring our world and our lives without drawing attention. A shipping container itself is a banal generic object, as is a truck, and so together the combination is distinctly ordinary, yet that should not blind us to its great importance. The most powerful and revealing forms of globalization, arguably, are those that extend their tentacles most deeply into the mundane fabric of the national and local, and yet escape notice in the process. The way the container works itself unobtrusively into the trucking system allows global supply chains to insert themselves smoothly into the domestic transport infrastructure, and territorial space, of the American nation-state.

Central to the American image over the past century has been the prominence of the automobile and the roads and highways it moves so freely upon. But in its early years the United States was characterized by relatively poor roads that lagged behind those of several European counterparts. In the beginning it was waterways, not roads, that provided the most effective transportation through the vast American territory. The eastern half of the U.S. is particularly well-endowed with corridors for water-based movement, most significantly the Great Lakes system, the Mississippi River and its tributaries, and numerous smaller rivers that flow to the East Coast. Coastal shipping also flourished up and down the Atlantic, linking the cities of the East together, and in addition the construction of canals began in the late 1700s. (The history of the inland waterways is described in greater detail in chapter 10.) The long distances involved in American transport (as opposed to European nations) made road-based travel difficult and road construction arduous. Yet obviously waterways, whether natural or constructed, could not reach everywhere, and so movement by road was necessary. As Americans expanded westward, and especially as they sought to cross the Appalachian Mountains, these roads served to open new regions to settlement and growth.

By the late 1700s a few such roads across the Appalachians existed, though they were invariably rough and sometimes little better than trails. In upstate New York there was the sequence of the Mohawk Turnpike and Great Genesee Road, in Pennsylvania there was the Forbes Road, in Maryland and Pennsylvania there was Braddock's Road, and in Kentucky there was the Wilderness Road, famously blazed by Daniel Boone.[1] George Washington took a personal interest in Braddock's Road, for in the 1750s as a young British officer during the French and Indian War he traveled up and down its route, originally known as Nemacolin's Trail, and even helped improve it. After the American Revolution he traveled west again in 1784 to carry out a survey and see how settlement was progressing. Elected president in 1789, he continued to press for better roads westward in the interest of national unity and expansion. But Washington's vision of the configuration of this evolving national unity may have been influenced by loyalty to his native Virginia, neighboring Maryland, and the soon-to-be capital of Washington, D.C. In supporting the development of this particular route it is possible Washington hoped to make this region, rather than areas further north centered on Philadelphia and New York City, the starting point and chief beneficiary of western growth.[2]

It was not until 1806, during the presidency of Thomas Jefferson, that the federal government passed legislation to create what was to be called the National Road, to pass through Maryland, Pennsylvania and Virginia (now West Virginia) to the Ohio border. Jefferson's Secretary of the Treasury, Albert Gallatin, envisioned a national network of transportation corridors and played an important role in mustering support for the road. (His famous "Gallatin Plan" would appear in 1808.) The National Road—its very name connoting aspirations of nation-building and unity—would begin at Cumberland, Maryland, which was conveniently located on the North Branch Potomac River and also connected by road to Baltimore. The route would roughly follow Braddock's Road (by this time much deteriorated) in Maryland and Pennsylvania, but then continue further west through Pennsylvania and Virginia to Wheeling, on the border with Ohio. This represented a distance of 131 miles, mostly through lightly-settled areas and over mountainous terrain. It was already tentatively intended the National Road would continue through Ohio, Indiana and Illinois, but its location in these states was left undecided. The road was to be federally funded, and its exact path set by the federal government as well, as this was seen as necessary to pay for such a large project and also to overcome the sectional rivalries of different states and towns.[3]

After a few years of surveying, mapping and planning, construction of the National Road began in 1811; plans called for a road 66 feet wide with a maximum grade of five degrees, stringent standards for the time. Thanks to these expectations, along with the hilly topography, the desire to apply good paving techniques, and the need to build many sturdy bridges, the work was laborious and slow. In 1818 the road finally reached Wheeling, and upon completion this stretch immediately attracted numerous settlers and great quantities of freight.[4] In 1820 surveying began on the continuation of the National Road across Ohio, Indiana and Illinois, with construction beginning in 1825, while two acts of Congress in the 1820s helped set the exact route

---

[1] Joseph S. Wood, "The Idea of a National Road," in: Karl Raitz (ed.), *The National Road* (Baltimore: The Johns Hopkins University Press, 1996), pp. 99-101.
[2] Gregory S. Rose, "Extending the Road West," in: Raitz, *The National Road*, pp. 159-160.
[3] Ibid., pp. 160-164.
[4] Billy Joe Peyton, "Surveying and Building the Road," in: Raitz, *The National Road*, pp. 127-143.

definitively. From Wheeling the road went west and slightly southward through Columbus and Indianapolis, and then bent a bit more to the south as it continued west to Vandalia, Illinois. This far longer stretch was at least easier terrain for road-building, characterized by flatlands and gently rolling hills, and was built with a width of 80 feet. As each segment was finished it drew substantial traffic, at least in Ohio and Indiana during the 1820s and early '30s. But even as construction on the National Road continued in the 1830s its significance diminished, as other transportation corridors of both road and water (and increasingly railroad too) competed with it. Originally meant to reach the Mississippi River, the road petered out in Vandalia in 1839 when Congress chose not to authorize additional funds.[5] This decline notwithstanding, on both a practical and symbolic level the National Road played a vital role in the nation's westward growth, and in maintaining a link between the burgeoning Midwest and the East. But riverine and rail-based movement eventually eclipsed it, and in the process the Northeastern metropolises (along with New Orleans) surpassed Baltimore.

Given the vastness of the American territory and its relatively sparse population, its roads though important were limited in their reach. In the smaller and more densely populated European nations the situation was different. The British and French were preeminent in this regard, being pioneers in the technology of road-building and eager to tie together their national territories and carry out nation-building. In Great Britain the national project of road construction began in the late eighteenth century and proceeded apace in the nineteenth century, revolutionizing the nation's transportation and mobility and also having substantial effects on society, economics and politics. Even before the railroad began to exert its great impact, the improved roads had brought a measure of modernity to Britain.[6] In France during the same period there was a potent aspiration to achieve national unity through a variety of rationalized infrastructures, including roads.[7]

By the mid-1800s the railroad was starting to make its presence felt, and travel by road, whether for passengers or freight, soon became for the most part an accessory of rail. During the second half of the nineteenth century, an era of dramatic American expansion as the nation pushed westward, it was the railroad that was the driving force of movement, making a profound impact on the geography of American settlement and transportation that still endures. (The story is told in chapter 5.) Consequently there was a lack of investment in roads, whose conditions generally remained shabby. But near the close of the century enthusiasm sprang up for a novel transport invention that did use roads: the bicycle. Battered by bone-jarring rides,

---

[5] Rose, "Extending the Road West," in: Raitz, *The National Road*, pp. 164-176; Peyton, "Surveying and Building the Road," in: Raitz, *The National Road*, pp. 143-147.

[6] See Jo Guldi, *Roads to Power: Britain Invents the Infrastructure State* (Cambridge, MA: Harvard University Press, 2012).

[7] Cecil O. Smith, "The Longest Run: Public Engineers and Planning in France," *The American Historical Review*, Vol. 95, No. 3 (June 1990), pp. 657-692.

cyclists agitated for better roads and started the "Good Roads" movement.[8] In the meantime of course a more revolutionary invention was underway for road-based travel, one that powered itself and consequently was called the "automobile." While it was invented in Germany, the U.S. caught up swiftly. The first American gasoline-powered motor vehicle was introduced by the Duryea brothers of Springfield, Massachusetts, in 1893. If cycling created a desire for better roads, the automobile truly generated the need. The Office of Road Inquiry, in the U.S. Department of Agriculture, was created in 1893 and in 1896 built the first of its many "object-lesson" roads, a stretch of smooth road a quarter-mile long in Atlanta. Over the next three years the office built 21 object-lesson roads scattered about the country; as with the Atlanta example they were all extremely short and served primarily as demonstrations of the value of good roads.[9] As automobile use grew the purpose of such road-building gradually shifted, from being oriented to wagons, carts and bicycles to a concern for motor vehicle movement as well. For the automobile to move easily it required better and smoother roads, and since it inflicted a pounding on road surfaces improved construction methods would be necessary.

Early travel by motor vehicle was most definitely local in nature; the idea of moving a long distance was inconceivable due to the primitive nature of the technology and the awful condition of many roads, especially in the countryside. The story of one premature attempt at long-distance travel serves to illustrate the point. John and Louise Davis set out in 1899 in their new automobile with the intention of traveling from New York to Chicago. The slow pace of their progress, marked by breakdowns, can be gauged from their realization after about 300 miles of travel that a one-armed bicyclist passing them had left New York ten days after they did; little wonder the Davises abandoned the journey soon after.[10] The first cross-country trip by automobile was in 1903, when it took Dr. H. Nelson Jackson and mechanic/chauffeur Sewall Crocker roughly two months to laboriously make their way from San Francisco to New York. Jackson undertook the trip in order to win a bet, and upon returning to his native Vermont was fined for driving faster than six miles an hour.[11] For obvious reasons, motor vehicle use remained primarily at the local scale. As such it did not yet present any challenge to the railroad—on the contrary automobiles (like wagons and carts) served as accessories to the rail network. Indeed, the railroad companies were supporters of the Good Roads movement, for they saw better roads as creating improved access to their depots and stations. With this motivation they established the Good Roads Trains, elaborate and well-publicized traveling road-shows that, during the first two decades of the twentieth century, spread the gospel of good roads through demonstrations of road-building

[8] Tom Lewis, *Divided Highways: Building the Interstate Highways, Transforming American Life* (New York: Penguin, 1997), pp. 7-8; Dan McNichol, *The Roads That Built America: The Incredible Story of the U.S. Interstate System* (New York: Sterling Publishing, 2006), pp. 36-37.
[9] McNichol, *The Roads That Built America*, pp. 40-41.
[10] Dianne Perrier, *Onramps and Overpasses: A Cultural History of Interstate Travel* (Gainesville, FL: University Press of Florida, 2009), p. 3.
[11] McNichol, *The Roads That Built America*, pp. 42-46.

equipment.[12] (Previously during the 1800s railroads had assisted road-building efforts that would improve wagon movement, for much the same reason.[13])

In the first decade of the century owning a car was almost exclusively the province of the wealthy, but this quickly changed as automobiles became cheaper and more rugged, the introduction of Henry Ford's Model T in 1908 being a turning point. Designed to be eminently practical rather than stylish, in the stern spirit of Ford himself, the car was an astonishing success. In its method of manufacture the Model T was even more significant, for Ford and his associates pioneered the assembly line approach of mass production, with incalculable repercussions for the world. General Motors introduced its competing Chevrolet line, also aimed at buyers of normal means, in 1912. Automobile use grew dramatically, and by 1916 there were approximately three-and-a-half million cars and 250,000 trucks in the U.S., though those figures were still dwarfed by the nation's 21 million horses.[14]

As with the car, use of the truck was growing quickly. In these early days trucking was typically practiced by very small firms, often consisting of just one owner-operator, and it sought to replace the local cartage of freight by horse-drawn wagons. This involved pickups and deliveries in cities and towns, as well as transfers to and from train depots.[15] The importance of all this local traffic was immense, both in its own right and as a segment of long-distance freight. The railroads depended heavily on such local transport to handle the "last mile," and before the coming of the motor vehicle the results were problematic, as an article in 1911 pointed out: "It is estimated that 90 per cent of all freight which the railroads haul is rehandled at one end or the other by horses, and to a large extent the unsatisfactory conditions in freight haulage, shortage of cars, warehouse congestions, and slow freight movement may be charged to their cause."[16] The advantages of the truck were evident, and over the course of the 1910s it made substantial inroads in the movement of local freight.

Farmers also were early adopters of the truck, using it to carry produce to market or depot and bring supplies back. Trucks proved to be of military value in World War I as the army ordered 30,000 trucks, most of them from manufacturers in the Detroit region. With the railroads tied up handling war-related traffic, these trucks had to be driven all the way to the eastern ports. Such a long haul was almost unthinkable, and the condition of roads was so uncertain that at least one reconnaissance team was sent to scout a feasible route. Moving in convoys, the trucks made the trip at a top speed of 14 miles per hour.[17] In the process their steel and solid rubber (i.e., not pneumatic) tires inflicted tremendous damage—one official called it "the simultaneous

---

[12] Stephen B. Goddard, *Getting There: The Epic Struggle Between Road and Rail in the American Century* (New York: BasicBooks [HarperCollins], 1994), pp. 52-53, 60; McNichol, *The Roads That Built America*, p. 41.
[13] Goddard, *Getting There*, pp. 46-47.
[14] Lewis, *Divided Highways*, p. 11.
[15] William R. Childs, *Trucking and the Public Interest: The Emergence of Federal Regulation 1914-1940* (Knoxville, TN: University of Tennessee Press, 1985), pp. 7-8, 16-17.
[16] *Freight* [also known as *Freight: The Shipper's Forum*], "The Motor Truck a Strong Link in the Transportation Chain," Vol. 12, No. 1 (January 1911), p. 14.
[17] McNichol, *The Roads That Built America*, pp. 51-53.

destruction of the entire road system."[18] During the war freight transport by truck was also initiated over previously unprecedented distances of a few hundred miles. The Goodyear Tire Company even launched a run from Boston to San Francisco, and though this was largely for publicity purposes it appears to have been the first use of trucking to move goods across the full span of the nation.[19]

Increasingly the vision of some road builders and drivers was of a national network of movement for the automobile. In 1912 the energetic Carl Graham Fisher, manufacturer of headlights and founder of the Indianapolis Speedway, proposed the Lincoln Highway, a transcontinental road from New York to San Francisco. Ultimately this would consist of numerous roads of varying quality marked under one name.[20] Other long-distance roads, sometimes known as "auto trails," soon followed, such as the Dixie Highway, Yellowstone Trail, Victory Highway and Jefferson Highway. Like the Lincoln Highway they essentially consisted of local and regional roads linked together under a common identity. The military also got involved, as Dwight Eisenhower, at the time a young lieutenant colonel, was part of a convoy that in 1919 crossed the nation from Washington, D.C. to San Francisco as an exercise to determine the state of the roads and the army's ability to use them. The trip lasted two months, with the convoy traveling an average of only 58 miles a day due to the brutal condition of the roads, more than half of which were unpaved. In 1922 the army released the "Pershing Map" showing a proposed highway network for the nation, with General Pershing testifying to Congress that these roads could serve commerce, industry and personal travel, in addition to their military value.[21]

During the booming 1920s both car and truck use shot up, as the motor vehicle morphed from a complement to the railroads into a dangerous competitor. It offered a flexibility and mobility that trains, restricted to their fixed tracks and set schedules, could not possibly match. As settlement patterns spread out and metropolitan areas expanded the automobile grew ever more essential while the railroad, more suited to compact cities and towns, began to lose traction. Thanks to trucking, factories and warehouses could be sited in a more flexible fashion, no longer requiring locations on rail lines and spurs. While the Great Depression brought an end to the days of prosperity, the automobile's popularity and influence nevertheless continued to expand in the 1930s. The fictional Joads in *The Grapes of Wrath*, driving their battered car westward, were emblematic of Americans' determination to hold onto their cars. In Robert and Helen Lynd's famous sociological studies of "Middletown" (actually Muncie, Indiana) they found the automobile to be one of the few items resistant to cutbacks in family budgets during the Depression.[22] The comic Will Rogers famously jibed that Americans would be the first people to go to the poorhouse in an automobile. Suffering from the competition, railroad companies began

---

[18] Ibid., p. 53.
[19] McNichol, *The Roads That Built America*, pp. 49-51; Goddard, *Getting There*, pp. 91-92.
[20] Goddard, *Getting There*, pp. 60-61; Lewis, *Divided Highways*, pp. 50-51.
[21] McNichol, *The Roads That Built America*, p. 62, 87-94.
[22] Lewis, *Divided Highways*, p. 45.

to abandon certain routes as early as the 1920s, a trend that accelerated in the 1930s. The railroads were burdened by regulations that had once been amply justified but now put them at a disadvantage compared to trucking, which with the backing of pro-business courts and politicians fended off sorely needed federal regulation.[23] A similar transition was unfolding in public transit, as subway systems, commuter railroads and especially streetcars began to decline in the face of competition from cars and buses.

The design and construction of the truck progressed, as it became something clearly distinct from the car. While Ford and General Motors were the leading manufacturers, several other makers emerged, including Mack, White, Kenworth and International Harvester. Pneumatic tires were an especially useful advance, allowing trucks to be heavier and move faster with less destructive vibration, while the development of headlights made nighttime travel possible. (These two advances benefited cars as well.) Better frames made trucks more durable, and the creation of mechanical refrigeration allowed them to carry produce and perishable goods farther and in better condition. Improvements in suspension and shock absorption made for a less bruising ride for the driver and extended the life of the truck as well. Enclosed cabs and sleeper compartments also made long-distance travel easier for the driver. The development of better brakes was particularly valuable, since many accidents occurred when heavy trucks going downhill lost control.[24]

Another important development was the creation of a new type of truck that separated the body of the truck into separate components: the "tractor," mainly consisting of the cab and engine, and the trailer (technically a semi-trailer) that constitutes the bulk of the size and holds the cargo. The resulting combination truck is widely known, to Americans at least, as a "tractor-trailer." Until this point in time all trucks were composed of one discrete unit, which is termed a "one-body" design. The one-body truck of course did not go away, and remains the dominant type of truck in use today for a wide range of purposes, with one-body trucks being built in all sorts of sizes and shapes. But the tractor-trailer truck has become prevalent in long-haul trucking and is sometimes used for local or regional trips too; when the objective is simply to carry the largest possible quantity of freight from point A to B, the tractor-trailer truck is the logical choice. Because the trailer is able to rotate behind the tractor, a tractor-trailer truck can handle a turn much better than a one-body truck of the same length. Consequently the allowable legal length of a tractor-trailer truck is invariably longer than for a one-body truck, meaning that the tractor-trailer can hold a larger volume of freight. As the trailer is detachable, its use brings other advantages too. A trailer can be dropped off and left for a while—at a loading dock, for instance—while the tractor and driver go off to do work elsewhere and return later to pick it up. A trailer can also be switched between different tractors as is necessary or convenient.

One of the first makers of semi-trailers designed to be pulled by trucks was August Fruehauf, a blacksmith and carriage builder in Detroit. After having success in building several semi-

[23] Goddard, *Getting There*, pp. 98-100, 114-119.
[24] Childs, *Trucking and the Public Interest*, pp. 11-13; Shane Hamilton, *Trucking Country: The Road to America's Wal-Mart Economy* (Princeton, NJ: Princeton University Press, 2008), p. 46.

trailers, he founded the Fruehauf Trailer Company in 1918 and opened a new factory in Detroit in 1920 to handle the growing business.[25] Another pioneer was John Endebrock, who built semi-trailers in the 1910s while working for the carriage builder Sechler & Company, which introduced the Trailmobile brand of trailers and would eventually change its company name to Trailmobile in recognition of the brand's success. (As will be described later, Fruehauf and Trailmobile were each to play a role in the development of the shipping container in the 1950s.) Most significantly, in 1918 Endebrock along with some other engineers came up with a scheme to better connect the trailer to the tractor: this involved a mechanism known as the "fifth wheel" at the rear of the tractor, along with the "kingpin" attached to the trailer. With the kingpin held in the fifth wheel the trailer and tractor are firmly attached, yet the trailer can rotate. The design was eventually improved so the trailer could be easily attached and detached, and is the basis for the system widely in use today.[26] The spread of a standardized system for linking together tractor and trailer was crucial to the success of the tractor-trailer system, as it allowed truckers to switch trailers between different tractors. Gradually trucking firms worked out agreements for interchanging trailers from one company to another, a practice sometimes known as interlining, much as the railroad companies before had learned to interchange railcars.

Trucks grew larger in the 1920s and '30s, a trend driven by technological improvements, better roads, and the economies of scale inherent in carrying the biggest possible loads. Trucks in the 1920s typically were under 20′ long, and trailers—on the rare occasions they were used at all—had a similar length. Gradually the size of trucks and trailers grew, such that during the 1930s they advanced to over 20′ long. Even in the 1930s, though, the use of trailers was uncommon, as the majority of trucks were of one-body design. (But after World War II the use of tractor-trailers would become standard practice in long-distance trucking.) The business of trucking, including the size and weight of trucks and trailers, became increasingly enmeshed in a web of regulations that differed from state to state, while federal regulation was nearly nonexistent. The one spatial characteristic that was most uniformly imposed, even at this early point in time, was a maximum width of eight feet.[27] (The persistence of this dimension would eventually cause it to become the width of the shipping container.) But otherwise there was great variation in the state standards, and this posed a problem for the burgeoning trucking industry whose routes increasingly extended over multiple states. The different state laws did not only relate to size and weight, but also to licensing fees, gasoline taxes and other bureaucratic details. Illegal "gypsy" truckers evaded the rules and undercut legitimate operators. The state governments though had sound reasons for many of the laws, as road conditions varied widely,

---

[25] "Fruehauf History – Semitrailer History," At http://home.uninet.ee/~trailer/tech_info/history.pdf, accessed 9/29/11.

[26] *Coachbuilt* website, Coachbuilt.com, "Trailmobile." (http://www.coachbuilt.com/bui/t/trailmobile/trailmobile.htm, accessed 10/30/11); American Trailer Exchange, "Information About a Semi-Trailer or Truck Trailer." (http://www.amtrex.net/semitrailer_definition.htm, accessed 12/11/11)

[27] John B. Rae, *The Road and the Car in American Life* (Cambridge, MA: MIT Press, 1971), p. 112; Childs, *Trucking and the Public Interest*, p. 52.

and there was little public sympathy for the truckers whose cumbersome vehicles clogged up roads and caused accidents. The railroads used their political sway to make the regulations as restrictive as possible at the state level (even as they could not persuade the federal government to impose regulations), and to otherwise harass the trucking business.[28]

In the 1920s and '30s the mystique of American trucking developed—the idea of truckers as rugged independent owner-operators, modern-day cowboys who relish the freedom of the open road.[29] Yet this was also a period—at least from the late 1920s onwards—when the industry began to organize itself. Several trucking associations and trade groups sprang up in the late 1920s and '30s, as the previously individualistic industry, still dominated by small companies and individual owner-operators, grew more established and started to act collectively. The bigger trucking firms were especially active in these activities and in the 1930s began to push for cartels and/or regulations that would quash illegal truckers, and more generally would diminish competition and create stability. Their desire for regulation found a receptive audience with New Deal administrators. After an attempt at self-regulation in partnership with the National Recovery Administration (NRA) failed in the early 1930s, more firms became supportive of some form of government regulation. With passage of the Motor Carrier Act of 1935 they received it, as trucking became a highly-regulated industry with significant barriers to entry.[30] The new regulatory framework had the unanticipated consequence of giving drivers greater leverage in their efforts to unionize, and during the late 1930s the Teamsters Union (officially known as the International Brotherhood of Teamsters) enjoyed tremendous success. Previously the union had focused on drivers in local haulage, but now it broadened to regional and long-haul drivers and by 1939 had grown dramatically to over 400,000 members.[31] Wages and working conditions for drivers improved greatly.

The railroad companies had also supported regulation of trucking, for the trucks were making ever-greater inroads on their business. Yet railroads and truckers were not invariably hostile. While most local deliveries were now done by truck, long-distance freight movement was still dominated by rail, and some innovative minds began to see the promise of intermodalism. Given the time and expense of shifting goods between the two modes, perhaps one might simply transfer a very large container, or an entire truck trailer, between train and truck, with the freight itself remaining inside the container or trailer. A few such schemes, some involving containers and others trailers, were tried with moderate success. As it was mainly the railroads that introduced these practices in the 1920s and '30s, the subject is covered more extensively in chapter 5. The shipping containers used in these systems were very small by later standards, measuring only four to ten feet in each dimension—though sometimes the length might be a bit longer. The trailers in use at the time were larger than this but still of modest size, as has been already detailed, and the practice of carrying them on rail flatcars soon became known as

---

[28] Childs, *Trucking and the Public Interest*, pp. 52-54.
[29] Hamilton, *Trucking Country*, pp. 47-51.
[30] Childs, *Trucking and the Public Interest*, pp. 54-57, 60-63; Hamilton, *Trucking Country*, pp. 51-54.
[31] Hamilton, *Trucking Country*, pp. 54-56.

"piggyback." Neither containerization nor piggyback was able to make a major impact in this period, for there were drawbacks as well as advantages associated with them, but both were used regularly.

In the meantime road construction and improvement continued apace. Until the 1920s road building was typically a local matter, handled in a manner that might reflect much effort but not a high level of organization, technical sophistication or coordination with neighboring jurisdictions. With the need for greater expertise evident and motor vehicles traveling longer distances, such practices were no longer feasible and more sophisticated organizational and technical approaches emerged. Just as the railroad had brought a new and more systematic approach that was formative in the modern corporation, so the new motor vehicle technology, and the more sophisticated roads necessary for it, led to new methods of governance. Expanded bureaucracies were important to these changes, and the role of engineers and the technical expertise they represented was crucial. In many ways road building was a step towards a more centralized, bureaucratic and modernized state.[32] This did not reduce the political dimensions of road infrastructure, however, as multiple interests competed for their priorities; industry sought better roads in developed areas, farmers pushed for improvements in rural areas, and motorists focused on their own routes of travel and commuting.

In 1924 planning began on a new system for naming the existing long-distance roads, now to be termed "highways," which abandoned the colorful names of the auto trails for a numbered scheme in which each highway received the label of "U.S. Route" rather than a state identifier. (Bitter squabbling between Kentucky and its neighbors over which route would be numbered 60 almost torpedoed the accord, until a compromise was reached that had the side effect of assigning the designation Route 66 to a series of roads from Chicago to Los Angeles.) New standards for road signs were also promulgated, involving typeface, color, shape and size; the iconic shield emblem for signs displaying highway numbers originates from this time. In 1926 the final plan, calling for 96,626 miles of highways, was officially released.[33] As with the railroads in an earlier era, the motor vehicle and its roads were being utilized to construct a unity across the territory of the nation-state, as an exercise in nation-building. But here the role of government was larger and certainly more direct, and the process was happening more quickly. Furthermore, while the railroads had to some degree actually driven the process of American expansion, the new roads and highways worked to cement this vast national space more tightly, and to fill in regions rail had neglected. Yet even as a national vision was emerging, the planning and construction of roads and highways in this period was usually at the scale of a state or region.

The highways of the 1920s and '30s gave automobile drivers a newfound ability to move about quickly, and allowed truckers to expand their business, but as traffic boomed the roads

---

[32] For more on this topic, see Michael R. Fein, *Paving the Way: New York Road Building and the American State, 1880-1956* (Lawrence, KS: University Press of Kansas, 2008). Also see Mark H. Rose and Raymond A. Mohl, *Interstate: Highway Politics and Policy Since 1939* (3rd ed.) (Knoxville, TN: University of Tennessee Press, 2012), pp. 8-10.
[33] McNichol, *The Roads That Built America*, pp. 67-78; Lewis, *Divided Highways*, pp. 18-19.

were swiftly clogged up. These highways were impressive for their time, being paved and amenable to fairly high speeds, but generally consisted of just one lane in each direction, with cross streets and traffic signals that slowed movement. A solution was emerging, however: the limited-access divided highway with multiple lanes in each direction—what Americans today would regard as a real highway. Such a design is distinguished by a totally unfettered and continuous flow of traffic, thanks to its complete grade separation from any transport route (or other obstacle) that crosses its path. Such roads were originally known as parkways and were built with pleasure in mind as much as functionality, typically winding their way through a picturesque landscape. (The parkway actually originated in the late nineteenth century, as planners and designers, most notably Calvert Vaux and Frederick Law Olmsted, created the earliest parkways for horse-drawn carriages.) Arguably the first was the Long Island Motor Parkway, a private raceway built in 1906 by the absurdly wealthy racing car enthusiast William Vanderbilt, Jr. Work began in 1907 on the Bronx River Parkway, the first parkway built for the general public, though it would not be completed until 1923. In the 1920s Robert Moses, the builder of public works in and around New York City who would eventually rise to great fame and power, built a series of parkways in Long Island, and in the 1930s he proceeded with new parkways to the north of the city, most notably the elegant Taconic State Parkway. Other regions also initiated parkways: the Bureau of Public Roads began a parkway in Virginia in 1928, and then the Skyline Drive, also in Virginia, in 1930. The first segment of Connecticut's Merritt Parkway, perhaps the finest and most attractive of all the parkways, opened in 1938. In the same year work began on the Arroyo Seco Parkway in Pasadena, California.[34]

The parkways were limited in their reach, but some visionaries imagined longer ribbons of asphalt extending across the nation. The most persuasive presentation of such ambitions was Futurama, the famous General Motors exhibit designed by Norman Bel Geddes at the New York World's Fair in 1939. It featured a giant 36,000-square-foot diorama showing a glittering vision of tomorrow, a futuristic high-tech landscape of city and country highlighted by highways with miniature cars and trucks shown moving along them. Geddes' proposed "Magic Motorways" were massive for the time—the widest was fourteen lanes across—and spanned the countryside but also cut a broad swath through the cities. These were of another scale entirely from the parkways. They also connected smoothly into each other, with cloverleafs, entrance ramps and exit ramps designed for speeds of 50 miles per hour. It was an altogether dazzling display that left a deep impression on the public.[35]

In the meantime the future had already arrived elsewhere, for in the 1930s the German autobahns, forming a modern highway network covering much of the country, were a revolutionary advance and a propaganda triumph for Hitler's evil regime. But some actual

---

[34] Lewis, *Divided Highways*, pp. 26-31, 37-38; Phil Patton, *Open Road: A Celebration of the American Highway* (New York: Simon and Schuster, 1986), pp. 67-71.

[35] Lewis, *Divided Highways*, pp. 41-44; Earl Swift, *The Big Roads: The Untold Story of the Engineers, Visionaries, and Trailblazers Who Created the American Superhighways* (Boston: Houghton Mifflin Harcourt, 2011), pp. 127-132.

highway builders were dubious of the revolutionary visions embodied by Futurama and the autobahns. Robert Moses scorned proposals for a nationwide highway system and referred to Geddes' Magic Motorways as "bunk," arguing instead for regional parkways of the kind he had already been successful in building.[36] Thomas MacDonald, the influential head of the Bureau of Public Roads, did not see the point of divided grade-separated highways, especially in rural areas. When President Franklin Roosevelt (an enthusiastic but terrible driver—his wife Eleanor refused to get in the car when he drove) proposed an ambitious scheme of highways spanning the nation, MacDonald issued a report pointing out that most traffic was local in nature and centered on cities. He also opined that Americans would not be willing to pay tolls on highways.[37]

Such doubts were erased by the success of the Pennsylvania Turnpike, the first long-distance modern highway in the U.S., which was completed in 1940 and connected Pittsburgh to Harrisburg through the mountains of southwest Pennsylvania. Receiving support from the federal government in the form of a direct grant and the purchase of bonds—Roosevelt was eager to stimulate employment—the state began construction in 1938. It was a project of massive scale, inasmuch as its builders had to remold the landscape in order to build two traffic lanes in each direction with a median in between, a 200-foot right of way in total, at a grade never higher than 3%. Construction of 114 bridges and viaducts was necessary, along with seven miles of tunnels. After two years of relentless often round-the-clock work, the highway opened to immediate acclaim and popularity. 160 miles long, the astonishing new roadway reduced the journey by five hours, and aside from such practicalities many found simply driving on it to be an extraordinary experience. Soon over 10,000 vehicles were traveling on the turnpike each day—exponentially more than the 715 that MacDonald's Bureau of Public Roads had predicted. Operators of both cars and trucks showed little reluctance to pay the toll, and money poured into the state's coffers.[38]

Other states were eager to follow, but World War II delayed their progress. As soon as the war ended the pent-up demand for auto travel was set loose, and Americans returned to the road in droves. The railroads, which had done well during the war and played a vital role in the war effort, saw their fortunes quickly sag. From 1945 to 1950 the number of registered motor vehicles across the nation rose from 31 million to 49 million, the latter figure including 8.6 million trucks.[39] Road and highway builders scrambled to keep up. In 1947 Maine opened its turnpike, followed a year later by New Hampshire whose modest fifteen-mile turnpike was an extension of Maine's. Construction of the New York State Thruway began in 1946, with the first part opening in 1954 and other segments gradually following until its completion in 1957, while the New Jersey Turnpike started construction in 1950 and commenced operations in 1952. These Northeastern turnpikes were financially successful beyond expectations, and Midwestern states quickly

---

[36] Lewis, *Divided Highways*, p. 43.
[37] McNichol, *The Roads That Built America*, pp. 78-81; Lewis, *Divided Highways*, pp. 48-55.
[38] Patton, *Open Road*, pp. 75, 77-80; Swift, *The Big Roads*, pp. 132-136; Lewis, *Divided Highways*, pp. 58-69.
[39] Rose and Mohl, *Interstate: Highway Politics and Policy Since 1939*, p. 31.

followed suit. The Ohio Turnpike was completed in 1955 and the Indiana Toll Road in 1956; these connected with each other, and also with the Pennsylvania Turnpike. Back in the Northeast, the Massachusetts Turnpike was finished in 1957 (except for a small segment into downtown Boston that would be added later) and the Connecticut Turnpike in 1958. Other states that built turnpikes in this period included Oklahoma, Kansas, Kentucky and West Virginia. (Florida began construction on its turnpike too, but the bulk of it would be built in the 1960s and '70s.) Shorter tolled highways appeared in Texas, Colorado, Illinois and Virginia. California was also energetic in building highways in the late 1940s and '50s but decided to avoid making them toll roads, choosing to fund them through state taxes instead. At the local and regional level new and better highways were also being created. In the 1950s Route 128 was built around Boston—the first such divided limited-access highway to encircle a metropolitan area. The Illinois Tollway similarly was built to provide access to the periphery of Chicago, as well as a bypass route around the city. The Detroit area, locus of the automobile industry, was predictably engaged in building highways, notably the Edsel Ford Expressway and John C. Lodge Freeway. In Los Angeles as well several new highways were built in the 1950s.[40]

In the immediate postwar years the role of the federal government in road building, and especially highway building, was modest, reflecting President Harry Truman's reluctance to commit substantial funding. While business groups and truckers in particular clamored for new and improved roads, and for reducing taxes on gasoline, the Truman administration held firm. (Those in favor of roads were hardly united; the business establishment and urban dwellers favored major highways, while farmers and rural inhabitants wanted better country roads.) The expense of the Korean War was an additional rationale for Truman to limit road construction.[41] Consequently the evolving network of modern highways was being cobbled together on a state by state basis, in spite of the nationally standardized identifying numbers and signage, and this led to problems. A particularly spectacular example received wide publicity in 1956 when the Kansas Turnpike opened, for it came to an abrupt dead end at a field on the Oklahoma border where an unfortunate farmer had to deal with about a crash each day on his land.[42]

A unified national system could avoid such gaps, provide common standards, and offer a consistent travel experience across the entire nation. The need to create such a network was becoming evident to the public, the business community, and the government. The benefits of a national highway infrastructure for the military was another justification, given the prevailing Cold War mentality. President Eisenhower, elected in 1952, had long understood the importance of road transportation—his arduous 1919 cross-country trip in a military convoy has already been noted. In the closing stages of World War II he was astonished by the German autobahns, which the Americans exploited to advance rapidly into the prostrate nation. In one of his memoirs he noted how the German highways transformed his conception of the possibilities of

---

[40] Rae, *The Road and the Car in American Life*, pp. 174-186; Lewis, *Divided Highways*, pp. 68-69.
[41] Rose and Mohl, *Interstate: Highway Politics and Policy Since 1939*, pp. 35-39.
[42] McNichol, *The Roads That Built America*, p. 125.

automotive movement: "The old convoy had started me thinking about good, two-lane highways, but Germany had made me see the wisdom of broader ribbons across the land."[43]

The Eisenhower administration worked to craft a strategy for a national highway system. A committee created by the president, headed by Lucius Clay, issued a report in January of 1955 recommending the creation of an "Interstate Highway System" of modern (i.e., divided, limited-access, multi-lane) highways, to be financed by federally issued 30-year bonds, with the federal government covering 90% of the cost of construction and the remainder falling to the states. But the Senate and House of Representatives were cool to the proposal, especially the notion of taking on debt by issuing bonds, and it went nowhere. Other ideas, including legislation that sought to pay for the highways largely through taxes and fees on gasoline, trucks and tires, also failed to advance through Congress in 1955. By the following year a sense of urgency had taken hold, and many in the automotive and trucking industries dropped their opposition to such taxes. Another motivating factor was a federal report titled *General Location of National System of Interstate Highways Including All Additional Routes at Urban Areas*. The "Yellow Book," as it came to be more concisely known thanks to the color of its cover, contained maps showing where the proposed Interstate highways would be placed in every metropolitan area of any significance. The report was sent to members of Congress in late 1955 and this proved a clever tactic, for now they could see where the new roads would go and thus comprehend in a more tangible fashion the economic boost that would come from construction and higher property values.[44]

Consequently 1956 proved more fruitful, as Congressmen George Fallon and Hale Boggs took the lead and sponsored new legislation, with Senator Albert Gore also eventually playing a key role. The Highway Trust Fund, supported by taxes on gasoline, diesel, oil, tires and trucks, was established to finance construction, while the idea of the federal government paying 90% of construction costs reemerged and became part of the new law. The House passed the legislation by a vote of 388 to 19, the Senate approved it by a voice vote, and on June 29th Eisenhower signed the historic Federal-Aid Highway Act of 1956. The U.S. Interstate highway system, officially named the "National System of Interstate and Defense Highways," was now in existence.[45] Next came the challenge of actually building the massive network; while the existing highways were incorporated into the Interstate system, the vast bulk of it remained to be built. This would primarily be carried out in the 1950s, '60s and '70s (though work lingered into later decades), and ranks as perhaps the largest public works project in history.

The new Interstate highways were commonly laid out in existing transportation corridors, often parallel with railroad routes and preexisting roads and smaller highways. It was logical for the Interstates to serve major cities that already existed. So the new highway network reflected the history of the nation, its geography, and its transportation legacy. Countless examples could be enumerated. In upstate New York, the New York State Thruway ran alongside the New York

---

[43] Dwight D. Eisenhower, *At Ease: Stories I Tell to Friends* (Garden City, NY: Doubleday, 1967), pp. 166-167.
[44] Swift, *The Big Roads*, pp. 177-182, 184, 188-189.
[45] Rose and Mohl, *Interstate: Highway Politics and Policy Since 1939*, pp. 88-90; Swift, *The Big Roads*, pp. 183-187.

Central Railroad's Water Level Route, which in turn had followed the Erie Canal. In southern Pennsylvania the Pennsylvania Turnpike roughly paralleled the old Pennsylvania Railroad Main Line. Between Maryland and Illinois Interstate 70 ran very close to the path of the old National Road, which previously had seen U.S. Highway 40 laid out along its route in the 1920s.[46] In Nebraska Interstate 80 ran parallel to the Lincoln Highway, signed as U.S. Highway 34, which in turn had been laid out near the first transcontinental railroad. The legacy went further, for that railroad route was largely placed alongside the Platte River, which due to its value as a water source had been followed closely by the original settlers in their wagons.[47] Likewise in the Southwest Interstate 40 traced a very similar path to Route 66, which in turn had largely followed the Beale Trail used by pioneers traveling from Arkansas to California.

Occasionally the highways blazed new trails, even if they did so to connect existing metropolises. Interstate 80 was built straight through the mountains of central Pennsylvania, creating a more direct route from Cleveland to New York as it goes through relatively unpopulated areas. In the Central Valley of California Interstate 5 does not follow the chain of existing cities, already well-served by State Route 99, but rather is a bit to the west, making a slightly more direct connection between Los Angeles and San Francisco. But new corridors like these were uncommon, and it is noteworthy that they did not generate new cities. No American city has dramatically boomed due to a highway connection, in contrast to the growth once caused by the railroad in places like Chicago, Kansas City and Los Angeles. Compared to the railroad system the highway network is more spread out and diffuse, connecting a vast array of places and not having the dramatic centralizing effect that trains could endow to a place like Chicago. Perhaps more importantly, the highway network grew in an era of consolidation rather than raw creation. (Certainly many suburban and exurban areas have grown dramatically thanks to highways, but this phenomenon happened at the metropolitan scale, around cities that already existed.) However, the Interstates in spanning the nation did provide a certain equality of economic opportunity that helped "underdeveloped" regions, such as the Sun Belt and the West, and moderately populated rural areas in general, develop from the 1970s onward.

Though actual construction of the Interstates would be done by the states, the U.S. government was charged with coordinating the entire effort and setting the basic guidelines. The Interstate highway system like so many American projects is a compromise between top-down federal control and state autonomy, but in its overall design it has a cohesion and consistency that gives it a national stamp. The space of the nation-state is made whole and unified by this remarkable infrastructure; it is crucially important the network has a sameness about it everywhere. Boring though this quality can be to many travelers, who lament the blandness of the highway landscape, this consistency helps make the Interstate highways comprehensible,

[46] A collection of essays that explores the heritage of the National Road, and the overlapping changes over time to the route and its landscape, is Karl Raitz (ed.), *The National Road* (Baltimore: The Johns Hopkins University Press, 1996). In particular see the chapter "Adapting the Road to New Transport Technology" by Craig E. Colten, pp. 193-223.
[47] For more on the history of this pathway across Nebraska, see Lewis, *Divided Highways*, pp. 155-158.

efficient and safe to its users. It negates local and regional variations, so that a person from one corner of the country feels comfortable—and need not learn any nuances of a different system—in another region. As one historian comments, "standardization is the Interstate's hallmark and perhaps its most important characteristic."[48] This standardization encompasses many spatial characteristics, such as the width of lanes, the minimum turning radius for curves, the maximum grade of slopes, the vertical clearance, and so forth. Of course a wide variety of other things are also standardized: the materials used in the asphalt paving, the color and typeface of the signage, the numbers used to identify the highways, regulations concerning driver behavior, allowable pollution emissions, etc. But our main concern here is with the dimensional details—along with certain other physical characteristics—for they are what constitute the spatial regime of American highways.

The Interstate builders quickly got to work setting these standards. In 1957 a section of highway in Maryland not yet opened to traffic was used to decide on the color scheme of the highway signs; background options of blue, green and black, all with white text, were tested as hundreds of drivers went past and then voted for their favorite. Green won handily, and consequently the now familiar green signs would be instituted nationwide. The design of the highway identification signs, with their iconic shield shape, was also established in 1957. In the same year the numbering system for the highway names was put in place; to avoid confusion with the already existing U.S. Routes the new scheme reversed their system. The even numbed east-west highways would be numerically higher further to the north, and the odd-numbered north-south highways would be numerically higher to the east. Meanwhile in Illinois engineers and officials built an experimental highway seven miles long in order to test a wide variety of pavings, subsurface materials, and design approaches, creating a total of 836 segments each built in a different fashion. This road was completed in 1958 and then vehicles of various size and weight drove relentlessly over it for two years.[49]

One standard that would have implications for the size of trucks and trailers—and ultimately the size of shipping containers too—is the vertical clearance. This is a key part of the spatial regime of American trucking. The creation of the Interstate system offered a chance to create a national standard, one that would initially apply to the highways but was likely to be subsumed into the construction of ordinary roads also. Originally a dimension of 14′ was recommended, but the military claimed its vehicles needed a 17′ clearance. In 1960 the federal government issued a compromise decision requiring 16′ in rural settings but allowing 14′ in urban areas, and leaving many preexisting clearances unaffected. Over time the military and several government agencies worked together to gradually create a continuous network of routes with 16′ clearances; most major urban regions therefore have at least one highway corridor with a 16′ clearance.[50]

---

[48] McNichol, *The Roads That Built America*, p. 114.

[49] McNichol, *The Roads That Built America*, pp. 114-123; Swift, *The Big Roads*, pp. 195-199.

[50] Federal Highway Administration (U.S. Department of Transportation), "Right of Passage: The Controversy Over Vertical Clearance on the Interstate System [Highway History]." (http://www.fhwa.dot.gov/infrastructure/50vertical.cfm, accessed 10/17/11); Swift, *The Big Roads*, p. 223.

(Presumably these debates and compromises are the source of the widely repeated anecdote, only partly true, that the Interstate highways were built with clearances too low for military use.)

It is the 14′ clearance that has gradually become the nationwide standard for nearly all major highways and roads—standard in the sense that it is a minimum which can be assumed everywhere. (Any clearance lower than 14′ should be well marked with signage.) This figure has expanded gradually, and significantly, over time. Before World War II it was only around 10′, so trailers had to be lower than that height. By the early 1960s the typical clearance was up to 13′, and so a normal tractor-trailer truck was 12′-6″ high. (A six-inch spatial buffer is generally expected.) In the later years of the decade the 14′ dimension became more established, at least on major routes, and most new trailers were built at a 13′-6″ height, as is still the case today.[51] As the container height of 8′-6″ was originally established in the late 1950s and early '60s largely so that the container when carried on a trailer chassis could fit under the 13′ vertical road clearance of the time, the shift to a 14′ clearance meant another 12 inches was in play. (The initial standard container was actually 8′ high, but the 8′-6″ height remained more common and eventually the standard was switched to that dimension. This is described later in this chapter.) Hence the American trucking infrastructure, at least, could accommodate containers 9′-6″ high by the late 1960s. The rest of the world was another matter of course, and so the container's dimensions could hardly be altered merely for the sake of the American trucking spatial regime. But many years later this potential would eventually be exploited by domestic containers 9′-6″ high, and also by global high-cube containers of a 9′-6″ height.

As highway construction advanced in the 1940s and '50s, and suburban sprawl developed rapidly, trucking grew more and more central to American freight practices. As noted earlier in this chapter, as far back as the 1920s manufacturers, warehouses and other industrial facilities began to disperse spatially as they found themselves less dependent on the railroad. The truck offered an alternative to the train's longstanding hegemony. The process accelerated in the postwar era by leaps and bounds, as a rail connection simply became unnecessary for a wide spectrum of industrial sites. Increasingly it was highways and roads, along with the ever-larger and swifter trucks traveling on them, that provided the critical access. The truck was the key unit in the new network of freight movement. A railroad trade journal acknowledged in 1960 that "as

---

[51] Figures on road clearances are hard to uncover but can be gleaned from various sources. In a 1961 paper a trucking expert notes the typical trailers of the time were 12′-6″ high, which implies a vertical clearance of 13′. See E. B. Ogden, "What the Operator Wants in Containers," Society of Automotive Engineers, New York, 1961 (1961 SAE International Congress and Exposition of Automotive Engineering, Detroit, MI, January 9-13, 1961), p. 1. A pair of articles in a railroad trade journal also note that as of 1960 a 12′-6″ height was typical for trailers. See David P. Morgan, "The Paraphernalia of Piggyback," *Trains*, Vol. 20, No. 8 (June 1960), p. 37; David P. Morgan, "What Price Piggyback?" *Trains*, Vol. 20, No. 7 (May 1960), p. 41. The first article ("Paraphernalia") also mentions the 10′ clearance before World War II. For information on the rise to a 14′ clearance and 13′-6″ high trailers by the late 1960s, see Truck Trailer Manufacturers Association, *Containerization: Problems of Today and Potential for Tomorrow*, Panel Discussion, 26th Annual Convention, Grand Bahama Island, April 17, 1967, p. 56. The speaker even points out that the American trucking infrastructure, as of 1967, potentially could accommodate containers 9′-6″ high.

admirable a vehicle as the box car is, there is no denying that much of American commerce has found itself more comfortably secured inside a truck trailer."[52]

The truck's newfound dominance, in particular its ability to reach all shippers, consignees and clients over the ubiquitous roads, made it advisable if not imperative for railroad companies to cooperate with it. Intermodalism between trucking and railroads in the form of containerization and piggyback had originally emerged in the 1920s, as previously mentioned. After nearly disappearing in the 1940s both practices returned in the 1950s, with trailers and shipping containers that were considerably bigger. (This is described in detail in chapter 5, as it was railroads that usually ran these operations.) For both piggyback and containerization the railroads sometimes founded their own trucking subsidiaries in order to better control this aspect of the journey—a form of competition the trucking industry did not welcome. In the late 1950s the railroads found piggyback to be more profitable, and their use of containers began to fade. Yet in the meantime containerized transport was being introduced by a few ocean-going shipping lines, with containers roughly comparable in size to those of the railroads (about 20′-40′ long, 8′ or 8′-6″ high, and 8′ wide). The most important of the pioneers introducing these containers was Malcom McLean, a successful trucking executive who boldly abandoned that business in order to pursue containerization in the shipping industry. His Sea-Land service, initiated in 1956, was a success and so others companies cautiously followed suit, resulting in a flood of containers needing land-based transport to connect with their origins and destinations. (These developments are covered at length in chapter 2.) This presented obvious opportunities for truckers.

A few innovators in the Pacific Northwest began to use containerization in the early 1950s, slightly before McLean made his momentous move into containerization. The most important was the White Pass and Yukon Corporation, a Canadian transportation company primarily known for its railroad operations that (as detailed in chapters 2 and 5) commissioned and began using a container ship in 1955 as part of an intermodal network including trains and trucks. Other pioneers included the Alaska Steamship Company (known as "Alaska Steam") and the Alaska Railroad, but for this chapter's purposes the ones of most interest were the trucking companies Ocean Van Lines, Alaska Freight Lines, and Garrison Fast Freight. In 1951 Ocean Van Lines began a cooperative effort with Alaska Steam to move 30′-long stackable containers between Seattle and Alaska, with the truckers hauling containers from Alaska ports into the interior of the state. The partnership was abandoned in 1953 when Alaska Steam chose to pursue containerization with the Alaska Railroad instead; in the meantime Alaska Steam augmented its container service by also carrying trailers on deck, which were hauled overland by the trucking firm Garrison Fast Freight. (Garrison Fast Freight was a division of Consolidated Freightways, a major trucking company that would later play a role in container standardization, as will be described.) In 1953 Alaska Freight Lines, a major trucking company that also ran several barges along the coast, began a container service between Seattle and various points in Alaska. For this

[52] Morgan, "What Price Piggyback?" p. 36.

operation Alaska Freight Lines acquired many of the containers previously used by Ocean Van Lines.[53]

Figure 6.1: Ocean Van Lines containers

Source: Ken Goudy's Collection [Ocean Van Lines Collection]
(http://www.hankstruckpictures.com/kg_ovl.htm, accessed 12/15/12)

At this point a key aspect of container use in trucking, the trailer chassis, should be noted. By the 1950s the tractor-trailer had become dominant in American long-haul trucking, and so it was this type of truck that now moved containers. In order to do so it was necessary to create a type of trailer designed to hold the container. A normal flatbed trailer can do this but it is cumbersome and inefficient, and the attachments are difficult and slow to put in place. Furthermore if the container were 8'-6" high then the use of a flatbed trailer in the 1950s and early '60s could create occasional clearance issues with bridges and other obstructions above the roadway. If just a few containers are being used here and there, the awkwardness of a flatbed trailer is not such an issue, but with a larger number of containers involved it becomes worthwhile to design and build trailers specially intended to carry them. These are generally known as trailer chassis, and are

[53] Frank B. Norris, "Cargoes North: Containerization and Alaska's Postwar Shipping Crisis," *Alaska History,* Vol. 7, No. 1 (Spring 1992), pp. 19-24; Edwin M. Fitch, *The Alaska Railroad* (New York: Frederick A. Praeger, Publishers [Praeger Library of U.S. Government Departments and Agencies], 1967), p. 125.

analogous to the railcars designed specifically for containers in that they play a key role as interfaces between the global container infrastructure and the domestic trucking infrastructure. This makes them profoundly important, this dissertation argues, even though they are simple devices without any remarkable technological characteristics. In spite of their simplicity and mundane quality, trailer chassis do have some interesting nuances and will be described in much greater depth in chapter 8, but here their purpose and significance are at least noted.

The aforementioned efforts at containerization in the Pacific Northwest were pioneering but remained limited in scope and did not attract wide attention. It was Malcom McLean's Sea-Land service, initially providing coastal shipping of containers between Newark and several ports in the Southeast, that proved to be the watershed event in the development of containerization. With his background in trucking, McLean used his previous experience and contacts to build a network of truck movement to carry Sea-Land containers to and from ports. Since the regulations of the time forced him to sell off McLean Trucking (the succcessful trucking firm he had founded) before pursuing his marine ambitions, and also prevented his new venture from contracting with McLean Trucking, McLean worked with various other trucking companies to pick up and deliver the containers. Due to the importance of having the containers moved quickly and reliably on land, the arrangements with truckers were made carefully. Since the Sea-Land network was geographically comparable to that of McLean Trucking—linking the Southeast and Gulf Coast with the Northeast—some of Sea-Land's new customers had previously been served by McLean Trucking.[54] The practical McLean saw his ships as providing an alternative to the road-based infrastructure of trucking; where previously McLean Trucking had carried goods between the Northeast and the Southeast, now it was through coastal shipping that Sea-Land moved freight between the two regions. As another figure in the shipping industry put it, many years later, "Malcom was trying to do trucking cheaper."[55]

Sea-Land's new terminal in Newark offered connections to trucking and roads far better than the traditional piers in Manhattan and Brooklyn upon which the New York region had depended for so long. At those older facilities trucks had to make their way through overcrowded streets and endure long waits at the piers, some of which were so narrow a large truck could not even turn around. Newark's port in contrast provided plentiful space for trucks and allowed them to get all the way to the water's edge, right next to the ship. Furthermore there was convenient access to the New Jersey Turnpike, completed just a few years earlier in 1952. (Over the years to come, many other new or improved container ports, typically in exurban or at least somewhat more distant locations, would provide similar advantages over constricted intown terminals.)

---

[54] Arthur Donovan and Joseph Bonney, *The Box That Changed the World: Fifty Years of Container Shipping—An Illustrated History* (East Windsor, NJ: Commonwealth Business Media [The Journal of Commerce], 2006), pp. 44-45, 61; Brian J. Cudahy, *Box Boats: How Container Ships Changed the World* (New York: Fordham University Press, 2006), p. 29.

[55] Stanley Powell, Jr. in: Robert J. Pfeiffer and Stanley Powell, Jr., Interview by Arthur Donovan and Andrew Gibson, June 18, 1997, Containerization Oral History Collection 1995-1998, Archives Center, National Museum of American History, Washington, D.C., p. 9.

McLean's vision was still in many ways that of a trucker, using ships as intermediaries. Indeed, McLean originally wanted to carry trailers onboard, a practice known as roll-on/roll-off or "RO-RO," before deciding containers would work better. He rhetorically asked one of his executives, who had previously worked with him in trucking, "did you ever see one tractor pulling 226 trailers?" then pointed to a new container ship and said "there's one right there."[56] The same person, recollecting his years at Sea-Land, said that for McLean "a ship was just a huge tractor."[57] McLean's conception of the ship as an extension of the highway is reflected in a 1966 advertisement for Sea-Land's new service to Europe that featured a playful pastiche image of an imaginary highway stretching over the ocean from New York to Europe.[58] Sea-Land persisted in referring to its containers as vans or trailers, and its ships as "trailerships," into the mid-1960s. McLean's trucking background was also revealed in his insistence that Sea-Land containers not be stacked at port terminals (even though they were of course entirely stackable), as he preferred each container stay on a trailer chassis for convenience in movement. This state of affairs persisted into the 1980s until it finally became impractical, and made a striking contrast with the terminal operations of other shipping lines which were characterized by stacks of containers. Commenting on this practice, so distinctive to Sea-Land, a trade journal perceptively commented in 1982 that "few other shipping lines have their services so firmly linked to an overall trucking concept…"[59]

Sea-Land's container service began in 1956. Initially the containers were 33′ long in order to maximize the space available on the deck of the ships Sea-Land used while also complying with highway regulations. (In other words, the length of the deck space was divisible by 33′, and the next highest figure it was divisible by was too long for highway rules.) Soon Sea-Land decided to introduce true container ships with containers stacked in cells inside the hold, and thus was able to select an ideal container size and design the ship around it. The company chose to use containers 35′ long, 8′ wide and 8′-6″ high. This size was directly determined by trucking and road-related considerations, for the length and width were the maximum permitted for a trailer on roads in most eastern states, while the height was judged the upper limit for a container to rest on a modified flatbed trailer and fit beneath road clearances.[60] The 35′ length would soon be a bone of contention for Sea-Land and other container innovators; most states gradually expanded the allowable trailer length to 40′ during the 1950s, but Pennsylvania, under the influence of the Pennsylvania Railroad which sought to hinder trucking, held the line at a 35′ length into the late 1950s.[61] For Sea-Land the situation in Pennsylvania was especially relevant given the amount of

---

[56] Paul Richardson, Interview by Arthur Donovan and Andrew Gibson, Containerization Oral History Collection 1995-1998, Archives Center, National Museum of American History, July 1, 1997, p. 4.
[57] Ibid., p. 12.
[58] The image is in Donovan and Bonney, *The Box That Changed the World*, p. 111.
[59] A. M. Smith, "Sea-Land Terminals: Incompatibility Isolates the Innovator," *Containerisation International*, Vol. 16, No. 10 (October 1982), p. 75.
[60] Donovan and Bonney, *The Box That Changed the World*, pp. 59, 68.
[61] Andrew Gibson, Interview by Arthur Donovan, Containerization Oral History Collection 1995-1998, Archives Center, National Museum of American History, April 28, 1998, p. 38.

containerized trucking the company sent into that state, just west of New Jersey. Once locked into this container size Sea-Land stayed with it for a considerable time, long after virtually all the other major shipping lines had adopted the globally standardized 20′ and 40′-long containers.

Following quickly after Sea-Land, the Matson Navigation Company introduced shipping containers in 1958 on its routes between Hawaii and the West Coast, and chose to use 24′-long containers that were 8′ wide and 8′-6″ high. The size was selected after extensive calculations by the Matson Research Department, under its director Foster Weldon, that incorporated numerous factors. A consideration of additional significance was that some Western states allowed trucks composed of two trailers each 24′ long, for it was assumed that hauling two containers at a time over the road would be a somewhat common practice.[62] Like Sea-Land, in these early years Matson relied primarily on trucks for the overland segments of container movement. Another shipping line planning containerization in the late 1950s, the Grace Line, chose 17′-long containers because the company intended to serve Venezuela and judged that containers any longer would be hard to carry on the local roads there, which were not designed for very large trucks. (As noted in chapter 2, Grace Line was unable to permanently establish its container operation, thanks to the opposition of Venezuelan longshoremen.) This 17′ dimension was also desirable because it allowed two containers to be carried together on a trailer chassis in the U.S., as their combined length could fit under the aforementioned upper limit of 35′ for trailer length.[63] (Incidentally, the idea of a truck carrying two containers, though originally appealing for many of containerization's innovators such as Matson and Grace, has rarely been carried out in actual practice.) These early examples make it clear that the spatial character of roads and trucking was a key factor determining the size of containers—in other words, trucking's spatial regime had a formative influence on the container's spatial regime.

A few truck and trailer manufacturers played a prominent role in the design and construction of Sea-Land's early containers. Once Malcom McLean decided his ships would carry containers rather than trailers, he contacted the Brown Trailer Company of Toledo, Ohio. Brown Trailer had built the 30′ containers for the aforementioned Ocean Van Lines' containerized operations in the Pacific Northwest; these containers were stackable and meant to be carried by both ship and truck. Such a container closely resembled a trailer without its wheels and other apparatus, and in fact was often called a "van" or "demountable trailer." So it is not surprising a

---

[62] Foster L. Weldon, "Cargo Containerization in the West Coast-Hawaiian Trade," *Operations Research,* Vol. 6, No. 5 (September-October 1958), pp. 649-670; Les [Leslie] Harlander, Interview by Arthur Donovan and Andrew Gibson, June 19, 1997, Containerization Oral History Collection 1995-1998, Archives Center, National Museum of American History, Washington, D.C., pp. 16-17. Charles Cushing argues that Matson's container system would have worked reasonably well with any length between 20′ and 35′, and that the company would have been wiser to choose a standard already in use. See Charles Cushing, Interview by Arthur Donovan and Andrew Gibson, May 8, 1995, Containerization Oral History Collection 1995-1998, Archives Center, National Museum of American History, Washington, D.C.

[63] Gibson, Interview, Containerization Oral History Collection, pp. 38-39; *Marine Engineering/Log,* "Grace Initiates Seatainer Service," Vol. 65, No. 2 (February 1960), pp. 55-56; Marc Levinson, *The Box: How the Shipping Container Made the World Smaller and the World Economy Bigger* (Princeton, NJ: Princeton University Press, 2006), p. 130.

company that manufactured trailers would be in a good position to make containers. Keith Tantlinger, Brown Trailer's vice-president of engineering, met with McLean and agreed to supply containers of a 33′ length. Soon Tantlinger joined Sea-Land to help with the difficult and novel challenges involved in large-scale containerization, in which he would prove invaluable.[64]

Figure 6.2: Twistlock on a trailer chassis

Source: Chassis King website (http://www.chassisking.com/products/twist-locks/twist-locks-with-light-holes/, accessed 12/15/12)

When Sea-Land in 1957 switched to 35′ containers that were stacked in container ships rather than merely placed on deck, the method of holding them in place was improved: an eyelet was built into each corner of the container—this is generally known as a "corner casting"—so that a twistlock device could hold the container in place. Such a twistlock mechanism can be part of a crane lifting a container from above, or a trailer chassis or railcar holding a container from below. Small twistlock devices are also used in the interbox connectors (IBCs) that hold containers to each other. It was Tantlinger who designed this remarkable scheme of twistlocks and corner castings.[65] (In the 1960s the ISO would accept it as a fundamental part of the globally standardized container system, thanks largely to Tantlinger's advocacy and also McLean's willingness to release Sea-Land's patent rights, and so it endures today in containers and their attachments everywhere.) As part of this shift to a new container design—with its new method of

[64] Donovan and Bonney, *The Box That Changed the World*, pp. 56-58.
[65] Donovan and Bonney, *The Box That Changed the World*, p. 71; Levinson, *The Box*, pp. 138-142.

connection and containers now two feet longer—a new type of trailer chassis was also necessary, and this too was designed by Tantlinger. The new chassis had built-in connections at each corner, which could attach themselves, in a fashion similar to the twistlock, into the container's corner castings when the longshoreman turned a handle. Sea-Land's previous method of attaching containers to chassis involved manually attaching iron chains at each corner, so the new approach was substantially faster and easier.[66]

After its initial order of containers from Brown Trailer, Sea-Land switched to containers made by the Strick division of the Fruehauf Trailer Company. Fruehauf had been one of the dominant players in building truck bodies and trailers for a long time, and, as already described, had previously innovated in the design and construction of the early commercial semi-trailers. President Roy Fruehauf was impressed with the idea of containerization, so in addition to manufacturing containers for Sea-Land his company agreed to make the trailer chassis that were needed, and also to provide financing to Sea-Land for the purchase of these containers and chassis.[67] In 1958 Tantlinger left Sea-Land and became chief engineer at Fruehauf, where he continued to work with containers. More importantly, over the years he played a key role in the process of container standardization, working extensively on a committee of the American Standards Association (ASA) and later being critically involved with the ISO's efforts.[68]

Along with Tantlinger, another major figure in the trucking industry who loomed large in the standardization process was Eugene Hinden, an executive at Strick Trailers. (Strick was bought by Fruehauf in 1956, but eventually sold off in 1965 due to government concern about the monopolistic nature of the two trailer manufacturers being under the same corporate umbrella.) Hinden worked with Tantlinger for several years on an ASA committee, and in the ISO as well.[69] In addition, a few more manufacturers of trailers and truck bodies got involved in early container design and construction. One was Trailmobile, well known in the trucking industry, whose engineers helped Matson develop its containerized system and built two 24′ containers, along with two trailer chassis to carry them, for Matson to test. Another was the Highway Trailer Company, which built the containers for Grace Line's brief and ill-fated container service. Others included Dorsey, Great Dane and Trailmobile. In a brief survey of container makers that appeared in a trade journal in 1966, the majority were companies (or divisions) dedicated primarily to trailer manufacture.[70]

---

[66] Levinson, *The Box*, p. 55.

[67] Donovan and Bonney, *The Box That Changed the World*, pp. 56 (see asterisk note), 68.

[68] K. W. [Keith W.] Tantlinger, "Van Container Standardization – Goals, Problems and Progress," Society of Automotive Engineers, New York, 1961 (1961 SAE International Congress and Exposition of Automotive Engineering, Detroit, MI, January 9-13, 1961); Levinson, *The Box*, pp. 139-140, 142; Eugene Hinden, "Factors Affecting Container Design," in: *Ship Design Implications of Recent Marine Cargo Handling Research*, Conference Proceedings, University of California, Berkeley, May 2-4, 1962, p. 5.

[69] Hinden, "Factors Affecting Container Design"; Levinson, *The Box*, p. 142.

[70] Harlander, Interview, Containerization Oral History Collection, p. 5; *Marine Engineering/Log*, "Grace Initiates Seatainer Service," p. 56; *Railway Age*, "Containerization: Always a Bridesmaid?" Vol. 161, No. 23 (December 12, 1966), pp. 23, 34-35.

The railroads that introduced their own container schemes in the 1950s created varied designs for the containers, trailer chassis, and fittings and mechanisms to hold containers in place. The New York Central Railroad's Flexi-Van was the most successful of these containerized systems, and in its design the railroad worked with the Strick division of Fruehauf—the same company that was building Sea-Land containers and chassis at about the same time.[71] Flexi-Van containers were transferred between train and truck by a method of sliding and rotating the container; no crane was necessary and in theory the truck driver could do the transfer all by himself, but the process could be awkward and was especially problematic in wintry weather. While moving by truck the container did not rest on an entire trailer chassis, but rather only a bogie with wheels attached beneath it. Since the bogie did not extend to reach the tractor, it was necessary for the container itself to be attached to the tractor through additional equipment.[72] The convenience of not using a full-length chassis was probably not enough in practice to compensate for the awkwardness of the separate bogie and all the equipment and fittings needed on the tractor, container, bogie and specially-designed railcar in order to carry out the transfer between truck and train. The other railroad companies practicing containerization in the 1950s and early '60s generally chose to use a trailer chassis or flatbed trailer to carry the container by truck, and to do the transfer by crane or some other lifting device.[73] All these container schemes would gradually lose favor, however, as the railroads found piggyback to be more profitable than containerization. In the meantime the containers introduced by the shipping companies would become dominant, especially after the ISO completed the standardization process in the late 1960s, while those of the railroads faded away.

When the United States Maritime Administration, known as "Marad," commenced work on container standardization in 1958, one of its few easy decisions was that all containers would be 8' wide.[74] All subsequent work on standardization would hew to that 8' figure, which derived from the maximum allowable width of a truck or trailer in the U.S.—a dimension that as already noted was in place by the 1930s. This width turned out to have the added benefit of being feasible in nearly every part of the world. For this reason a global shipping container, whatever its length and height, is always eight feet wide; this has been the case from the beginning and is likely to remain so for the foreseeable future. As one industry veteran commented, "that eight foot width is about the only container dimension that has stayed to this day…the eight foot width for trucks on highways is highly standardized throughout the world."[75] Many of the European countries, however, originally wanted containers to be slightly wider than 8', to match their own regulations and practices for trucks. (This remains a problem, especially since an 8'-wide

---

[71] *Railway Age,* "Containerization: Always a Bridesmaid?" p. 35.

[72] Brian Solomon, *Intermodal Railroading* (St. Paul, MN: Voyageur Press [MBI Publishing], 2007), pp. 61-66; David J. DeBoer, *Piggyback and Containers: A History of Rail Intermodal on America's Steel Highway* (San Marino, CA: Golden West Books, 1992), pp. 63-65; Frank B. Norris, *Spatial Diffusion of Intermodal Rail Technologies*, PhD Dissertation (Geography), University of Washington, 1994, pp. 122-126.

[73] DeBoer, *Piggyback and Containers*, pp. 58-63; Norris, *Spatial Diffusion of Intermodal Rail Technologies*, p. 119.

[74] Levinson, *The Box*, p. 130.

[75] Andrew Gibson, Interview, Containerization Oral History Collection, pp. 18-19.

container cannot hold two standard European pallets side by side.) But since so many other nations limited the width of motor vehicles to 8′, the Europeans had to give way on this point. (Ironically the U.S. has since gone to a maximum width of 8′-6″ in trucking, as will be explained in chapter 8; consequently domestic containers are 8′-6″ wide.)

The issue of height was far more contentious, and would continue to be debated in the standardization processes of both the ASA and ISO. Sea-Land and Matson were both using containers 8′-6″ high, which when resting upon trailer chassis of a gooseneck design (the gooseneck will be described in chapter 8—basically it allows a container to be held a few inches lower) could fit with an adequate margin of safety beneath the 13′ vertical clearance that was common, as described earlier in this chapter, for roads and highways at the time. This 8′-6″ container height was also sufficient to allow a forklift to work inside the container—a major advantage. But an 8′-6″ high container riding on a normal flatbed trailer, or on a trailer chassis without the gooseneck design, would have clearance issues on some American roads and highways, especially in the East. If it was carried on such standard equipment, only a container of 8′ height could be at (or reasonably close to) the upper limit of 12′-6″ for total height, and thus acceptably below the 13′ vertical clearance.[76] Many Europeans also preferred the 8′ height, arguing that in their countries an 8′-6″ height likewise would lead to clearance issues. Consequently the 8′ height won out in the setting of standards at both the ASA and ISO, though amidst fierce debate. Discussing the decision-making process at the ASA, one participant recounted that "the controversy between an 8′ height and an 8′-6″ height raged violently for months."[77] The result provoked heated objections from those like Sea-Land and Matson who were already using the 8′-6″ height, but they would have the last laugh since in the late 1960s the 8′-6″ height was also made an ISO standard in recognition of the reality that the industry was using it anyway. It then became the dominant dimension for height, while the 8′ height was slowly abandoned. (Eventually the high-cube container with its 9′-6″ height would become an additional standard.)

Container length was also difficult to gain agreement on. The American Standards Association (ASA) began work on container standardization in 1958; where Marad was inherently more oriented to the shipping industry, the ASA's process was also influenced by those in trucking and rail. A retired engineer named Herbert Hall was put in charge of ASA container standardization, and worked energetically to create a modular set of standard lengths of 10′, 20′, 30′ and 40′. Ultimately he was successful, in the face of much debate, as both the ASA and Marad agreed on these lengths in 1961.[78] Hall's insistence on the 40′ length (for the largest container, from which the other lengths derived) apparently stemmed from the realization that by the end of the 1950s this was the maximum allowable trailer length in nearly all the states, and

---

[76] Leslie Harlander, Interview, Containerization Oral History Collection, p. 17; Hinden, "Factors Affecting Container Design," pp. 2-3; Levinson, *The Box*, pp. 131-133; Herman D. Tabak, *Cargo Containers: Their Stowage, Handling and Movement* (Cambridge, MD: Cornell Maritime Press, 1970), p. 111.
[77] Hinden, "Factors Affecting Container Design," p. 2.
[78] Levinson, *The Box*, pp. 132-137.

hence would soon be a trailer standard.[79] So as with the earlier decisions on container size by Sea-Land, Matson and Grace, the spatial regime of trucking and roads was the key consideration. Predictably the 40′ choice met with strong objections from Sea-Land and Matson, who had no wish to abandon their own container sizes, already embedded in their operations. While a few allowances were made for them, at least by American regulators, shipping would gradually coalesce around the 20′ and 40′ lengths that the ASA and later the ISO agreed upon. The 10′ and 30′ lengths, though also put in place by the ASA and ISO, never gained popularity. (Not everything worked out Hall's way: on the issue of height he strongly supported 8′ rather than 8′-6″.)

Another individual in the trucking industry who played a prominent role in container standardization during this period was E. B. Ogden of Consolidated Freightways, the largest American trucking company at the time. Ogden served as chairman of the ASA's subcommittee on container dimensions during the decision-making process overseen by Hall. In a meeting of the subcommittee in 1959 he emphasized that since nearly all the states in the U.S. now allowed a 40′ maximum trailer length, the logic of Sea-Land's 35′ container no longer applied.[80] It is unclear whether Ogden actually wished to foreclose the possibility of the 35′ length as a standard, but obviously Hall chose to do so. In the meantime Ogden remained involved in such issues; in 1961 he presented a paper, at the SAE (Society of Automotive Engineers) International Congress and Exposition of Automotive Engineering, titled "What the Operator Wants in Containers" that gave a brief summary of the trucking industry's concerns and priorities with regard to container use.[81]

Given that the shipping container has become a global standard of enduring power it is worth understanding where its dimensions, of such fundamental importance to it, come from. Too often the literature on globalization, both popular and scholarly, views global dynamics as possessing their own inherent logic, somehow emblematic of the zeitgeist. This is a vision of globalization as a brave new world, often cast in a neoliberal tint, and represents a deeply ahistorical stance. Understanding the historical narratives behind global forces can counteract this attitude. In the case of the container, its dimensions in all three measures—length, width and height—derive from what was allowable for truck trailers on American highways in the late 1950s and early '60s. The global practice of containerization is not innate to some mysterious essence of globalization, but stems from a particular time and place. This is a legacy of some significance; as with many aspects of globalization, the container comes in an American template that reflects the influence and power of the U.S. in the second half of the twentieth century.

It was trucking rather than the railroads that initially benefited most from the rising tide of containers put into use by the shipping industry, as truckers provided the majority of the land-

---

[79] Levinson argues that Hall's desire for the 40′ length (along with 10′, 20′ and 30′) was a somewhat irrational preference for mathematical elegance. But Levinson's own account would seem to indicate otherwise, as he notes that the 40′ trailer length was becoming the American standard at this time. Levinson makes a more convincing case that Hall used his position as leader of ASA's container standardization process to excessively impose his preferences. See Levinson, *The Box*, pp. 135-137.

[80] Ibid., p. 135.

[81] Ogden, "What the Operator Wants in Containers."

based movement of these containers. (This was particularly true since the railroads were getting less and less interested in containerization, concluding that piggyback was for them a better intermodal strategy.) Yet some trucking firms were resistant, even though these containers represented a promising source of business for them. While trucking companies were hostile to rail-based containerization, seeing it as a threat to their long-haul business, no such objection could be levied against containers made available by shipping lines. Still there were doubts about altering traditional trucking practices. Perhaps in order to overcome this reluctance, the shipping lines established the practice of supplying truckers with the trailer chassis necessary to hold the container. (In other nations it is typically the trucking companies that provide the trailer chassis, charging a higher price in return, and in recent years this has started to become the practice in the U.S. too, as will be discussed further in chapter 8.) Given that the trailer chassis could connect to the tractors that truckers already possessed, this made it easier for the trucking companies to accept this new business without having to rethink their own operations. Writing in 1973, shipping expert Eric Rath comments that:

> When trucks were initially presented with requests to accommodate containers for inland movement, the handling of trucklines' interchange trailers was already a well-established system… Rather than recognizing the container as a system unto itself, it was forced into an already existing national transport system. As long as container movements remained small, this posed no problem. The motor carrier accepted the container on conventional terms, furnished by the steamship, on wheels [trailer chassis], then moved it through his normal system.[82]

The trucking companies did not need to understand the full significance of this new cargo; they could participate in this emerging globalization while being oriented to their own business internal to American trucking. Nevertheless they raised objections. As Rath goes on to describe, the truckers were not fond of longer inland container movements beyond the vicinity of the port because it was hard to find freight for the backhaul. In addition many of the containers were between 20' and 35' long and these were regarded as inefficient sizes by truckers, whose trailers by now were typically 40' long.[83] Indeed, it appears some trucking firms were simply resistant to anything that did not fit with business as usual. Furthermore there was a sense of rivalry and competition between the different freight transport modes. But the rivalry seemed absurd in this case, because truckers and shipping lines could hardly be competitors; as Rath points out with dry wit, the truckers reluctance to cooperate "is difficult to understand since most water carriers would seem to have considerable difficulty in reaching the majority of inland destinations by themselves."[84] These frictions meant the container's potential for seamless intermodal transport was slow in its realization; for instance, as of 1969 nearly half of the containerized cargo at Newark was still being moved into or out of the containers at the pier, where it was loaded or

---

[82] Eric Rath, *Container Systems* (New York: John Wiley & Sons, 1973), p. 253.
[83] Ibid., p. 254.
[84] Ibid., p. 255.

unloaded into normal truck trailers.[85] While there were a variety of reasons for this (including the longshoremen's desire to hold onto their work), the resistance of truckers against altering their operations was a factor.

One solution was to found new trucking companies that specialized in hauling containers. An example was True Transport, which started in 1968 carrying containers to and from Newark's port to serve the surrounding region. Acknowledging the need to look beyond typical trucking practices, True Transport hired several people with experience in ocean shipping.[86] Compared to a typical trucking firm of the period, therefore, the company was to some minor degree globalized—its expertise and knowledge extended, if ever so slightly, beyond the bounds of the national space. True Transport was for a time the nation's largest trucking company under African-American ownership, and consequently there is more historical information about it. Founder Leamon McCoy, according to a 1974 article in *Black Enterprise*, "was one of the few in the industry to see…that if special new equipment and methods were justified for handling containers in the marine cargo business, the same had to be true for ground transportation."[87] His belief in the logic of a firm specializing in hauling containers for shipping lines proved valid, for True Transport thrived in the 1970s and into the '80s, serving the Northeast, Mid-Atlantic and Midwest, though it eventually folded in 1989.[88]

Some established trucking companies also sought to get into the business of hauling containers. Eastern Express was a trucking firm based in Indiana that had participated in carrying import and export traffic since 1946, with several well-established routes linking the Midwest to Northeastern ports. Hence it was sensible for the firm to transition into hauling containers, as it did in the 1960s while also maintaining its domestic traffic. Eastern Express went further by taking on a measure of responsibility for the entire international container journey, even though it could only directly carry out the portion of the trip in the U.S. By the mid-1960s the company was quoting through rates on containers moving door-to-door between the U.S. and Europe, though regulations prevented it from providing a through bill of lading.[89] The firm's director of sales told a trade journal in 1966 that "we have traveled to Europe to set up working arrangements with carriers and agents there… One-carrier responsibility would greatly enhance the attractiveness of foreign trade for many more U.S. shippers and importers."[90] While Eastern Express had previously played a part in the global movement of goods, it had been within one particular national space; this new strategy was fundamentally different in its transnational

[85] Robert E. Howell, "What Is a Container? A Container Is…," *CCJ (Commercial Car Journal),* Vol. 117, No. 3 (May 1969), pp. 96-97.
[86] Rath, *Container Systems*, pp. 274-275.
[87] Jean Perry, "Riding the Crest of Innovation in Trucking [Black Business in Profile: Leamon McCoy]," *Black Enterprise*, Vol. 4, No. 10 (May 1974), p. 37.
[88] *Black Enterprise*, "Tomorrow, the World," Vol. 19, No. 11 (June 1989), p. 196.
[89] Robert E. Howell, "Containers…Facts You Need to Get a Piece of the Action," *CCJ (Commercial Car Journal),* Vol. 117, No. 4 (June 1969), p. 148; *Distribution Age*, "Highway Carriers Eye Foreign Markets," Vol. 65, No. 10 (October 1966), p. 35.
[90] *Distribution Age*, "Highway Carriers Eye Foreign Markets," p. 35.

ambitions. The container, thanks to the way it makes possible a seamless door-to-door journey for its entire volume of cargo, facilitated such novel approaches.

Another trucking carrier to pursue global containerization was IML Freight, which took charge of containers moving across the Pacific. In 1966 its vice-president said the firm was "line-loading containers in Yokohama for one company, consolidating shipments from as many as 60 vendors. We put them in a container, bring them back and deliver them directly to retail outlets in Kansas City and St. Louis."[91] IML also set up container services from Japan to Europe that used the continental U.S. as a "landbridge"—a practice that would soon be far more widely associated with the railroads. In addition IML made arrangements with two trucking companies in Europe to carry IML's containers there, and set up the operation so freight would move on a single through bill of lading.[92] But perhaps the most daring American trucking company to build an international network of container movement was DC International, formerly known as the Denver-Chicago Trucking Company. In 1965 DC International bought out the Dutch trucker West-Friesland Eurotransport, a company operating in several European countries, and became the first trucking firm to offer container transport by the same carrier in both the U.S. and Europe. The experiment was unsuccessful, however, and within a year DC International gave it up and sold off West-Friesland.[93]

A similar leap was made by the trucking company Helm's Express. The firm had already been active in domestic intermodalism, quoting rates for containerized freight from door to door within the Midwest and Northeast. (As such it was one of the few truckers to coordinate domestic container movement—usually railroads or freight forwarders did so.) Helm's Express then became active in international containerization, creating subsidiary Helm's International for this purpose in 1964. The company owned some of its containers, took responsibility for liability for the oceanic portion of the trip, and partnered with NW Konig & Co., a trucking firm in Rotterdam, to ensure its connection in Europe.[94] In a talk at a conference in 1967 the president of Helm's Express, Harry Werksman, mentioned that his company was essentially seeking to turn the shipping lines into "bridge carriers"; he envisioned a future where his firm would quote rates and handle all the other details directly with the shipper (i.e., customer), with the shipping company under contract and only concerned with carrying containers. However, Werksman noted the shipping lines were strongly resistant to the notion.[95] Little wonder, for the idea would put the trucking companies in the driver's seat. Given that the shipping companies were

---

[91] Ibid., p. 35.
[92] Regular Common Carrier Conference (of the American Trucking Associations, Inc.), *Report on Containerization in International and Domestic Commerce,* Washington, D.C., 1967, pp. 24-25.
[93] *Distribution Age*, "Highway Carriers Eye Foreign Markets," pp. 34-35.
[94] Paul A. Cavazos, "Containerization: A New Tool in Motor Carrier Commercial Transportation," Paper submitted for membership in the American Society of Traffic and Transportation, Morton Grove, IL, 1972, pp. 12-13; *Distribution Age*, "Highway Carriers Eye Foreign Markets," p. 35; *New York Port Handbook*, Port Resources Information Committee, New York, 1964, p. 114.
[95] Truck Trailer Manufacturers Association, *Containerization: Problems of Today and Potential for Tomorrow*, p. 11.

powerful and their numbers limited (much like a cartel, in fact), they generally held the upper hand, and there was little chance their role could become so limited.

The concept of such a "bridge" becomes logical with containerization, as the nature of container movement, spanning multiple transport modes, makes it likely some carriers will carry out an intermediate function while others have more contact with the actual shipper and coordinate the entire movement. Given the power and importance of the shipping lines it is not surprising they have generally maintained control and relegated others to such "bridge" status. (In chapters 5 and 7 this is discussed in the context of the railroads providing "landbridge" container movement.) Consequently Werksman's vision has not been realized; in terms of global container movement American truckers have typically been relegated to minor "bridge" status, as relatively powerless carriers. From a position of weakness in a very competitive market the truckers contract with shipping lines, logistics companies, and third-party forwarders. On the other hand, a few major trucking companies have been successful in gaining a much larger role in domestic containerization since its emergence in the 1990s, frequently turning the railroads into "bridge" carriers. These trends will be explored in chapters 8 and 11.

As container use grew during the 1960s and '70s, port hinterlands grew larger and truckers were called upon to extend the reach of overland freight movement. For the shipping lines containerization made it more profitable to call at just a few ports; rapid trips back and forth over the ocean were the new order of business, rather than stopping at several ports up and down a coastline. A few large ports that chose or were able to invest in building giant new container terminals benefited greatly, having achieved the necessary economies of scale, while others withered. The traditional notion of each port having its own hinterland that it exclusively served was no longer applicable. Containers were moving longer distances overland by truck, a trend enabled by the Interstate highways that now linked all major cities, and so a port could easily serve a far larger region than before. Port officials in Seattle were among the first to grasp the new reality, for as early as 1966 they imagined their port could serve not just its immediate region but a great extent of territory reaching to the Midwest. Reacting quickly to the new container traffic on the Pacific, Seattle opened new facilities at its port in 1970. Nearby Portland failed to keep pace and consequently found much of its international trade funneled to the road, as shipping lines found it more efficient to dock at Seattle only and use trucks hauling containers to make the link with Portland.[96] Likewise in the Northeast the runaway success of Newark meant that Philadelphia and Boston, despite building container terminals of their own, saw an increasing amount of their trade in the 1970s moving by truck to and from the New York region.[97] (Ultimately this trend toward larger hinterlands, and longer land-based container journeys, would benefit the railroads even more, as described in chapter 7.)

By the late 1970s the American trucking industry was deeply involved in carrying containers, which had grown from a niche business in the 1950s to a more substantial operation. It was still

---

[96] Levinson, *The Box*, pp. 196-197.
[97] Rath, *Container Systems*, pp. 275-276.

very small in relation to the overall domestic trucking industry, but had become established and gained practices of its own. In the meantime the U.S. highway system had grown by leaps and bounds since the 1950s thanks to the development of the Interstate system, and trucking had eclipsed the railroads to become far and away the most important transport mode for freight movement. Thanks to the shipping container, this massive trucking infrastructure was now increasingly integrated into global networks, into the worldwide infrastructure of containerization. But this had not dramatically impacted the trucking business. As with the railroads during the same period, the tendency was to make do with existing systems, and to stick with what already worked. Besides, the quantity of containers moving by truck, though substantial, was miniscule relative to the entire trucking industry. The container by and large was shoehorned into the trucking infrastructure, which adjusted only slightly to accommodate it. More changes would transpire in the decades to follow, and that is the subject of chapter 8, which covers the impact of the container on American trucking from the late 1970s up to the present. But in the next chapter our focus returns to the domestic railroad system.

Chapter 7 ~ The Transformation of the Railroads

By the late 1970s the shipping container was an established cargo on American railroads and represented a growing business for them. But it had not altered the nation's rail system in any significant way. Deeper transformations began to slowly get under way towards the end of the 1970s, a process that has continued and strengthened in the decades since. These changes have globalized the railroad infrastructure of the United States in some important ways, and are the subject of this chapter, which traces the container's ever-growing impact on the railroads from the late 1970s up to the present. The effect of containerization on rail has been significant and deep, and is evidence of globalization's power to carry out changes deep within the domestic territory, in the basic workings of the nation-state. Yet important as these changes have been, they do not constitute a wholesale overhaul. The American railroad network gained its essential form and character over a century ago, and is embedded in the history and geography of the country. The global infrastructure of container movement, as it functions within U.S. railroads, works through this longstanding system for the most part, transforming it in particular ways but not completely reshaping it. After all, the existing system possesses the spatial and material inertia characteristic of physical infrastructures, and to alter it is consequently very hard. This means new global flows are more likely to move through the infrastructure already in place, especially since the container is designed to do precisely that. But where the inertia of materiality has been overcome and changes have taken place, such alterations reveal the power of containerization and globalization. American railroads have, in some ways at least, been significantly changed by containerization since the 1980s.

U.S. railroad companies have seen their fortunes greatly improve since the dark days of the late 1960s and '70s. The rebound began in the 1980s, about the same time the container was becoming a substantial part of rail operations. This is not entirely coincidental, though it should be emphasized that many factors have contributed to rail's success over the past few decades. The lines have been able to streamline and modernize their operations, helped by government deregulation (in particular the Staggers Act of 1980) and a series of mergers and buyouts in the industry. Growing congestion on the nation's highways, along with shortages of qualified truck drivers, have also been a factor shifting freight to the rails, and rising gas prices and an enhanced environmental awareness have been an even more powerful impetus recently. The current railroad renaissance extends to passenger rail as well, for Amtrak is carrying more passengers than ever. But in the 1970s all this was far in the future, and the outlook was bleak; the industry's hesitant embrace of containerization in this decade was taking place amidst a backdrop of great concern and uncertainty.

It was evident that railcars better customized for the container were needed. As described in chapter 5, a few railcars designed to carry containers and/or trailers had been introduced in the late 1960s and '70s, to modest success. A bolder idea also emerged in the 1960s, but had not been implemented: the double-stack railcar that would carry containers two-high. To make such a concept workable it is necessary to hold the bottom container as low as possible, so the top container can fit within clearances. (Because the bottom container is held so far down, double-stack railcars are sometimes known as "well cars.") The wheels cannot possibly fit in the minute space below the bottom container, and hence are placed farther forward and back, with the container resting between them. All in all, the double-stack car was a very different sort of design for a railcar. Malcom McLean proposed the idea to the unreceptive railroads in 1966 (as noted in chapter 5). Even in the early 1960s, according to the recollections of one former Sea-Land manager, McLean was already advocating for double-stack cars to move in unit trains.[1] He was not the only one contemplating stacking containers on railcars at the time. The Rail-Trailer Company considered the idea, and the consulting firm A.T. Kearney came up with a somewhat eccentric proposal for a very large railcar that could hold stacked containers of a variety of sizes (20′, 24′, 35′ and 40′ lengths) and in several configurations. North of the border, the Canadian Pacific Railway introduced and tested its own design for a double-stack railcar, and slightly later in the early 1970s the Canadian National Railway did likewise.[2] None of these concepts panned out, however.

During the 1970s McLean sought to persuade the Southern Pacific Railroad, to which Sea-Land was supplying large quantities of containers for minibridge routes from Southern California to the Gulf Coast, to create a double-stack car. Told that stacking containers would lead to issues with vertical clearance, McLean wondered how low it would be possible to hold the bottom container above the tracks in a railcar. One particular anecdote vividly reveals his interest. While at Union Station in Washington D.C. with his family, on their way to an event with the President, he noticed some nearby railcars had various equipment hanging down close to the rails, and promptly crawled amidst the cars to measure the distance between the rails and the lowest equipment. When he arrived at the White House later in the day, the condition of McLean's clothing sadly reflected this little adventure.[3]

By the late 1970s McLean was no longer involved in running Sea-Land—he sold the company to R.J. Reynolds in 1969 and left the R.J. Reynolds board of directors in 1977. Later he would pull out completely by selling his stock for $44.5 million in 1980. But it is possible his enthusiasm for

---

[1] Ron Katims, Interview by Arthur Donovan and Andrew Gibson, Containerization Oral History Collection 1995-1998, Archives Center, National Museum of American History, April 9, 1997, p. 32.
[2] Herman D. Tabak, *Cargo Containers: Their Stowage, Handling and Movement* (Cambridge, MD: Cornell Maritime Press, 1970), pp. 133, 136; Peter S. Douglas, "Year of Decision Ahead for the 20-Foot Container," *Traffic World,* Vol. 128, No. 11 (12/10/66), p. 65; David J. DeBoer, *Piggyback and Containers: A History of Rail Intermodal on America's Steel Highway* (San Marino, CA: Golden West Books, 1992), p. 108; *Traffic World*, "CN Car 'Double-Decks' Containers [Services and Products]," Vol. 146, No. 11 (June 14, 1971), p. 77.
[3] Brian J. Cudahy, *Box Boats: How Container Ships Changed the World* (New York: Fordham University Press, 2006), pp. 163-164.

the double-stack concept at Sea-Land outlived his actual leadership, or perhaps behind the scenes he continued to campaign for it. In any case, Sea-Land and Southern Pacific began to strategize jointly on a design for a double-stack railcar. As their work progressed, American Car & Foundry, a firm that actually built railcars, was brought on board to construct a prototype. Since stacking containers inevitably made for a very different and novel type of railcar, the design involved several innovative elements, and the high center of gravity was a source of particular concern. The prototype appeared in 1977 and was tested successfully, but by this time Southern Pacific had decided an articulated car would be more efficient than a single unit car. An articulated car is basically one that appears to be several cars, but is actually several units comprising one long car. The critical distinction is that the units cannot be separated—the links between them allow for pivoting, but cannot be undone—and hence are permanently connected. With these connections permanently in place, the wheel components (bogies, in rail terminology) can be shared by adjacent units, so only half as many wheels are needed. In addition there is less slack action when articulated cars are used in a train, resulting in a smoother ride and less damage to cargo. In 1979 a prototype of an articulated three-unit double-stack car arrived. Southern Pacific chose to keep tinkering, and in 1981 finally put another design, an articulated five-unit double-stack car, into regular use.[4] It was a watershed moment for the American railroads.

The obvious advantage of a double-stack car or unit over a normal container-carrying railcar is that it holds two containers instead of one. Though some extra length is required for the wheels (which as noted earlier cannot be underneath the containers, as is the case with a normal car), the result nevertheless is that far more containers can be carried by a train composed of double-stack cars. This is significant since freight trains must be within certain maximum lengths because of technical factors intrinsic to the trains themselves, and also due to the length of the sidings where trains at times must pull aside. (For some freight trains carrying extremely heavy cargo such as coal the limiting factor is weight rather than length, but this is not the case with relatively light containers.) Railroad companies wish to run as few trains as possible, in order to minimize labor, equipment and operational costs, so anything that increases the amount of cargo carried per train is embraced. On some busy corridors the maximum possible number of trains moving through is reached, making it even more imperative to maximize each train's capacity. A train of double-stack cars is also more fuel-efficient (by the measure of fuel consumption per container carried). The use of double-stack trains would be very profitable for American railroads; it is often stated in the industry that double-stacking makes otherwise marginal service profitable. This may or may not be true, for railroads in many countries around the world run trains carrying containers not stacked—the clearances in those places preventing double-stacking—and presumably have found it economical to do so. But certainly American railroad lines have fallen in love with double-stacking and the profits gained from it.

[4] Gus Welty, "SP's Entry for High Intermodal Stakes," *Railway Age,* Vol. 178, No. 21 (November 14, 1977), pp. 16-18; DeBoer, *Piggyback and Containers*, p. 139.

The greatest issue that has confronted double-stacking is vertical clearance. As explained in chapter 5, the clearances on rail corridors need not be rigorously standardized in the way some other dimensions of rail's spatial regime—such as the track gauge (i.e., the distance between the tracks)—must be. The vertical and horizontal dimensions of a train are known as the loading gauge, and while it is obviously necessary that a certain minimum loading gauge be met everywhere, many lines have a larger loading gauge. This can be for various reasons, such as the policy of the railroad company that built the line, the type of freight and railcars originally seen as likely to travel it, the era when it was constructed, and the improvements carried out since. As described in chapter 5, at present the minimum loading gauge in North America is known as AAR Plate B, which has a height of 15′-1″ and width of 10′-8″, in addition to a few more technical factors. A typical container being 8′-6″ tall, the 15′-1″ height of AAR Plate B is obviously inadequate for double-stacking. Fortunately most major corridors have a greater clearance than this, and in particular the western railroads, built more recently than those in the east, generally possess more generous clearances.

When double-stack railcars entered use in the early 1980s, the clearances on a few major rail corridors from the West Coast to the central portion of the nation either were sufficient for the new railcars to pass beneath or only required minor modification. This was a key factor in getting double-stack operations off the ground. But to go further east was rarely possible. If the global infrastructure of containerization was to take the form of double-stacking on American trains, then it would run up against certain limitations in the domestic U.S. infrastructure. The two spatial regimes, one of the global container, the other of the American rail system, were in apparent conflict. It was an ironic situation, for the container was originally designed to fit American infrastructure before it was accepted globally, as described in chapter 6. Some of its specifications, details and fittings were modified slightly by the ISO, but the basic size, the three dimensions of length, width and height, remained constant. Now the container's dimensions, paradoxically, represented an unexpected challenge in American space. It was a problem that could be solved, but only through expensive and laborious construction work on many routes to raise bridges and enlarge tunnels; in the adoption of the container by American railroads since the 1980s, nothing has been more important than the raising of clearances to accommodate double-stacking.

This raising of clearances has been a crucial event in the utilization of the container in American infrastructure, as it represents a point at which the domestic infrastructure of the nation-state, its spatial regime in particular, is fundamentally changed by the container. The original introduction of the container on American railroads was not such an event, because the rail system could generally continue in its established fashion, with its standards and procedures intact. New railcars to hold the containers were necessary, but these though important were not deep changes. As noted in chapter 5, it is more accurate to regard a railcar like this as an interface between the global infrastructure of containerization and the existing railroad infrastructure of the U.S. nation-state, and as such it allows the more fundamental qualities of the rail infrastructure to remain as they are. The raising of clearances made necessary by double-stacking is of a greater level of importance, as it represents an alteration being made to the fundamental nature of the railroad system, a key change to its entrenched spatial regime.

Any such change would be difficult to carry out, and that is especially the case for raising clearances, which is expensive and time-consuming, especially on routes with many tunnels. A simple change in a dimensional value, of merely a few feet (or even a few inches), has vast repercussions. While double-stacking has not caused the minimum loading gauge established for North American railroads (AAR Plate B) to change, the expectation increasingly is that any freight railroad corridor of significance should accommodate stacktrains. The height of a double-stack car carrying regular containers (i.e., with an 8′-6″ height) is 18′-3″, and the height of a double-stack car carrying "high-cube" containers (i.e., with a 9′-6″ height) is 20′-3″.[5] Since the "high-cube" containers are in widespread use—and domestic containers are also 9′-6″ high—the 20′-3″ figure has essentially become the vertical dimension for the loading gauge necessary for a line to accommodate stacktrain traffic. It should further be noted that while the loading gauge represents the maximum allowable dimensions of the train cars, it is the structure gauge that gives the actual required minimum dimensions of bridges and tunnels. Generally the structure gauge is six inches greater than the loading gauge, and so the necessary vertical clearance for a tunnel or bridge on a stacktrain route is usually given as 20′-9″.

The cooperation between Sea-Land and Southern Pacific—a shipping line and a railroad company—would characterize other double-stack innovations, as international and domestic freight transportation became increasingly entangled, blurring the once-clear boundaries. With rapidly growing quantities of containers entering the country from the export-oriented economies of East Asia over the course of the 1980s, the shipping companies were interested in moving these containers in bulk by train. It was not a question of a train with a few containers here and there, but rather entire trains loaded with nothing but containers. When such a train is composed entirely of double-stack railcars, it is termed a stacktrain. Minibridge and microbridge (these terms are defined in chapter 5) were more and more the trend, and the West Coast ports profited from this. Where previously shipments to the Northeast, Southeast or Midwest had usually entered via East Coast or Gulf Coast ports, now shipments from Asia could avoid the Panama Canal, simply crossing the Pacific and letting the railroads handle the rest of the trip. (In addition, West Coast ports had lower labor costs.) The domestic infrastructure of North America was being reconfigured as part of a global infrastructure. International and domestic freight movement were gradually becoming enmeshed with each other, as opposed to their traditional separation; this was a logical consequence of the container, which could travel on both in its journeys and thus linked them together more tightly than ever before. Shipping companies started to get involved in what happened on land, rather than giving up responsibility for their cargo at the port, while domestic railroads began to think in global terms.

[5] Some sources give these dimensions as 18′-2″ and 20′-2″, rather than 18′-3″ and 20′-3″. It is unclear why there is a one inch discrepancy—perhaps it is a matter of rounding, some technical difference of interpretation, or a difference between actual and nominal figures.

Sea-Land was not the only shipping line to perceive the benefits of double-stacking. American President Lines (APL) was also emerging as a container innovator in this period. APL was a well-established company, with a long history in the Pacific in both passenger and freight operations, but the former business had essentially disappeared due to air travel, and the once traditional line modernized and brought containerization to its freight business in the 1970s. In 1977 APL appointed a new and innovative president, W. Bruce Seaton, a man with a background in the oil industry. Seaton and a few of APL's managers perceived the value of using more systematic methods, including computers and better information technology, to track and route containers. They also began to think about inland connections, for it had become clear it was necessary to track and control container movements more effectively not just over the ocean but on land. The incompetence of the railroads was quickly evident to Seaton, and their problems were reinforced by fierce snowstorms in the Midwest and Northeast during the winter of 1977-1978 that caused APL containers traveling by rail to be lost for weeks.[6]

In 1977 APL hired Donald C. Orris, a manager with a background in the railroad industry and experience in its intermodal operations, to help organize rail services. Two years later the company introduced its coast-to-coast "LinerTrain," a service that carried containers on railcars between West Coast ports and a terminal at South Kearny, New Jersey. These cars held the containers in traditional fashion (i.e., not double-stacked), and sometimes containers were even carried on their trailer chassis which rode the train in piggyback fashion. The service functioned in effect as a substitute for bringing shipments by water all the way from Asia to East Coast ports. As a primarily Pacific carrier, APL chose to save time and expense by using western ports, avoiding the Panama Canal and Atlantic Ocean, and having the railroads do the rest through a landbridge operation. APL got involved in the railroad business to an unprecedented extent by leasing railcars, setting train schedules, and acquiring inland rail terminals. The railroad companies were only hired to operate the trains—in other words, to move APL's railcars over specified routes at particular times.[7]

The logical next step for APL was to follow the lead of Sea-Land into double-stack operations. Along with railcar designers and makers Budd Company and Thrall Car Manufacturing Company, and with some involvement from the Union Pacific Railroad, APL worked on a slightly different type of double-stack car. Where the car used by Sea-Land and Southern Pacific had bulkheads at each end to hold the upper container in place, the new Budd Lo-Pac 2000 car relied on the use of interbox connectors (IBCs) to hold the upper container to the lower container. This obviated the need for bulkheads, making the car much lighter. As with the Sea-Land design, it was constructed as an articulated five-unit car. Once again it was APL that

---

[6] Bruce Seaton, Interviews by Arthur Donovan and Andrew Gibson, June 19, 1997 and July 25, 1997, Containerization Oral History Collection 1995-1998, Archives Center, National Museum of American History, Washington, D.C., pp. 7-18; John Niven, *The American President Lines and Its Forebears, 1848-1984* (Newark, DE: University of Delaware Press, 1987), pp. 267-269.

[7] Brian Solomon, *Intermodal Railroading* (St. Paul, MN: Voyageur Press [MBI Publishing], 2007), pp. 85-87; Niven, *The American President Lines and Its Forebears, 1848-1984*, pp. 269-270.

acquired the railcars and provided them to the railroad companies.[8] In 1984 APL started using the cars in regularly scheduled stacktrains running between the West Coast and Chicago, an operation that soon became coast-to-coast when it was extended to northern New Jersey. Rail yards in Chicago, in particular the Chicago and North Western Railway's Wood Street rail yard (soon to become the Global I terminal, as described in chapter 9), functioned as key hubs for the stacktrains' movement. Clearances though were an issue, especially to the east. As will be discussed later in this chapter, a little-used corridor in upstate New York with sufficient clearance provided a route for stacktrains to reach northern New Jersey. But rail corridors in most of the East simply lacked the necessary clearances (a situation that would gradually change, as will be described), and so it was necessary for containers headed to other eastern destinations to be removed from stacktrains at Chicago and placed on trains in a single-stack configuration. Even in Chicago itself, one low clearance blocked the most direct path from west of the city to the Wood Street yard, necessitating use of a secondary route that added three hours to the trip.[9]

Stacktrains caught on quickly and enjoyed remarkable success, bringing traffic and profits to the railroad industry, which was beginning to come back after falling to its deepest lows during the 1970s. Thanks to both stacktrains and trains carrying containers one-high on more typical flatcars, container movement grew rapidly, leading the trade journal *Railway Age* to point out in 1985 that "containerization is no longer just an offshoot of TOFC [piggyback]."[10] Sea-Land soon extended its service all the way to the East Coast, running stacktrains to Little Ferry, New Jersey. By 1987 APL was running routes to and from Seattle-Tacoma, Oakland, Los Angeles-Long Beach, Chicago, South Kearny, New Orleans, Memphis and Atlanta, with 32 round-trip stacktrains per week. As of the same year, in fact, twelve shipping companies had stacktrains running over the American railroad network.[11] An early drawback was that these containers had little or no cargo to carry on their return trips back to Asia, as the international traffic was imbalanced in favor of Asian imports, and so the stacktrains typically ran empty from east to west. As described in greater detail in chapter 11, APL and some others began to solve this in the 1980s by using the containers to haul domestic traffic westward across the U.S. for low rates. The distinction between global and domestic movement was further blurred, as the containers carried one type of freight in one direction and the other type in the opposite direction.

Various designs for double-stack railcars have been utilized over the years, including a few that use the bulkhead approach and some that are single-unit cars. In addition, some ordinary (i.e., not double-stack) railcars capable of carrying both containers and trailers have been introduced—these are an updated version of the "all-purpose" flatcars described in chapter 5, but are lighter and usually in articulated multi-unit form. But the dominant method of transporting

---

[8] Solomon, *Intermodal Railroading*, pp. 116-118; Frank Malone, "APL Linertrains Stack Up Profits," *Railway Age,* Vol. 186, No. 4 (April 1985), pp. 62-64.
[9] Malone, "APL Linertrains Stack Up Profits," pp. 62-64.
[10] Gus Welty, "Intermodal Terminals: The Tempo Quickens [High-Tech Railroading]," *Railway Age*, Vol. 186, No. 11 (November 1985), p. 43.
[11] Solomon, *Intermodal Railroading*, pp. 88-89.

containers on American trains has followed the template of the Lo-Pac 2000 introduced by APL: a double-stack articulated railcar (usually of three or five units) optimized to be as light as possible, and using IBCs rather than bulkheads to hold the upper container in place. Aside from the savings in weight, another advantage of doing without bulkheads is that a longer container can be carried above. Since 45′-long containers were eventually introduced for international use, and more recently domestic containers (i.e., for the U.S. and Canada only) of 48′ and 53′ lengths have become common, the ability to carry such larger containers is valuable. In fact many of the current double-stack railcars are longer than earlier designs, and can hold containers up to 53′ long on the bottom as well.

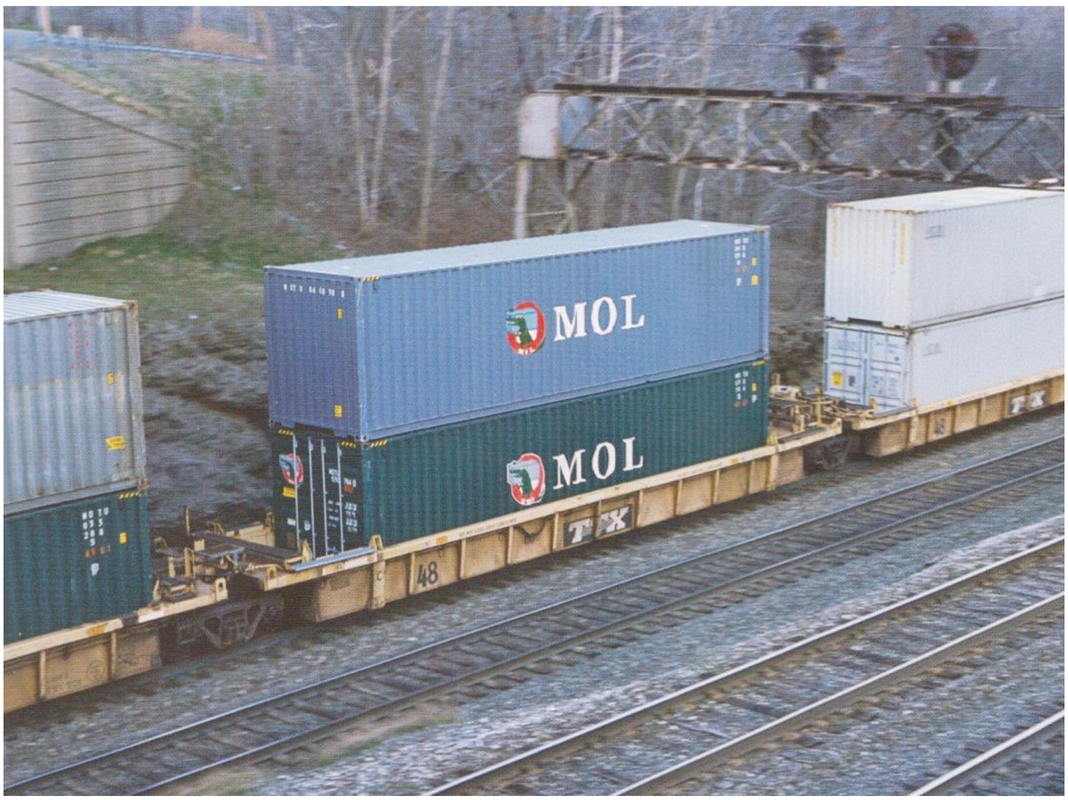

Figure 7.1: Unit of an articulated double-stack railcar

Source: Brian Solomon, *Intermodal Railroading* (St. Paul, MN: Voyageur Press [MBI Publishing], 2007), p. 119

Double-stacking was benefiting the railroads, but it was generally the shipping companies that initiated and organized stacktrain operations, even though the railroads ran them. One could attribute this to the well-known caution of the railroads, but by the late 1980s the rail industry, given more flexibility by deregulation and strengthened by consolidation, was somewhat more innovative. Perhaps the relevant factor was that the shipping lines actually provided the container cargo, and furthermore had an orientation that was inherently more global as they spanned oceans and tied together different countries. However, there was one notable exception, a case where a railroad tried to make the jump from domestic to global freight operations. In 1986 the CSX Railroad bought out Sea-Land (which R.J. Reynolds had spun off in 1984), with the objective of gaining the benefits of controlling multiple transportation companies working in different modes.

CSX had been pursuing a more integrated intermodal approach within the domestic scale for some time, its ambitions made possible by a 1982 decision of the Interstate Commerce Commission (ICC) to no longer block railroads from owning trucking and shipping companies. At about the same time CSX created a trucking subsidiary, Chessie Motor Express.[12] In 1984 CSX completed the purchase of American Commercial Lines, one of the largest operators of barges on the nation's inland waterways; as with Chessie Motor Express, the addition of the barge carrier helped the railroad extend its network of freight movement and become more versatile. Once again the ICC played a key part, allowing the merger in a hotly contested decision.[13] With the 1986 acquisition of Sea-Land as well, the possibilities for synergy were evident for CSX:

> …with a new corporate emphasis that CSX planned to place on "seamless" intermodal transport, it would be possible—at least in theory—for a container of export merchandise that originated, say, in an industrial park outside Toledo, Ohio, to travel from there to a local railyard on a highway chassis, west to Saint Louis aboard a CSX freight train, down the Mississippi River from Saint Louis to the port of New Orleans under the care of an American Commercial barge, and at New Orleans be hoisted aboard a Sea-Land container ship bound for Rotterdam. Ohio to Holland—aboard four different modes of transport—and all of them part of the CSX family.[14]

Such ambitions were remarkable—somewhat reminiscent of Canadian Pacific's transnational container system of the 1970s (described in chapter 5), but on a grander scale. The failure of this vision to materialize profitably may have been due to CSX's reluctance to properly invest in Sea-Land, which it eventually sold to the giant Danish shipping company Maersk in 1999. (American Commercial Lines was spun off as an independent company in 1998.) The railroad valued continuous profits, and the economics of ocean shipping proved too turbulent for its corporate culture. Furthermore CSX was soon engaged in an expensive acquisition of a chunk of Conrail, and then faced the challenge of integrating Conrail's operations into its own.[15] But while CSX may have been affected by its own particular circumstances, it is notable that there have been hardly any successful attempts to tie together infrastructures through direct control across various modes and/or nations for the purpose of moving containers more efficiently. The tendency rather has been for each provider of transportation to maintain at least a nominal

---

[12] Mark H. Rose, Bruce E. Seely, and Paul F. Barrett, *The Best Transportation System in the World: Railroads, Trucks, Airlines, and American Public Policy in the Twentieth Century* (Columbus, OH: Ohio State University Press, 2006), p. 226.

[13] John A. LoDico, "ICC Allows CSX and ACL to Create Nation's First Rail-Barge Company," *Traffic World*, Vol. 199, No. 5 (July 30, 1984), pp. 31-33.

[14] Cudahy, *Box Boats*, p. 162.

[15] Ibid., pp. 187-191.

independence, as it specializes in what it does best. The overall coordination of a worldwide container trip is typically carried out by the ocean shipping company, by a third-party forwarder or logistics specialist, or by the actual corporation whose goods are being moved. With the rise of Just-In-Time manufacturing and retailing the latter option has become especially common; companies like Walmart and Toyota innovated by controlling and monitoring their supply chains with great care in the 1990s, and other corporations now make similar efforts. But the actual provision of transportation is usually left to those based in that business.

In the development of rail containerization since the 1980s the creation of large mechanized terminals, where containers are transferred between train and truck, has arguably been as important as the changes to rail operations. These intermodal terminals, with their cranes and other assorted machines for moving containers about and transferring them, play a key role in the national container network. Since intermodal transportation depends on multiple transport modes and efficient connections between them, it is necessary to have many such terminals, operating efficiently and easily accessible, throughout the domestic network. The number of mechanized terminals began to grow in the 1970s; one motive for this rise in mechanization was the desire to transfer trailers more quickly, rather than with the slow circus loading process, but the possibility of loading containers on railcars was also a major consideration. Over time the industry concentrated its intermodal transfers into fewer terminals, which grew larger and became mechanized, while abandoning many smaller circus loading facilities. Efficiency was better served by running trains long distances from point to point without halting, rather than stopping frequently to add or remove a few trailers or containers. This trend continued in the 1980s, paralleling that decade's growth in stacktrain traffic. Chapter 9 will examine the development and history of these intermodal terminals, especially the massive facilities built recently.

With the dramatic increase in global container traffic on U.S. railroads, it bothers some people in transportation policy that the overall rail network does not appear well suited for the new routes of the cargo moving upon it. (This concern is in addition to more ordinary worries about efficiency, capacity, etc.) A trope that recurs in writings and discussions about American railroads, especially in relation to their role in global container traffic, is the apparent difficulty of a nineteenth century network trying to cope with contemporary twenty-first century commerce. The American rail system was designed primarily for domestic routes and services, in an era of national territorial expansion and then unity, and now must handle very different and more globalized circumstances. Admittedly there are strains that result. Some corridors, especially those carrying containers of Asian imports from West Coast ports to the central and eastern regions of the nation, are congested. Particular bottlenecks and obstacles have also emerged. Some of the most obvious are at the rail connections to ports, and at major hubs like Chicago and Kansas City; particular examples (and the work done to fix them) will be discussed later in this chapter. Yet by and large the railroad network continues to move containers reasonably well. So while these concerns are justified to some degree, they fail to account for the reality that novel patterns of flow and movement often conform to existing infrastructures, rather than the other way around.

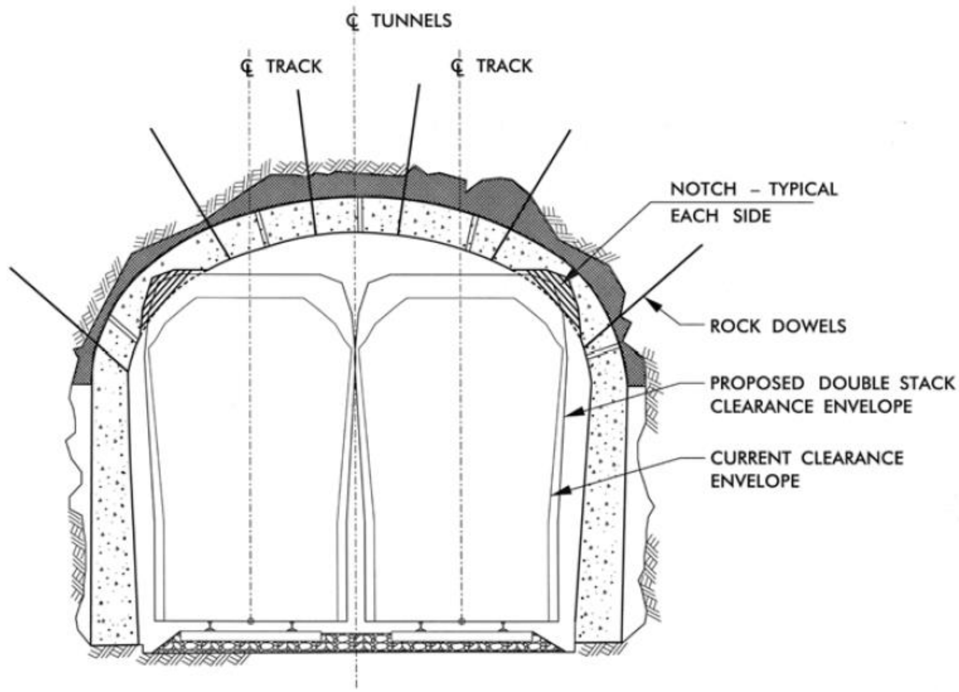

Figure 7.2: Example of clearance-raising work in a tunnel

Source: James N. Carter, Jr. [Chief Engineer Bridges and Structures, Norfolk Southern Railway] "Heartland Corridor Clearance Improvement Project," p. 15 (http://www.arema.org/files/library/2010_Conference_Proceedings/Heartland_Corridor_Clearance_Improvement_Project.pdf, accessed 2/8/12)

When Southern Pacific began running stacktrains in coordination with Sea-Land in the early 1980s, the railroad acted quickly to enlarge clearances on its Sunset Route, a key line running from Los Angeles through the Southwest and on to Texas, Louisiana and the Gulf Coast. This historic corridor had originally been a key part of the second transcontinental railroad, completed in 1881 (and made possible by the Gadsden Purchase of land from Mexico). With few tunnels along it, the Sunset Route was not especially difficult to upgrade. In the mid-1980s Union Pacific adjusted clearances on some major routes to and from the Los Angeles area, the San Francisco Bay area, and the Pacific Northwest. The most challenging of these was a corridor with numerous tunnels going through the Feather River Canyon. This route connects Oakland to Salt Lake City through the Sierra Nevada mountains, and was acquired by Union Pacific through its purchase of the Western Pacific Railroad in 1983. The cost of raising the clearances on the Feather River Canyon route was jointly covered by Union Pacific, APL and the Port of Oakland, which gives a good indication of the multiple actors who stood to benefit. In the mid-1990s the Atchison, Topeka and Santa Fe Railway (the "Santa Fe") raised clearances on its route through the Tehachapi Mountains of Southern California.[16]

It took longer in general for clearances to be raised in the East. The journey from Chicago to New York City is of obvious importance, and there have long been two principal railroad routes between the two cities. The "Water Level Route," once under the New York Central Railroad, passes through upstate New York paralleling the Erie Canal and then cuts through Cleveland and Toledo, moving largely on level terrain and often alongside some body of water (hence its name). The other route, under the control of the Pennsylvania Railroad in its glory days, goes through Philadelphia, across the hills and mountains of southern Pennsylvania to Pittsburgh, and then through northern Ohio and Indiana; this is a slightly shorter route but a more topographically challenging one, highlighted by the famous Horseshoe Curve at Altoona, Pennsylvania. Both these corridors possess a long and prominent history. The Water Level Route, in the days of the New York Central, had the celebrated *20th Century Limited* and *Lake Shore Limited* trains running upon it. The former during its peak was the last word in prestige and luxury (and incidentally the setting for the train scenes in Alfred Hitchcock's *North by Northwest*). Likewise the Pennsylvania Railroad ran the prestigious *Broadway Limited* upon its route. Freight had also moved in great quantities through each route. But for railroad companies in the 1980s, more concerned with the present than the past, the problem with both corridors was that their clearances did not allow stacktrains.

In the mid-1980s the Consolidated Rail Corporation—widely known as Conrail—raised the clearances between Chicago and Buffalo on the Water Level Route. (Conrail was the government-run railroad that in 1976 took over several bankrupt Northeastern and Midwestern lines.) This still left the Water Level Route with clearance issues from Buffalo to New York, but there was another option: the line of the former Erie Railroad, which had been built with a higher clearance back in the early and middle decades of the 1800s.[17] (This line was also originally built with a track gauge of 6′, as opposed to the standard 4′-8½″, but that was later changed.) This route also runs through upstate New York but on a pathway south of the Water Level Route through the region commonly termed the "Southern Tier." It had long been less important than the Water Level Route, but now, with a minor difference in clearance dimensions suddenly critical, it gained an unexpected significance. At the time the line was split between the Delaware and Hudson Railway and the New York, Susquehanna and Western Railway (known as the "Susquehanna," or more informally the "Susie Q"). In 1985 Sea-Land and APL began working with the two railroads to move stacktrains over the former Erie line between Buffalo and an intermodal terminal at Little Ferry, New Jersey (close to Newark), with the Delaware and Hudson making the haul between Buffalo and Binghamton and the Susquehanna handling the

---

[16] Solomon, *Intermodal Railroading*, p. 173; David R. McKenzie, Mark C. North, and Daniel S. Smith, *Intermodal Transportation—The Whole Story* (Omaha, NE: Simmons-Boardman Books, 1989), p. 25.
[17] Solomon, *Intermodal Railroading*, p. 173.

leg between Binghamton and Little Ferry.[18] Thus the New York City area was tied into the burgeoning national stacktrain network, and better connected to the worldwide system of container movement, all thanks to an obscure engineering decision made in the 1800s. By 1989 clearance improvements were completed by Conrail on the Water Level Route, and most container traffic returned to this traditionally more important line. Clearances were also raised on the corridor towards Boston—a continuation of the Water Level Route that runs east from Albany, rather than south—allowing stacktrains to get all the way to Worcester, Massachusetts.[19]

It was inevitable the former Pennsylvania Railroad line through southern Pennsylvania would eventually receive similar treatment. A particular impetus for this was the desire to revive the fortunes of the port of Philadelphia, whose container traffic was disappointingly low. There were various reasons for the downturn in the port's business, but the lack of access for stacktrains was becoming an issue. Thus the state government, various local governments, and the port itself came together with Conrail to jointly fund clearance enhancements that were completed in 1995. With many tunnels involved in the mountainous terrain, it was an expensive corridor to alter. The impact of the improvements was far-reaching, providing better connections not merely to Philadelphia's port, but also those of Newark, Baltimore, Wilmington and Hampton Roads, and furthermore improving the rail links of Pittsburgh and Harrisburg.[20]

In the midst of such efforts to orient the railroads to carry containers on their global pathways, there was also an impetus to better connect with both Canada and Mexico in the wake of the 1994 North American Free Trade Agreement (NAFTA). This type of traffic is also international but can be regarded as regional rather than truly global, and consists of many different types of freight only some of which moves by container. With the burgeoning trade generated by NAFTA in mind, the Kansas City Southern Railway, bidding together with Transportation Maritima Mexico, gained the Ferrocarril de Noreste in 1996, thus achieving possession of several key lines in Mexico. Having alliances already with the I&M Rail Link in the Midwest, and Canadian Pacific in Canada, the Kansas City Southern's reach now spanned all three nations.[21] The company "billed itself as the NAFTA Line and…began dreaming of through Mexico City-Montreal intermodals [container or piggyback trains]."[22] Meanwhile in 1997 the Canadian National Railway acquired the Illinois Central Railroad, giving it possession of an extensive north-south network of lines reaching all the way to New Orleans to complement its

---

[18] Cudahy, *Box Boats*, pp. 166-167; Stephen B. Goddard, *Getting There: The Epic Struggle Between Road and Rail in the American Century* (New York: BasicBooks [HarperCollins Publishers], 1994), pp. 240-241; Solomon, *Intermodal Railroading*, pp. 87-88, 173. It is unclear which shipping line was the first to send stacktrains on the former Erie line, as Cudahy and Goddard identify Sea-Land and Solomon identifies APL.

[19] Solomon, *Intermodal Railroading*, pp. 87, 173.

[20] National Cooperative Highway Research Program (Transportation Research Board), *Rail Freight Solutions to Roadway Congestion—Final Report and Guidebook* [NCHRP Report 586] (Washington, D.C.: Transportation Research Board, 2007), pp. 27-31.

[21] Richard Saunders, Jr., *Main Lines: Rebirth of the North American Railroads, 1970-2002* (DeKalb, IL: Northern Illinois University Press, 2003), pp. 316-318.

[22] Ibid., p. 318.

Canadian system. In 1998 the Kansas City Southern switched Canadian allies, going from Canadian Pacific to Canadian National.[23]

Today the Mexican portion of the Kansas City Southern network is run by the Kansas City Southern de Mexico, part of the Kansas City Southern's corporate family. (The share of Transportation Maritima Mexico was bought out in 2005.) The Kansas City Southern also has good links on the U.S. side near the border, and in 2009 rebuilt the old "Macaroni Line" (which had been abandoned, with most of its track gone) in Texas to improve its network. Owning the Texas-Mexican Railway International Bridge at Laredo gives the Kansas City Southern an important rail link to Mexico at the border. Some stacktrains hauling domestic containers move on the Kansas City Southern lines in both the U.S. and Mexico, going back and forth between the countries.[24] Similar developments have occurred along the U.S.-Canada border. In 1995 a new rail tunnel large enough for stacktrains was built between Port Huron, Michigan, and Sarnia, Ontario, under the St. Clair River. Currently proposals are being advanced for the construction of a similar tunnel beneath the Detroit River to allow stacktrains to travel between Detroit and Windsor, Ontario, as the existing rail tunnel lacks adequate clearance and would be difficult to enlarge.[25] (The idea seems unlikely to be realized in the foreseeable future, though.)

In recent years the process of raising U.S. railroad clearances has continued. Southern Pacific's line through the Donner Pass of Northern California, connecting the San Francisco Bay area with Nevada, was able to accommodate stacktrains with normal-height containers, but not high-cube 9'-6" high containers or domestic containers.[26] Union Pacific, having bought out Southern Pacific in 1996, finally raised the Donner Pass clearances in 2009. In this project fifteen tunnels were raised, involving about three and a half miles of notching, and two tunnels had their floors lowered (which also involves removing and rebuilding track). Various other technical improvements were also carried out, such as upgrading to CTC (centralized traffic control), but the clearance work was the main thrust of the project.[27] The Donner Pass has a particularly prominent historical legacy. It played a major role in the nation's westward expansion into California as a route for settlers to pass through, including the notorious party of 1846-1847 that was stranded in brutal winter storms and apparently resorted to cannibalism. Trains came through the pass in 1868, as the first transcontinental railroad was built at tremendous effort. Later the road through the pass was made part of the Lincoln Highway—it remains today as

---

[23] Ibid., pp. 318, 338-340.

[24] Wikipedia, "Kansas City Southern Railway." (http://en.wikipedia.org/wiki/Kansas_City_Southern, accessed 7/2/11); John R. Stilgoe, *Train Time: Railroads and the Imminent Reshaping of the United States Landscape* (Charlottesville, VA: University of Virginia Press, 2007), pp. 156-158; Nate Muhlethaler, "Mexican Railroads: Photographic Profiles of Mexican Rail Lines and Operations." (http://mexicanrailroads.blogspot.com/2008/08/kcs-de-mexico-south-from-laredo.html, accessed 7/2/11).

[25] Continental Rail Gateway website, "It's Time to Build the High-Clearance Replacement Rail Tunnel at the Detroit/Windsor Crossing." (http://crgateway.com/LinkClick.aspx?fileticket=w75XuM2hbig%3d&tabid=74, accessed 7/2/11).

[26] Solomon, *Intermodal Railroading*, p. 173.

[27] *Railway Age*, "Doublestacks on Donner Pass," November 24, 2009; Solomon, *Intermodal Railroading*, p. 173.

Route 40—and in the 1960s Interstate 80 was built near the pass.[28] The global containers passing along this corridor today, therefore, are only the latest in a long series of flows moving through.

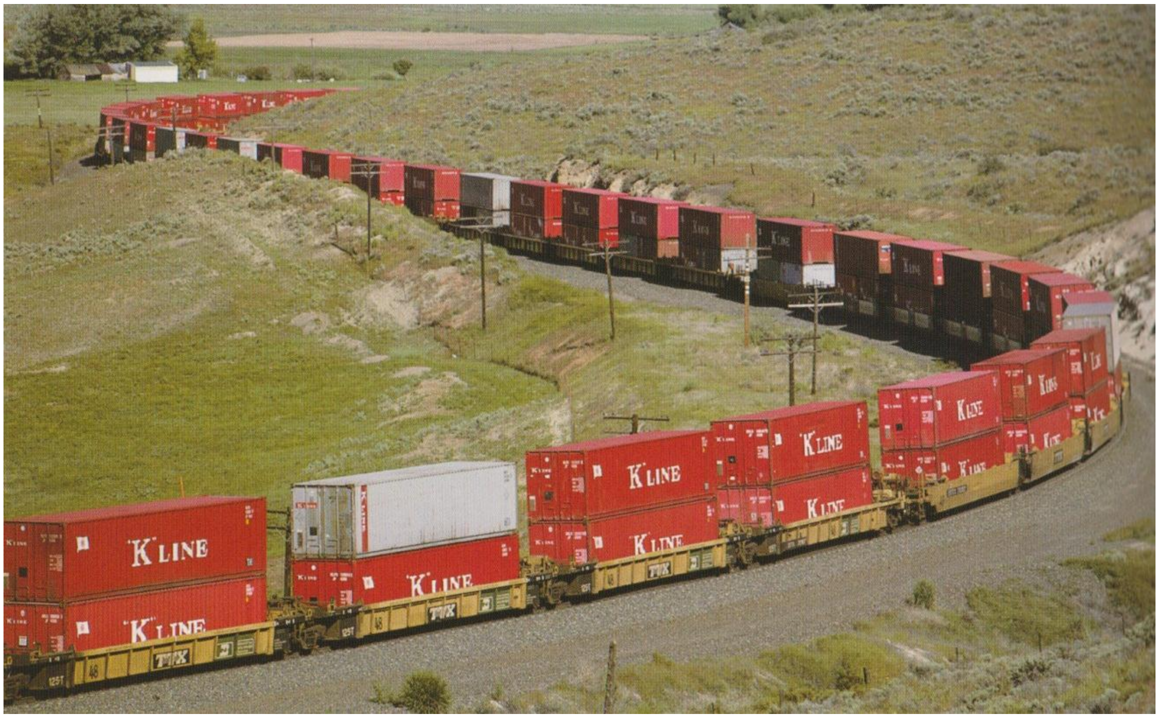

Figure 7.3: A stacktrain

Source: Brian Solomon, *Intermodal Railroading* (St. Paul, MN: Voyageur Press [MBI Publishing], 2007), p. 88

Despite the example of the Donner Pass, the bulk of the clearance-raising projects over the past decade have been in the East. A recent trend towards greater use of East Coast ports (especially in the Southeast) has helped fuel this, but the main cause is simply the challenge of lower clearances on the older, eastern lines. A prominent example is the "Heartland Corridor" project, a partnership between the Norfolk Southern Railway and a variety of government bodies that was completed in 2010. The intent of the Heartland Corridor was essentially to raise clearances on a Norfolk Southern corridor between the port of Hampton Roads (i.e., the Norfolk area) in Virginia and Columbus, Ohio. The primary focus of the work was in the mountains of West Virginia, where many tunnels had to be enlarged. (The route runs through Virginia, West Virginia, a small sliver of Kentucky, and Ohio.) Originally built in the late 1800s, the route historically was used primarily for coal traffic from the mines, which it still carries to some extent. Before the clearance work it had also moved containers carried one level high, but most of the containers moving from Virginia's ports into the Midwest had been routed on a longer path, accessible to stacktrains, that led through Pennsylvania. The Heartland Corridor cost more than $320 million, including a $69-million intermodal terminal in Columbus. Funding came through a

[28] Wikipedia, "Donner Pass." (http://en.wikipedia.org/wiki/Donner_Pass, accessed 7/4/11).

combination of federal and state funds, along with money from Norfolk Southern, leading to some criticism of the idea of public money going to improve the infrastructure of a private company. The company's counter-argument was that the project benefited the economies of the three states (Virginia, West Virginia and Ohio), and that furthermore the trucking industry essentially gets its road infrastructure provided for free by the government. The work involved raising clearances on 28 tunnels, as well as raising 24 other obstructions such as bridges. The tunnel work extended over about five and a half miles of track, including notching arched roofs, excavating roofs, and lowering tracks. In one case a tunnel had its top removed completely, a solution known as "daylighting."[29]

The Heartland Corridor is clearly oriented to global trade, and now serves primarily to accommodate the movement of containers on global trajectories. It is revealing that so much of the new investment in American rail infrastructure actively seeks to funnel goods into and out of the country, rather than promoting connectivity within the nation. (It presumably will have the latter effect also, but only incidentally.) Seen in this light, the branding of the project as the Heartland Corridor seems cynical if not downright deceptive; such a name with its overtones of patriotism and domestic geographic space implies an effort at national unity that is contrary to the project's actual purpose. Here as elsewhere, the space of the U.S. nation-state has been made more porous and opened up to a globalized world. This enhanced transnational access is seen by some as a positive; an article in *USA Today* about the Heartland Corridor explains earnestly that "it will give poor mountainous areas in West Virginia a chance to enter the global marketplace."[30] The reality is likely to be more ambiguous, for stacktrains may help West Virginia slightly but in general will simply pass through. Ironically, much of the coal that once traveled on the route was sent to the port of Hampton Roads for export, so the corridor's new orientation to containerization is reminiscent of the global nature of its older purpose, though the direction is reversed.

A similarly ambitious enterprise, complete with its own catchy title of the "National Gateway," was initiated in 2008 by CSX, the major rival of Norfolk Southern in the east. Currently in progress, the National Gateway will be a route similar to what Norfolk Southern accomplished with the Heartland Corridor, one that brings stacktrains from certain ports of the Southeast and Mid-Atlantic to the Midwest. Its pathway though is slightly more northern than the Heartland Corridor, traversing the Appalachians for the most part in western Pennsylvania rather than West Virginia. In addition the National Gateway involves substantial work in the region of Baltimore and Washington, D.C., and extends south into Virginia and North Carolina. The project's total estimated cost is $850 million, which also includes the construction of a few

[29] John D. Boyd, "If You Build it… Stacking Up Hopes in the Heartland," *The Journal of Commerce*, September 6, 2010; Norfolk Southern Corporation, "'New Thinking, New Resolve, and New Optimism' Characterize Official Opening of Norfolk Southern's Heartland Corridor" (press release), September 9, 2010. (http://www.nscorp.com/nscportal/nscorp/Media/News%20Releases/2010/heartland_opening.html, accessed 7/4/11); Dennis Cauchon, "Rail Project Goes Through the Roof," *USA Today*, October 9, 2006.
[30] Cauchon, "Rail Project Goes Through the Roof."

new intermodal terminals. Not surprisingly, CSX has pushed for government subsidies to help pay for some of the clearance work. There are 61 clearances along the National Gateway's lines, in the states of Ohio, Pennsylvania, West Virginia, Maryland and Virginia, and also in Washington D.C., that need to be raised for stacktrains to pass beneath them. The most notable is Washington, D.C.'s Virginia Avenue Tunnel, which for a price of $160 million is being made both higher and wider so that it goes from single-track to double-track in addition to accommodating stacktrains. Construction work on the tunnel is impacting several neighborhoods in Washington, D.C., and has aroused some controversy there—another reminder of how the global and local are intertwined.[31]

Projects like the Heartland Corridor and National Gateway are promoted to an extent far beyond a typical railroad improvement project—even their catchy and vaguely patriotic names, clearly an exercise in branding, attest to this. With a growing awareness of environmental issues and traffic congestion, and the use of rail being seen (quite correctly, in fact) as an approach that can lessen both problems, the railroad companies perceive the benefit of promoting their activities. Probably the most crucial factor, though, is their desire to get assistance with funding from the government. For this purpose presumably a certain amount of promotion and branding is worthwhile, both to persuade the general public and hard-headed politicians and bureaucrats.[32] Predictably, supporters view the resulting projects as models of public-private partnership, while critics argue they are the recipients of needless subsidies.

The alterations of clearances have been the most difficult and expensive of the improvements made by the railroad lines for their growing container traffic, especially inasmuch as these corridors extend for hundreds or even thousands of miles. But there have also been projects to resolve particular traffic bottlenecks that do not involve much distance but are challenging nonetheless. A noteworthy example is the Sheffield Flyover in Kansas City. Second only to Chicago in its rail traffic, Kansas City is a large hub and connection point for several major lines. A crossover of a few busy lines on the east side of the city was regarded as the nation's third-busiest rail intersection in the 1990s, due to activity from the Burlington Northern and Santa Fe Railway (BNSF), the Kansas City Southern, Union Pacific, and numerous local trains. All told about 200 trains were passing through daily, including many stacktrains carrying containers as the BNSF tracks are on a major route from Los Angeles to Chicago. Delays were frequent and consequently rail grade crossings on the local street network were often blocked by stopped trains. Pollution was also an issue. On top of these motivating factors, the city wanted to maintain its importance on the nationwide railroad network rather than see trains rerouted elsewhere. The

---

[31] Jeff Stagl, "CSX Wagers on a Public-Private Partnership to Place the Double-Stack National Gateway in the Intermodal Win Column," *Progressive Railroading*, January 2009; John D. Boyd, "Railroads Redraw the Intermodal Map," *The Journal of Commerce,* August 6, 2010.

[32] Daniel Smith makes a similar point about the role of "packaging" in promoting a series of related infrastructural improvements under one name, though he is referring to government projects. See: Daniel Smith, "Freight Projects of National Significance: Toward a Working Definition," in: Transportation Research Board, *Policy Options for Intermodal Freight Transportation* [special report 252] (Washington, D.C.: National Academy Press, 1998), pp. 226-227.

result was the Sheffield Flyover, a project to carry trains on one line raised in the air, above the other lines on the ground. The flyover actually consists of three separate bridges, the largest being 6,740 feet long while the other two are 890 feet long and 150 feet long. Completed in 2000 at a cost of $75 million, it necessitated a complex financing structure in which government bodies (mainly the Missouri state government) were extensively involved but the expense was mostly borne by the railroads.[33]

The most pressing bottlenecks in the nation's rail system, it is widely acknowledged, are at the great heart of the network—Chicago, which remains the premier hub for North American railroading and consequently a site of frustrating delays. A common lament is that sometimes it takes as long for a train to go from the West Coast to the periphery of the Chicago area as it does to get from there to its final destination in the city (or to the other side of the city). Anecdotes abound, for instance of the train carrying sulphur that took 27 hours to move across the city, moving at an average speed of 1.13 miles per hour. At some points a train engineer must walk back the entire length of a train (some freight trains, especially those carrying containers, can be over a mile long) to manually operate a switch, and then return to the cabin.[34] It seems astonishing rail companies tolerate such problems, but they have little choice. As described in chapter 5, Chicago's status as the crossroads of American rail is embedded in the history of its growth and the development of the nation's rail system. The corporate geography of the railroad industry also centers on the city, as the six largest North American railroads serve Chicago: BNSF, Union Pacific, CSX, Norfolk Southern, Canadian National and Canadian Pacific. Indeed, it has long been a key junction point between western and eastern railroad lines. With new intermodal terminals being built on giant exurban sites (mainly to have sufficient space for their large-scale operations, but also to avoid the traffic of the city), the role of the city proper may be diminishing but the larger metropolitan area remains as vital as ever.

Nevertheless the region's congestion does provide a motive for railroads to consider bypassing it, as appears to be the intent of CSX's new intermodal terminal at North Baltimore in northwest Ohio, for instance. The Chicago Region Environmental and Transportation Efficiency program, known by its acronym CREATE and jointly run by the rail companies and various governmental agencies, was founded in 2004 in an effort to help maintain the area's centrality. It focuses on the city and nearby suburbs, which have a large number of important intermodal terminals and rail yards that are likely to remain significant. CREATE seeks to improve five major corridors, including creating road-rail separation at congested grade crossings, building flyovers for troublesome rail-rail intersections, and making improvements to tracks and signaling. One of CREATE's most significant ongoing projects is the $140 million Englewood Flyover, which addresses a bottleneck where a confluence of freight trains, commuter trains and

---

[33] National Cooperative Highway Research Program, *Rail Freight Solutions to Roadway Congestion*, pp. 42-45.
[34] John Schwartz, "Freight Train Late? Blame Chicago," *New York Times*, May 7, 2012.

Amtrak trains causes delays.[35] As with the previous examples, CREATE is especially interesting because it implicates various scales. There is the global traffic of containers, but there are also domestic containers as well as other types of domestic rail freight, in addition to passenger trains. The elimination of grade crossings would help local automobile traffic in specific neighborhoods, and some of the rail improvements would allow the city's METRA commuter rail trains to move more easily.

A bottleneck in the U.S. railroad network's link to global shipping has long been the connections at ports. The rise of container shipping brought about a new era for ports, putting an emphasis on better connections to the domestic infrastructure. Many of the major ports before containerization were bounded in confined urban locations and had surprisingly cumbersome transport links—the docks of Manhattan being the quintessential example. With the sheer growth in cargo brought about by the container, as well as the emphasis on quick transfers between transport modes that the container encourages, many ports shifted to more exurban locations. The port of New York essentially moved to Newark, the port of San Francisco went to Oakland, and similar shifts happened elsewhere. Infrastructural connections were crucial in these decisions; where getting trucks and trains in and out of Manhattan had long been a nightmare, Newark was conveniently adjacent to the New Jersey Turnpike and also had good rail connections. Likewise Oakland possessed much better transport links than congested San Francisco, isolated on its peninsula. With the rise of stacktrains in the 1980s and '90s many ports and railroad carriers worked to make these links even better, and to bring rail service as near the docks as possible so containers could be swiftly moved between ship and train. (While it is generally impractical to transfer containers directly from ship to train, or vice-versa, it is desirable to bring the trains close, preferably within the port complex.) Newark is an example, as its existing links have been greatly improved. Its $600 million ExpressRail project (which also connects with the Howland Hook terminal on Staten Island), begun in the early 1990s and constantly continued since, has extended numerous tracks directly into the port itself, in addition to improving rail links at the nearby intermodal terminals.[36]

The railroad connections for the adjacent ports of Los Angeles and Long Beach represented a particularly nasty bottleneck by the 1990s. A few rail corridors ran from the ports northward to downtown L.A., where they connected to the key lines leading to the rest of the country, primarily eastwards. These routes between the ports and downtown were problematic because of their numerous at-grade crossings, resulting in slow train speeds, great inconvenience for local communities, and excessive noise and pollution. Furthermore their capacity was limited and so many containers were being drayed (i.e., carried by local truckers) from the ports to various railheads in the downtown area and further afield, resulting in highway traffic and pollution. While the trains and trucks were carrying global freight coming from (or bound for) faraway

[35] Chicago Metropolis 2020, *The Metropolis Freight Plan Technical Report: Delivering the Goods,* December 2004, p. 39. (http://www.chicagometropolis2020.org/documents/freighttechreport.pdf, accessed 12/9/09); Schwartz, "Freight Train Late? Blame Chicago."
[36] Joseph Bonney, "NY-NJ ExpressRail Volume Up 10 Percent," *The Journal of Commerce,* July 31, 2012.

destinations, the problems they caused for the neighborhoods they passed through were certainly local in nature. In addition to the pressure from those communities, the ports had their own incentive to make changes, as ports are judged by their customers not merely on the basis of their internal operations but also the quality of their inland connections. It was therefore in the interest of many actors—corporate, institutional and political—to improve the situation.[37]

The Alameda Corridor was the result. Again, it is an example of different scales—the global, national, regional and local—becoming intertwined. About 20 years in planning and development, and 3 years in construction, the Alameda Corridor was completed in 2002 at an estimated cost of $2.4 billion. It is a consolidation of the disparate previous lines into one main route, which generally goes along the same corridor as a former Southern Pacific line, running a distance of 20 miles. Its most notable feature is a giant trench 33′ deep and 50′ wide, triple-tracked for its entire length and about ten miles long. The trench passes under surface roads and hence approximately 200 grade crossings were eliminated, a very substantial benefit for local traffic. The corridor has a capacity of up to 100 trains a day (though it typically carries fewer), and BNSF and Union Pacific use it by joint arrangement. The cost of the project was covered entirely by an assemblage of governmental entities, and in theory the debt will be repaid by the user fees paid by the railroad companies, though this arrangement has run into problems.[38] The success of the Alameda Corridor—on a functional level, if not financially—has led to a related project, the Alameda Corridor East, currently in its early stages. This will upgrade the Union Pacific rail corridors running east from downtown L.A. and eliminate many at-grade crossings, for an estimated cost of about one billion dollars. Similar plans have been tentatively advanced for the BNSF line that also runs east from downtown, known as the Orangethorpe Corridor.[39]

The high clearances that now exist through so much of the American railroad system, caused by the desire to use double-stack cars, created the opportunity to introduce other types of new railcars of a similar height. This is a key shift, as the alterations wrought upon the infrastructure by globalization bring about deeper changes in the workings of the purely domestic aspects of that infrastructure. The raising of clearances in the first place was a crucial change to accommodate containerization, but the new designs for railcars would seem to be an additional step, as the global spatial regime remolds that of the nation-state in greater detail. (Some of these high new railcars have in turn provided an additional impetus for the raising of clearances, incidentally, though the desire to allow double-stack cars is invariably the primary motivation.)

One of these new railcars is the autorack car; an autorack, also known as an auto carrier, is a railcar specially designed to carry new automobiles from the factory or port to a location near the dealerships where they will be sold. Originally this was done using boxcars, but gradually trucks

---

[37] Steven P. Erie, *Globalizing L.A.: Trade, Infrastructure, and Regional Development* (Stanford, CA: Stanford University Press, 2004), pp. 147-151; National Cooperative Highway Research Program, *Rail Freight Solutions to Roadway Congestion*, pp. 38-42; Solomon, *Intermodal Railroading*, pp. 173-174.
[38] National Cooperative Highway Research Program, *Rail Freight Solutions to Roadway Congestion*, pp. 38-42; Solomon, *Intermodal Railroading*, pp. 173-177; Erie, *Globalizing L.A.*, pp. 152-162.
[39] Erie, *Globalizing L.A.*, pp. 147-151; Alameda Corridor East Construction Authority website, "Project Description and Benefits." (http://www.theaceproject.org/project.htm, accessed 7/4/11).

captured most of the business. In the 1960s autoracks entered into use and began to take a little of this business back for the railroads, eventually becoming widespread in the 1980s and '90s. The early autoracks were generally bi-level in design (i.e., holding autos on two levels), with some tri-level models introduced to carry small cars. But higher clearances allowed tri-level autoracks to become common, and for them to carry larger cars, SUVs and minivans. Gunderson's "AutoMax" autorack, for instance, was introduced in 1999 and has a height of 20'-2", the same as that of a double-stack car holding high-cube containers.[40] Another new railcar design is the high-cube boxcar, which as its name implies is simply a taller boxcar—though its height rarely approaches the 20'-2" upper limit.[41] It is not only freight cars that have expanded their vertical dimensions. Since 1978 Amtrak has used a railcar known as the Superliner that carries passengers on two levels, but with a height of 16'-2" the car was originally restricted to certain western lines with sufficient clearance. Since clearances were raised on some major corridors in the east during the 1980s and '90s to accommodate stacktrains, the Superliner now sees use on several of Amtrak's eastern routes.[42]

The rising use of domestic shipping containers since the 1980s, which move within the U.S. and Canada (and sometimes Mexico) by both train and truck, has also impacted the American railroads. This topic is the focus of chapter 11, but merits a brief mention here. By the mid-1980s American infrastructure had been adjusted to a large degree to handle the global ISO container, with the railroad and trucking industries carrying containers in large quantities and a growing network of intermodal terminals in place to transfer them. This system now in place, it was logical to use it for long-distance domestic freight also, so that trucks could focus on pickup and delivery while more efficient trains handled the bulk of the journey. Indeed, as previously noted, containers were already occasionally carrying domestic freight, albeit only on their backhauls. Yet American and Canadian trailers had grown larger in size since the 1960s and could now hold far more than a global container—to use such a container for domestic freight would be inefficient. Consequently larger domestic containers were introduced, to be used only in North America, in the mid-1980s. To some extent they could move in the same network already created for global containers, though some significant adjustments had to be made. The domestic containers of the 1980s and early '90s were 48' long, 8'-6" wide and 9'-6" high, and during the later 1990s these were replaced by 53' containers of the same width and height. The railroad lines have done well in transporting these containers, but it has been the major trucking companies, along with the IMCs (intermodal marketing companies), that have been critical in coordinating the overall movement of domestic containers and generally running the networks. (This contrasts

---

[40] Ted Curphey ("Funnelfan"), "BNSF and KCS Auto-Max Cars," Trainweb website, February 14, 2000 (http://www.trainweb.org/funnelfan/automax.htm, accessed 7/4/11); World Trade Ref website (World Trade Press), "Guide to Railcars." (http://worldtraderef.com/wtr_site/rail_cars/guide_to_rail_cars.asp, accessed 7/4/11); Wikipedia, "Autorack." (http://en.wikipedia.org/wiki/Autorack, accessed 7/4/11)
[41] World Trade Ref website (World Trade Press), "Guide to Railcars." (http://worldtraderef.com/wtr_site/rail_cars/guide_to_rail_cars.asp, accessed 7/4/11).
[42] Brian Solomon, *Amtrak* (St. Paul, MN: Voyageur Press [MBI Publishing], 2004), pp. 129-132; Wikipedia, "Superliner (railcar)." (http://en.wikipedia.org/wiki/Superliner_(railcar), accessed 7/4/11).

with the domestic container systems of the 1920s through the '60s which were generally created and run by the railroads, with truckers in a supporting role.) In the meantime piggyback has declined significantly, especially over the past decade, as the domestic container serves the same purpose and has proven to be more efficient. All this is described in detail in chapter 11, and to a lesser degree in chapter 8 in the context of the trucking industry.

More than with trucking or the inland waterways, the U.S. railroad infrastructure has been deeply impacted by containerization since the 1980s. The alterations to vertical clearance have been especially significant, but particular projects, most notably the Alameda Corridor, should not be overlooked either. The depth of these changes is especially ironic inasmuch as the container is an object designed to avoid the need for such adjustments by working within preexisting transport systems. Yet the transformation has been carried out nonetheless, generally by the railroads themselves though often with assistance from government bodies, port authorities, and/or shipping lines. Most of these actors are not transnational but work at a national, regional or local scale, and they are not merely responding to global forces, but actively forming and reshaping globalization. Indeed, as Saskia Sassen would argue, they actively carry out globalization. They do so in a railroad infrastructure that is deeply embedded in American history, geography and practices, and consequently possesses its own inertia. The flows of container movement take place within this network, which is transformed in some ways but still retains its overall form and many of its longstanding qualities.

Chapter 8 ~ Trucking Put in Its Place

This chapter describes the impact of the shipping container on American trucking from the late 1970s to the present. During this period the growth of containerization in trucking has been rapid, going hand-in-hand with the rising tide of container use at the worldwide scale and the flood of imports into the country. But it has not registered in quite the same fashion as for the railroad industry, which as described in chapter 7 experienced some fundamental changes over these years. For trucking the increase in container traffic has been more of a purely quantitative phenomenon, wherein rising numbers of containers lead to more business, and more trucks hauling containers on roads and highways, but few deeper alterations. The nation's trucking system is a vast and bustling network of movement that moves a substantial majority of U.S. freight (as measured by volume or value), and so even the great quantity of containers carried within it constitutes a small percentage of its overall traffic. Furthermore the trend is increasingly for the bulk of long-distance overland container movement to be handled by train, with trucks taking care of just the pickup and delivery. This business of hauling containers by truck for pickup and/or delivery is known as "drayage," and it represents a particular sector of the trucking business that is fiercely competitive with profits hard to come by. So the prominence of trucking in the early decades of containerization, as described in chapter 6, has arguably been somewhat reduced, even as sheer volumes have jumped dramatically. There have been some important alterations caused by the container, to be sure, especially in major road and highway-building projects linking to container ports, and this chapter will discuss them. But broadly speaking the basic infrastructure of trucking, including the roads and highways it depends on, remains much the same (or when it has changed, containerization is not the reason). Actually, the greatest shift has probably been in the transport not of global containers, but of domestic containers. The major trucking firms have taken a leading role in domestic containerization over the past 20 years, using it to gain more business, reduce their costs, and involve the railroads while still retaining control over the movement of freight.

In sum, the trucking industry has been changed significantly, but not dramatically or in a genuinely transformative way, by the container's presence. Much the same could be said of the Interstate highways, the key network on which trucking so depends. Largely built out by the early 1980s, they have not been altered or expanded dramatically since, though improvements (additional lanes, new interchanges, better entrance/exit ramps, etc.) have been frequent. Certain key segments have been built or improved to provide better access to ports—this constitutes a "globalizing" of the infrastructure—but these are relatively minor changes in the overall network. There has been nothing quite comparable to the raising of clearances that railroad companies have carried out widely to accommodate container stacktrains. Probably the most significant alteration, from the perspective of trucking, has been the change in regulations and in particular the reconfiguration of the spatial regime governing trailer size. As will be described, the allowable dimensions for truck trailers have expanded in all three dimensions, with key implications for container use in the context of American trucking. But these changes were not done with containerization in mind, even if they had important consequences for it.

The greatest change to American trucking since the 1970s has doubtless been deregulation. Trucking was a highly regulated industry from the mid-1930s until about 1980, with the Interstate Commerce Commission (ICC) maintaining a regulatory structure of limited competition and respectable wages. The Teamsters Union also played a large role in ensuring decent pay and conditions for drivers. This model began to deteriorate in the 1970s; the Teamsters Union lost membership in that decade while the ranks of of nonunionized owner-operators swelled greatly, for a variety of reasons including the endemic corruption of the union and the temporary availability of higher pay for owner-operators.[1] (An owner-operator is a trucker who, at least in theory, is an independent business or contractor because he or she owns and operates the truck.) In the emerging neoliberal spirit of the times, along with pressure from shippers and owner-operators, the government commenced to deregulate the trucking industry in the late 1970s, and continued on this course in the 1980s and '90s. The Motor Carrier Act of 1980 is regarded as the most significant piece of legislation in this process. (1980 was a banner year for deregulation in transportation, as the Staggers Act largely deregulated the railroads in that year too.) The result of all these changes has been competition so fierce it is often described as cutthroat, the fragmentation of the industry into various specialized sectors, lower prices for shippers, the collapse of many larger unionized firms, the rise of many small and large new firms, and plunging membership in the Teamsters Union. Along with these trends there has been a severe decline in wages and working conditions for drivers, who are now (with some exceptions, generally for sectors or firms where unionization survives) badly exploited and poorly paid.[2] As will be discussed further in this chapter, drivers in drayage are among the most exploited and underpaid of all truckers.

Prior to the 1980s, most trucking operations relied heavily on terminals, essentially warehouses with loading docks where freight could be stored and reassembled into new groupings for the next trip. While some truck journeys went directly from shipper to consignee (the one who receives the goods), in most cases a terminal would be involved at some point. Major trucking firms generally handled multiple types of trucking. This changed in the wake of deregulation, as the industry splintered into more specialized firms. In particular, a key split emerged between truckload (TL) and less-than-truckload (LTL) operations, with the truckload

---

[1] Shane Hamilton, *Trucking Country: The Road to America's Wal-Mart Economy* (Princeton, NJ: Princeton University Press, 2008), pp. 207-214.

[2] See Michael H. Belzer, *Sweatshops on Wheels: Winners and Losers in Trucking Deregulation* (New York: Oxford University Press, 2000) for coverage of trucking from the 1970s up to 2000, with particular emphasis on drivers' conditions. Also see Hamilton, *Trucking Country*, pp. 224-230.

sector growing explosively and becoming almost entirely nonunion, while the LTL sector kept some union presence.[3] These two types of trucking should be defined. Truckload service is simply when the entire cargo is loaded at its origin, typically the shipper, and delivered directly to the recipient, typically the consignee. This means the shipper must have a substantial amount to ship, enough to fill the entire truck (or most of it), but it is the most efficient and cheapest way to ship by truck because no terminals are necessary and the freight need not be unloaded or reloaded at intermediate points. The bulk of long-distance trucking is now in the truckload sector. In LTL service shippers send out smaller quantities, and so the freight is brought to terminals where it is grouped together into volumes sufficient to fill a truck (i.e., freight from different shippers is assembled together), which then travels to another terminal where the freight is unloaded and sent off to its multiple destinations.

There are many other important sectors in trucking as well. The parcel and package delivery services, such as UPS and FedEx, are massive presences that operate trucks within their larger, global operations. (To some extent they compete with LTL firms, as there is overlap in the services they provide.) There are numerous other specialized types of trucking serving all sorts of purposes, such as tank trucking, refrigerated trucking, flatbed trucking, household movers, hauling of new automobiles, transport of hazardous materials, hauling of heavy or oversize cargoes, transport of livestock, etc. In addition of course there is drayage, which has grown to be one of the larger sectors. The drayage of global containers is a specialized sector unto itself, while the drayage of domestic containers is related to the truckload business, and is carried out by the largest truckload firms, by railroad companies, and by intermodal marketing companies (IMCs). Both of these types of drayage will be described in more detail later in this chapter.

One key modification to the domestic trucking system, made necessary by containerization, was the creation of the trailer chassis that is an integral part of a tractor-trailer combination hauling a container. The trailer chassis connects to the tractor as though it were a trailer, and serves to hold the container in place. Similar to a flatbed trailer, it differs in being specifically designed around the container, with fittings at the appropriate locations to allow for connection by twistlock to the container's corner castings. (Containers do occasionally move on flatbed trailers, but this requires cumbersome methods to tie them down and hold them in place—neither the container nor the flatbed trailer is designed for this.) There are various more technical terms sometimes used for trailer chassis, such as container skeletal semi-trailer, container skeletal carrier, container skeleton chassis, etc. The word "skeletal" or "skeleton" is indeed applicable, as these trailers do not offer a solid flat surface but rather a sort of steel lattice (lighter and hence more efficient than a flatbed trailer) that supports the container and holds it in place.

Mundane object though it is the trailer chassis has a crucial role to play, as it allows the global system of containerization to work in the particular context of American trucking. As with the specialized railcars designed to hold containers on trains (described in both chapters on the railroads), the trailer chassis helps the container insert itself smoothly into the existing American

[3] Belzer, *Sweatshops on Wheels*, pp. 39-44.

truck and road infrastructure. The chassis acts as a key interface between these two infrastructures, the global and national. On the one hand the chassis is designed to carry and securely hold the container, a globally standardized object carrying goods on their worldwide trajectories of movement. It is of the appropriate size to hold this giant object, and has the necessary fittings and attachments. On the other hand the chassis is designed to work in the American road system, to function properly in that infrastructure from a physical and regulatory viewpoint. Like a typical American trailer it has a total of eight wheels on two axles, and the design of its fifth wheel and kingpin fitting allows it to attach in the usual fashion to a standard truck tractor—the same tractor normally used for a full-sized tractor-trailer.

In chapter 6 the trailer chassis is briefly discussed as a necessary part of the development of containerized trucking. For the sake of a clear and full description, rather than splitting the topic into two different points in the text, the full evolution of the trailer chassis is described here, even though it extends back into the timespan covered in chapter 6. From the 1950s into the early 1970s a wide variety of containers were in use, as ISO standardization was not reached until the late 1960s and then took some time to take hold. Consequently specific trailer chassis were designed for each type of container, meaning that in practice a different chassis was usually required for the container of each shipping line, railroad or other provider. So truckers working with Sea-Land had to use one type of trailer chassis, while truckers handling Southern Railway containers used a different chassis, and so forth. The most obvious reason for the differences was that these containers were of varying sizes, but there were also discrepancies in the fittings and methods of attachment. Each shipping line or railroad typically provided the necessary trailer chassis to the trucking company with which it contracted to move containers. Sometimes flatbed trailers were used, but this was awkward and caused particular problems in the attachments needed to hold the container in place. Using a flatbed trailer could also lead to vertical clearance issues, as will be discussed shortly. A writer in 1970 states that the preference was definitely for using trailer chassis, though he grants that "unfortunately there are times when there is a shortage of equipment, temporary or otherwise, and the containers are placed on flatbed trucks, for moving about."[4] The trailer chassis evolved into a skeletal sort of design very quickly. This is evident in early photographs, and also in a 1961 conference paper by E. B. Ogden of Consolidated Freightways in which he mentions that both his company and the truckers working with Matson were using "skeleton chassis" trailers to haul containers.[5]

A book published in 1970, Herman D. Tabak's *Cargo Containers*, gives an overview of the trailer chassis in use at the time. Bogies are only mentioned briefly, showing that few if any container systems other than Flexi-Van used that method.[6] The chassis described and illustrated

[4] Herman D. Tabak, *Cargo Containers: Their Storage, Handling and Movement* (Cambridge, MD: Cornell Maritime Press, 1970), p. 115.
[5] E. B. Ogden, "What the Operator Wants in Containers," Society of Automotive Engineers, New York, 1961 (1961 SAE International Congress and Exposition of Automotive Engineering, Detroit, MI, January 9-13, 1961), p. 2.
[6] Tabak, *Cargo Containers*, p. 109.

are all of the skeletal type. The author presents several variations in chassis design, but they boil down essentially to two types, which he refers to as "parallel-frame" and "perimeter-frame." (These terms do not seem to have become common, as they are not seen elsewhere.) The parallel-frame chassis features a pair of beams running the length of the chassis between the wheels (i.e., fairly close to the middle) with small outrigger beams extending to the edges. The perimeter-frame chassis has beams that span the entire perimeter of the chassis, along with some beams running across. While the perimeter-frame design has some structural advantages, it is more expensive. It also holds the container higher up, both because it makes a gooseneck feature (to be described shortly) impossible and because the perimeter beams occupy space above the wheels, forcing the container to be raised further. The parallel-frame chassis allows the container to be held lower down, closer to the wheels, and furthermore makes possible the gooseneck design. The author points out that (as of 1970) the parallel-frame chassis was becoming the more widely-used design.[7] On the other hand, in 1973 another writer shows an example of what he terms a "typical" American trailer chassis that appears to be perimeter-frame.[8] By the late 1980s however this was assuredly not the case, as a report on chassis strength and testing in 1987 shows trailer chassis designs that are all parallel-frame, though some have the gooseneck feature and some do not.[9]

The gooseneck feature of the trailer chassis is a subtle yet important aspect of how American trucking accommodates the container, for it makes it possible to hold a container a few inches lower, allowing it to fit within vertical road clearances. It accomplishes this by dropping to a lower position once it is a few feet behind its connection at the fifth wheel to the tractor. At this point the tractor is no longer a physical obstacle, and so the frame of the trailer chassis can be slightly lower, though it still must be high enough that the container when held in position is above the wheels. For this to be workable it is crucial the trailer chassis be of parallel-frame design, so that—as already noted—the container can be as close as possible to the wheels, with no element of the chassis frame in between to force it slightly higher. The short perpendicular outrigger beams are positioned before and after the wheels, so they do not interfere either.

Where this gets very tricky is at the front of the trailer chassis, where it attaches to the tractor via the fifth wheel mechanism and kingpin, for the container is held so low that there is seemingly no space for the chassis itself between the fifth wheel and the container. At this point the chassis somehow must hold the container in place without actually being below it, yet the chassis needs to be present here because it must make the connection via the kingpin to the tractor's fifth wheel. (The way a standard tractor and trailer connect, through the fifth wheel and kingpin, is described in chapter 6.) This seemingly impossible task is made possible by a special feature of the container's design, a small recess or niche called the "tunnel" or "gooseneck tunnel" in the bottom of the container within which the chassis' gooseneck fits. The tunnel is a subtle adjustment to the otherwise simple rectangularity of the container, an indentation three or

---

[7] Ibid., pp. 109-117.
[8] Eric Rath, *Container Systems* (New York: John Wiley & Sons, 1973), p. 270.
[9] American Bureau of Shipping, *Marine Container Chassis Test Report* (pamphlet), 1987, p. 2.

four inches deep in the bottom of the container that requires some extra structural reinforcing around it but does not alter the floor level of the container's interior. (So strictly speaking it is not a tunnel at all, but a recess or indentation.) It is about three feet wide, and begins at one end of the container and extends roughly eight feet down the middle of the container (i.e., running parallel to the container's length). A container has just one tunnel, which is located at the opposite end from the container doors. (As the doors of course need to be at the rear when a container is on a chassis, for loading and unloading, the tunnel naturally is at the other end, where the chassis meets the tractor.) The tunnel has become a standard feature of both global and domestic containers. 20′ containers typically do not have a tunnel, however, as they can be placed farther back on a trailer chassis so they are behind rather than above the fifth wheel and kingpin. In addition 20′ containers are usually 8′-6″ high—they rarely come in the high-cube variant—and so vertical clearance is no longer an issue for them anyway.

Figure 8.1: Trailer chassis with gooseneck

Source: Chassis King website. (http://www.chassisking.com/products/40-foot-container-chassis/40-foot-tri-axle-container-chassis/, accessed 12/15/12)

While these spatial details are complex—and hard to visualize from a written explanation—the key point to realize is that the gooseneck/tunnel setup allows the container to rest a few inches lower than would otherwise be possible. (An additional advantage of the gooseneck and tunnel is that together they keep the container more firmly in place.) Though a few inches might seem trivial, it is enough to make a key difference in terms of vertical clearance. In the early days of containerization, when a 13′ clearance was the norm for American roads, it was generally acknowledged that it was only advisable to use an 8′-6″-high container if it were carried by such a gooseneck and tunnel arrangement when moving by truck.[10] Similar doubts existed in some other nations. Largely due to such issues, the original ASA and then ISO standard for container height was set at 8′ rather than 8′-6″. But since many in the transportation industry were determined to maximize the volume of their containers, the 8′-6″ height eventually triumphed, and that in turn made use of the gooseneck and tunnel necessary.

Today the parallel-frame trailer chassis with the gooseneck feature is universally used in the transport of containers by American trucking. The typical clearance for roads has been 14′ instead of 13′ for the past few decades (as explained in chapter 6) and hence the gooseneck/tunnel arrangement is no longer needed for an 8′-6″ high container. Nevertheless it is still used, doubtless in part since the system has become so entrenched, but mainly because it is necessary for high-cube containers, which with a 9′-6″ height precisely counterbalance the additional foot of clearance gained by the change from 13′ to 14′. The gooseneck is also used for domestic containers, which are 9′-6″ high too and likewise have the tunnel in their undersides. So in the U.S. (and Canada) the gooseneck/tunnel scheme is a key aspect of how the domestic trucking system accommodates the shipping container. (In many other nations the vertical road clearance is more generous, or else the fifth wheel connection is made at a lower point, and so containers are carried on a more simple flat skeletal trailer chassis without the gooseneck feature. But of course the container still has the tunnel in it—virtually all global containers today do.)

During the 1980s and '90s the design of trailer chassis grew more uniform and also more sophisticated. One innovation that applied not to the trailer chassis itself but the way it is handled was the introduction in the 1980s of a machine, known as a "flipper," that can rotate chassis so as to store them vertically in racks. (Chassis are also sometimes stacked horizontally, in another kind of rack.) Given the large amount of space otherwise needed for the numerous trailer chassis that must be held in availability, the practice saves valuable space at ports and intermodal terminals.[11] Another concept that took hold was the slider trailer chassis (sometimes known as a "sliding chassis," "extendable chassis," or "telescoping chassis"), which possesses a sliding mechanism that allows the chassis length to vary so it can carry containers of different lengths. This forestalls the need for having trailer chassis of multiple sizes on hand. Once the ISO container standards were in place the logic of a slider chassis was evident, as both 20′ and 40′ global containers possess the same fittings for attachment and so it is possible for a chassis to carry either one if only the divergence in length can be solved. Admittedly there are drawbacks, as the sliding device is cumbersome, adds weight, and takes time to adjust. One of the first

---

[10] Leslie Harlander, Interview by Arthur Donovan and Andrew Gibson, Containerization Oral History Collection 1995-1998, Archives Center, National Museum of American History, June 19, 1997, p. 17; Marc Levinson, *The Box: How the Shipping Container Made the World Smaller and the World Economy Bigger* (Princeton, NJ: Princeton University Press, 2006), pp. 131-133; Tabak, *Cargo Containers,* p. 111.

[11] David R. McKenzie, Mark C. North, and Daniel S. Smith, *Intermodal Transportation – The Whole Story* (Omaha, NE: Simmons-Boardman Books, 1989), p. 221; David J. DeBoer, *Piggyback and Containers: A History of Rail Intermodal on America's Steel Highway* (San Marino, CA: Golden West Books, 1992), p. 97.

examples—perhaps the first—of a slider chassis was introduced in 1984 by X-Ten Corporation, and was designed to carry any container between 20′ and 48′ in length.[12]

Over the 1980s and '90s several other slider chassis designs were introduced, and their use became widespread. Evidently their advantages are at least to some degree outweighed by their drawbacks, however, for while slider chassis are sometimes used the more common practice currently is to stick with chassis specific to one length. It should also be noted that it is not unusual to carry a 20′ container on a trailer chassis mainly designed for a 40′ container—the appearance is awkward as the container only takes up half of the chassis, but the extra fittings (i.e., to receive the corner castings at additional points) are in place on the chassis to do so. For domestic 53′ containers entirely different and longer trailer chassis are used than for global containers, and there have not been any efforts to create a slider chassis that can hold both, or to design a domestic chassis that could also hold the smaller global container. Perhaps this is because the two businesses, of global container movement and domestic container movement, are almost entirely separate anyway in the trucking industry. So a trucking company hauling domestic containers has little interest in gaining the flexibility to also haul global containers with the same equipment, and vice-versa.

Aside from getting under clearances, another advantage of holding the container in a low position is to put its floor at or near the level of most loading docks. In the U.S. the typical height of a loading dock is between 48 and 52 inches, with 48″ most common. This dimension obviously is tied to the interior floor height (i.e., the flooring on which the cargo rests) of a typical truck or trailer, for convenience in loading and unloading. (Smaller trucks and vans for local use have lower floors, adding an additional level of complication if the loading dock serves such vehicles as well.) Since containers on chassis are often brought to loading docks, it is ideal if they too fit into this aspect of the spatial regime of the trucking infrastructure. (As a loading dock is part of an actual building, this is perhaps the only point in this dissertation relevant to what is traditionally considered "architecture.") Therefore the height of the container floor, when the container rests on a trailer chassis, should be between 48″ and 52″.

The issue was recognized early on, for Tabak writing in 1970 states that: "The usual dock heights for highway trailers is 52″. In using a tunnel-type container with a gooseneck chassis this same height is maintained. With the flat-frame chassis and the flat-bottom container the height is increased about 6″, with resultant awkwardness of handling during loading and unloading."[13] Another author claims that the height of truck floors (which he puts at 48″) goes back to the days of the railroad, when boxcar floors were at this height and trucks sometimes received goods transferred directly from boxcars.[14] This notion seems unlikely, though not entirely implausible. Such accounts suggest the intricacies of how these spatial regimes are interwoven through gradually evolving practices and standards. Given that the top of an 8′-6″ high container should

[12] *Fleet Owner*, "Telescoping Container Trailer," Vol. 79, No. 3 (March 1984), p. 56.
[13] Tabak, *Cargo Containers*, p. 111.
[14] John R. Stilgoe, *Train Time: Railroads and the Imminent Reshaping of the United States Landscape* (Charlottesville, VA: University of Virginia Press, 2007), p. 220.

be about 12'-6" off the ground to keep a six-inch buffer below the previous standard 13' clearance (and the top of a 9'-6" high container must be about 13'-6" off the ground to maintain this six-inch buffer below the current standard 14' clearance), this means the bottom of the container is four feet above the ground. Thus the container's interior floor, about six inches higher, will be roughly 54" high, and therefore lines up fairly well with a 52" loading dock, and is at least in the vicinity of a 48" loading dock.

The challenges that arise when containers are carried on trailer chassis in the U.S. are not only spatial and dimensional, for weight also is a problem. The regulations that govern truck weight on American roads are complex (as they vary depending on the number of wheels and their positioning), but the bottom line is that the maximum legal weight for the cargo of a 40' container moving on a standard trailer chassis is about 44,000 pounds. Given that a 40' container is structurally certified to hold up to roughly 60,000 pounds, the potential for problems is evident. The container may be loaded to a legal weight in its own right (though even that is not always the case), but when moving by truck the overall weight of the tractor, trailer chassis, container and cargo, combined with the way all this is distributed on the wheels, violates the law. The problem does not arise with most types of cargo, as goods like electronics or clothing fill the volume of the container well before they approach such a substantial weight, but for denser cargo (paper products, ceramic tiles, resins, coffee, etc.) it is frequently an issue.[15] (For the railroads this is usually not a concern, as they can accommodate heavier cargoes.) A government study in the late 1980s found that about one-third of all containers passing through U.S. ports were too heavy to be legally hauled over the road, even though nearly all of them did move by truck for some segment of their journey.[16]

Such overweight containers cause greater wear and tear on roadways, and on the trailer chassis as well, and make for more hazardous driving conditions and a greater likelihood of accidents. The issue is not limited to trucks carrying containers; truck weights can be a problem for normal tractor-trailers moving within the U.S., and the system of weigh stations exists to control this. But while a trailer like a container hides the nature of its cargo, at least with a normal trailer the freight is loaded and unloaded at points within the U.S., where it can be seen. The contents of imported global containers have been loaded in another country, making knowledge or verification more difficult. Compounding the problem is the wide range of rules for road weights in other nations, and their sometimes erratic enforcement; a weight that is illegal in the U.S. might be legal (or commonly allowed in practice) elsewhere. Many European countries, for example, permit heavier trucks than the U.S. Furthermore, it is not easy for foreign shippers to be

---

[15] Transportation Research Board (National Research Council), *Intermodal Marine Container Transportation, Impediments and Opportunities* [special report 236], Washington, D.C., 1992, pp. 84-94; Yehuda Hayuth, "The Overweight Container Problem and International Intermodal Transportation," *Transportation Journal*, Vol. 34, No. 2 (Winter 1994), pp. 18-24.

[16] Transportation Research Board, *Intermodal Marine Container Transportation, Impediments and Opportunities*, pp. 84-85.

cognizant of the regulations in every nation their containers might go.[17] The very seamlessness of container movement, such an advantage at the global scale, becomes problematic at the national level.

Another contributing factor is that nearly everyone has an incentive to cheat; shippers and forwarders want to make money by loading their containers as fully as possible so they skirt the rules, while shipping lines do not wish to lose customers so they fail to hold the line. Ports often prefer to turn a blind eye as well, or else they lobby their state governments for higher weight limits on the roads leading to the port. Enforcement is typically lax in any case.[18] Aside from regulators and government officials, the excessive weights are of most concern to drayage operators, who feel greatly pressured to accept overloaded containers. Drivers worry about the fines and punishments they may face, issues of liability, wear and tear on their equipment, and dangers on the road. Consequently over the years much of the debate over container weights has come from them. In the mid-1980s it first became a major issue when drayage firms and drivers in both the Los Angeles and New York/New Jersey regions vigorously raised their concerns.[19] The aforementioned study of the late 1980s further publicized the problem, and since then the topic has been constantly discussed and debated. The Intermodal Safe Container Act, which was passed in 1992 and finally took effect in 1997 after various delays and modifications, sought to improve the situation, but the basic quandary remains. Illegal container weights remain a constant concern in the shipping industry, especially for regulators, and a source of frequent complaints among drayage truckers. The divergence between the standards and practices of the global infrastructure and conditions in a particular nation cannot be easily resolved.

The availability of trailer chassis, provided by the shipping lines, was important in encouraging trucking firms to get on board with containerization. By the late 1970s trucks were hauling containers all over the country, as container movement extended further beyond ports and deeper inland. In addition the ISO's container standardization had been largely achieved not just in theory but in practice by this time (except for a few holdouts), and that made it easier to move containers in the trucking network. No longer was it necessary to have the appropriate trailer chassis on hand for each company's container. The standardization of containers made a whole host of procedures simpler and allowed for consistency of equipment also; if a container had to be transferred between truck and train, the crane or other device for the job was designed for (and only for) ISO containers. Most important of all, there was a growing number of containers that needed to move overland within the domestic American territory, and a lack of large-scale competition from the railroads for this traffic. But gradually the railroad companies grew interested in the container business, and in the 1980s they emerged as serious participants

---

[17] Transportation Research Board, *Intermodal Marine Container Transportation, Impediments and Opportunities*, pp. 89-91; Hayuth, "The Overweight Container Problem and International Intermodal Transportation," p. 22.

[18] Transportation Research Board, *Intermodal Marine Container Transportation, Impediments and Opportunities*, pp. 91-94.

[19] Ibid., pp. 86-87.

in long-distance container movement, largely due to the efficiencies of stacktrains. The trend has continued since, and hence today most lengthy overland container journeys are done primarily by rail, with truckers fitting into this system by handling the pickup and delivery of containers, trips that are local or regional in nature. The long-distance movement of containers by trucking has certainly not been eliminated, but it is now relatively uncommon in comparison to the great quantity carried by train.

This does not mean trucking's role has become trivial. On the contrary it occupies a vital place in the container network, as only by truck can most containers be picked up at their origin or delivered to their destination. Despite the success of the railroads in recent decades the American transport network is still obviously oriented mainly to the motor vehicle, and this certainly applies to freight transportation as well. Factories, warehouses and distribution centers are typically only accessible by truck. This pickup and delivery is also the most labor-intensive part of the container's journey, as each truck requires its own driver and the actual loading or unloading of a container takes some time and usually involves other workers also. The container remains an object fundamentally designed around the needs of trucking—particularly in its spatial dimensions—and the truck remains the most indispensable transport mode for its movement. For those containers that do not go far inland but remain within a few hundred miles of the port, trucks typically handle the entire trip since the railroads are only more efficient for long distances (generally above 500 miles). In addition, the transfer from ship to train often is not made within the confines of the port, and so many trucks carry containers on local journeys between a port and nearby rail terminal. In the Chicago area trucks even do a substantial business hauling containers between the different rail terminals.

While the terms "pickup" and "delivery" imply trips that are short, this is not invariably the case. The railroad lines have set up giant new intermodal terminals that serve large regions, and so a truck may travel a substantial distance to deliver or pick up a container. (The development of the intermodal terminals, where containers are transferred between train and truck, is described in chapter 9.) Many containers departing from or arriving in the Detroit area, for example, are actually transferred to or from trains in the Chicago area, with the 300-mile trip between Detroit and Chicago handled by truck. Such hauls of a few hundred miles to and from rail terminals are common, and give the trucking companies plenty of business.

The term "drayage" is widely used in the trucking industry to refer to the movement of containers by truck. The word has a historical derivation, formerly referring to the short journeys made by horse-drawn carts called drays to connect rail depots or ports with local customers. But usage of the term varies. Some regard all container movements by truck as drayage. Others distinguish between short local journeys and long-distance line-hauls, defining only the former as drayage; this way of thinking retains the basic concept of drayage as a local trip involving the pickup or delivery of goods that is a small segment of a longer journey. But even when this distinction is made, it is unclear what the cut-off point is between local drayage and long-distance trucking—it could be a distance of anywhere between 50 miles and 200 miles.[20] At present it seems slightly more prevalent to use the term drayage to refer to any container journey by truck, no matter what the distance, and the dissertation follows this usage. It is often assumed, however, that a drayage trip is relatively short—the word carries this implication.

The trucking of global containers the short distance between ports and their associated intermodal terminals, distribution centers, cross-docking facilities and warehouses has become a distinctive part of the container trucking business, especially at major ports. Often it is called "port drayage" or "harbor drayage." This industry has gained a reputation for its exploitative nature, paying lower wages than is usual and with its drivers suffering under onerous conditions and struggling to get by. Drivers (or the firms that employ them) can generally only afford the oldest and most polluting trucks. Port drayage in Southern California, serving the massive ports of Los Angeles and Long Beach, is a particular focus of attention due to its polluting impact, contribution to congestion on local highways, and poor working conditions. Programs over the past decade or so have been put in place at these two ports to cut down on the pollution caused by a number of sources, including drayage, and to incrementally improve the conditions of drivers. These were achieved through heavy pressure, including lawsuits, from environmental and labor activists, with local communities (which receive the brunt of the pollution's impact) playing a prominent role.[21] Several other American ports have pursued similar, though more modest, efforts to reduce pollution. The traffic caused by trucks hauling containers has also been wrestled with, though efforts to expand highways for this purpose generally meet with little success. Limitations in government funding at all levels, and vociferous opposition from neighborhoods already suffering under excessive traffic that is both noisy and polluting, tend to limit the expansion of the roads and highways serving the ports. This is all to the advantage of the railroads, seen as a less negative presence, and so traffic congestion at ports has been a motivating force to create better and closer rail connections to them.[22]

The dynamics of port drayage, with the short journey distances, fairly simple and inexpensive nature of the operation, limited educational and/or training requirements for drivers, and wide-open field of competition, make it a business sector with few barriers to entry. This results in relentless competition and negligible profit margins. The business is handled by many small firms that in turn contract with the drivers, who are classified as individual owner-operators while the firms endeavor to keep physical assets off their books. As a book on logistics and labor comments, "everyone in the transportation industry surrounding the ports recognizes

---

[20] Ibid., p. 48.

[21] Joan Fitzgerald, *Emerald Cities: Urban Sustainability and Economic Development* (Oxford: Oxford University Press, 2010), pp. 151-156; National Cooperative Freight Research Program, *Truck Drayage Productivity Guide* [NCFRP Report 11], Washington, D.C.: Transportation Research Board (The National Academies), p. 3; Wade Graham, "Dark Side of the New Economy," *On Earth*, Spring 2007, pp. 14-21.

[22] Transportation Research Board (The National Academies), *Landside Access to U.S. Ports* [special report 238], Washington, D.C., 1993, pp. 47-65.

that the port truckers are at the bottom of the food chain."[23] Drivers come and go quickly, often leaving in frustration or disappointment. Another reason drivers leave is because port drayage can be a stepping stone for them, as within six to twelve months they are likely to have a shot at working in a better sector of the trucking business, for superior pay and working conditions.[24] Paradoxically, the situation can actually get worse when business is bustling, as slower delivery times and a larger workload make it even harder for drivers to break even.

Perhaps it is no coincidence that in American trucking the sector most tied to global trade, the business of drayage at ports, has been the one notorious for low wages, harsh working conditions, and a complete lack of unionization. While it may be hard to show a direct connection, it seems intuitive to link the bad conditions of port drayage truckers to the globalization they are participating in. Drayage is one of the few remaining points in American containerized movement where the work is labor-intensive. The general trend underlying container use has been to replace labor with capital and technology, as cranes, stacktrains, container ships, straddle carriers and a variety of other devices help keep employment to a minimum (and occasionally lead to high wages for the fortunate few who remain employed, as with skilled crane operators and some unionized West Coast longshoremen). The destruction of working-class jobs along the docks is integral to the story of containerization—it is part of the container's original purpose—but one can perceive a similar dynamic in other aspects of container transport. Stacktrains holding up to 200 or more containers, for instance, are operated by just a few railroad employees. Container ships that hold thousands of containers are even more efficient in minimizing labor per container. No such labor-saving efficiency is possible in drayage—each truck, and hence each container moving by truck, requires a driver. It is the one segment of the chain of container movement that is labor intensive.

The ongoing struggles and issues related to port drayage serve as a reminder that the particular qualities of metropolitan areas and regions have continuing relevance. As the worldwide system of container movement passes through, these places do not function as flattened locales that exert no friction against a global matrix—on the contrary their own qualities are important. In turn, the particular characteristics of the global infrastructure are important in terms of how they impact various localities, as the seamless nature of container movement does not mean its impact is insignificant. The competition between ports is increasingly based not only on the efficiency and quality of the ports themselves, but on their transport connections with their hinterlands and indeed the entire nation. Yet it is not merely a question of their infrastructures, but other factors too. For example, the large immigrant community of a region like Southern California represents a source of cheap labor easily exploited in port drayage. The global and the local constantly impact each other, through their varying characteristics and particular powers, and despite its local nature drayage can play an active role in the formation and character of

---

[23] Edna Bonacich and Jake B. Wilson, *Getting the Goods: Ports, Labor, and the Logistics Revolution* (Ithaca, NY: Cornell University Press, 2008), p. 106.
[24] Mindy Long, "Carriers Say Port Drayage Operations Vex Drivers," *Transport Topics,* Iss. 3603 (August 30, 2004), p. 30.

global supply chains. As a recent government report on port drayage points out, "despite their local orientation, drayage operations are nevertheless a component of a much longer international supply chain."[25]

In the past few years the problems of port drayage have gained greater recognition, and some efforts have been made to improve it. Some of the larger drayage companies have expanded to cover multiple ports, or bought out smaller competitors, in an effort to offer a more uniform service. Roadlink, currently the largest of the independent drayage firms, has grown in this manner and now spans the U.S. and Canada with drayage and warehousing services.[26] In addition some very large players in the business have purchased drayage companies, presumably in order to assure better control over the movement of their own containers—after all, a chain is no stronger than its weakest link. Since the early 1980s Maersk has had a subsidiary, Bridge Terminal Transport, that is the largest drayage provider in the U.S., and which contracts with other customers in addition to Maersk. In 2006 Hub Group, one of the largest intermodal marketing companies (IMCs) that manage the movement of domestic containers, bought out the major drayage firm Comtrak.[27] In spite of such adjustments, though, most drayage is still done by small or medium-size companies that specialize solely in that business.

In recent years some trucking companies, especially larger ones, have chosen to engage in several different sectors of the trucking business, rather than concentrating on one specialty as was usually the case previously. Some have branched out into warehousing and cross-docking also, as they try to attain a higher degree of vertical integration so as to handle a larger portion of the supply chain. The business of taking care of all aspects of transportation and storage, essentially handling an entire supply chain (whether at the domestic scale or globally), is known as third-party logistics, or 3PL for short, and has grown since the 1980s. Quite a few manufacturing and retail companies have abandoned their in-house transportation units and contracted the business to 3PL providers. In recent years some 3PLs have expanded into trucking—and some trucking firms have expanded into the 3PL business.[28] The trucking, logistics and warehouse company NFI (best known for trucking, originally its sole business) served as an example of these practices in a recent article in a trade journal. The article describes how a container of olive oil bottles was drayed by NFI from Newark to an intermodal terminal in New Jersey, then sent by a railroad that contracted with NFI to Chicago, where NFI again drayed it to a nearby distribution center also run by NFI, at which point the olive oil was unloaded from the

---

[25] National Cooperative Freight Research Program, *Truck Drayage Productivity Guide*, p. 3.

[26] Eric Kulisch, "RoadLink Snaps Up Drayage Firms," *American Shipper,* Vol. 50, Iss. 8 (August 2008), pp. 63-66.

[27] Satish Jindel, "Growing Imports Put More Containers Into the Transport Network," *World Trade*, Vol. 19, Iss. 12 (December 2006), p. 68.

[28] Deborah Lockridge, "The Changing Face of Trucking, Part 3: The Rise of Third-Party Logistics," *Truckinginfo ("the web site of* Heavy Duty Trucking *magazine"),* September 20, 2010. (http://www.truckinginfo.com/operations/news-detail.asp?news_id=71892&news_category_id=73, accessed 12/14/11)

container and stored, then gradually taken as needed by NFI trucks to retailers within 250 miles.[29] While this account may well have been cherry-picked to provide an idealized version of such operations, it nevertheless illustrates how extensive the activities of some truckers can be, beyond simply hauling containers from point A to B. 3PL firms do not always directly handle the entire movement of freight, however; sometimes they contract with local or regional trucking companies to do so. These local or regional truckers can thus tend to their own specialties, at their own scale of operations, even as they participate in global supply chains. The reverse can also happen—a local, regional or national trucking company charged with handling a global shipment might contract with a 3PL to take care of the bulk of the journey.[30]

Figure 8.2: 40' container moving by truck

Source: Flickriver [So Cal Metro] (http://www.flickriver.com/photos/southerncalifornian/48724692/, accessed 12/15/12)

One highly specialized type of container trucking consists of the movement of containers inside a port terminal. Specialized tractor-trailer trucks are used to move containers around the extensive port facilities, including taking them to and from the dock's edge where cranes move the containers between the trucks and the massive ships. These trucks also bring containers to and from the storage areas in the terminal, where the containers are stacked up. If there is an intermodal rail terminal within the boundaries of the port facility, then the trucks provide access

[29] Deborah Lockridge, "The Changing Supply Chain: It Takes More Than Trucks," *Heavy Duty Trucking*, Vol. 90, Iss. 8 (August 2011), pp. 57-62.
[30] Lockridge, "The Changing Face of Trucking, Part 3."

to it. Since it does not move over public roads but only inside the port, such a truck does not need the container to be firmly attached to it—it is simply placed on the chassis, which does not possess connections for twistlocks but rather has raised edges to prevent the container from sliding off. That is regarded as sufficiently safe, as the trucks move relatively slowly and the port is a controlled space outside the public realm. The truck's tractor differs from that of a typical truck tractor, being smaller with seating for only one person. As should be evident from this description, a container is not transferred directly from the ship to the normal truck that will actually take it to its inland destination, nor is a container arriving at the port by normal truck brought all the way to the ship by that same truck; such procedures would be impractical for various reasons, the main one being the impossibility of getting the timing right. Rather, containers going in either direction are held for a time at the port, with the specialized trucks shuttling them about. (There are devices known as straddle carriers that also move containers at ports—these have the advantage that they can stack containers also.) Since these trucks only move around inside the port they constitute part of the internal workings of the port facility itself, and for the purposes of this dissertation are not viewed as actors in the national domestic infrastructure. Hence their role is only briefly mentioned here.

Over the period from the 1970s to the '90s several key changes were made to trucking's spatial regime in the U.S., with the allowable trailer size gradually expanding to a significant degree. The steady growth in trailer dimensions over the years reflected the spatial affordances offered by the Interstate highways and the suburban landscape of sprawl, along with vigorous lobbying from the trucking industry. Because laws and practices differ from state to state, and the federal regulations are complex and often defer to the states, it is hard to identify exact years when larger trailer sizes took effect. Generally a larger size would be introduced in a few states, gradually take hold in more states, and eventually be instituted on a nationwide basis. Furthermore legalization did not mean instantaneous conversion, as it took a few years for practices to shift and for new trailers to come into use and replace existing ones. In this fashion, 45′-long trailers were introduced in the early 1970s and gradually became the standard over the course of that decade. They gave way to 48′ trailers in the early 1980s, with a crucial federal law (the Surface Transportation Act) passed in 1982 making the 48′ trailer allowable on highways in every state and raising the permissible trailer width from 8′ to 8′-6″. Over the mid- and late 1980s the 53′ trailer entered use in many states, and this became the national standard by the mid-1990s and remains so today.[31]

The maximum allowable overall length of the truck (the tractor plus trailer) is generally 80′ at present, though this varies slightly from state to state. Ever since the late 1960s a 14′ vertical clearance on roads has been typical—as discussed in chapter 6—leading to a standard trailer height of 13′-6″ with a 6″ gap between the top of the vehicle and obstructions above. The giant 53′ trailer currently in widespread use appears to be as long, wide and high as the federal

[31] U.S. Department of Transportation, *Comprehensive Truck Size and Weight Study, Final Report,* August 2000. (http://www.fhwa.dot.gov/reports/tswstudy/TSWfinal.htm, accessed 11/18/11)

government is willing to allow, given that its size has not been expanded since the mid-1990s. (A few states do permit trailers 57′ long. A more controversial practice is to have multiple trailers pulled by one tractor, which is allowed by some states on certain highways.) It would seem anything larger than a 53′ trailer is recognized as beyond the bounds of what is practical and safe given the physical reality—the spatial standards and characteristics—of American highways and roads. (The trucking industry does not see it this way, of course, and incessantly lobbies for bigger trucks and/or trailers, and for the expanded use of multiple trailers.) So the 53′-long trailer, 8′-6″ wide and 13′-6″ high, is a fundamental part of the spatial regime of American trucking at present.

If one follows the usual conception of globalization as making national and global practices more closely aligned, one would expect global container sizes to continue to follow the American trailer template, or else one might anticipate the reverse, that American trailer sizes would meekly follow global container dimensions. Neither came to pass. What happened instead is that the two spatial types after being in harmony for a brief period have increasingly diverged, with the global container remaining the same while the American trailer was steadily enlarged. The expansion of American trailer size has had no impact on the global container, despite the direct causal link that originally held between the two. (The U.S. and some European nations at various times in the 1990s and the 2000s pushed for the ISO to expand the container to a 45′ or 48′ length and an 8′-6″ width, with a distinct lack of success.) Meanwhile the global container, even though its importance has risen so dramatically over the decades, has failed to exert control over the dimensions of the American trailer which has followed its own progression. The global and the national are not locked together into some ever-tightening connection; they mutually influence each other, but also fluctuate on the basis of many other factors. Their interconnections are complex and nuanced, rather than the rigid dynamic one might expect from paradigms of a flat world or neoliberal hegemony.

The growth of domestic containerization since the 1980s, with larger containers that reflect the current American 53′ trailer size, makes the point even more evident. The domestic container network, a system that operates only within the U.S. and Canada (and to some degree Mexico), exploits the bigger dimensions allowable for American trailers. The use of domestic containers clearly reveals the divergence of the global and national spatial regimes. Yet there are additional factors to consider, for the domestic container network is in many ways built on the system that has been put in place to carry global containers in North America; in other words, it is the "globalization" of American infrastructure that helped bring about domestic containerization. Chapter 11 provides a detailed account of the creation and development of the domestic container. But since its existence so clearly derives from the new and larger trailer sizes, a brief description is given here that emphasizes its effect on American trucking.

The container systems introduced by the railroads in the 1920s and again in the 1950s were of course primarily domestic in nature (and are described in chapter 5), but as global containers did not yet exist those systems were not consciously intended as separate domestic networks. The first truly domestic container, it would seem, was a 44′-3″ long design introduced by the

Canadian Pacific Railway in 1979. This had little impact beyond Canadian Pacific's own operations, but eventually in 1985 American President Lines (APL) introduced a domestic container with a 48′ length, 9′-6″ height and 8′-6″ width, and this rapidly became a standard as others followed suit. This in turn was gradually replaced by the current 53′-long domestic container (also 9′-6″ high and 8′-6″ wide), which became the standard over the 1990s. The volumetric advantage of this container in comparison to the global ISO container is significant: two 53′ domestic containers possess roughly the same capacity as three 40′ global containers. Domestic containers have castings to receive twistlocks not only at the corners, but also at the same 40′ points as global containers, so they work with existing cranes and other such devices, and can be attached to global containers. New trailer chassis (and new railcars, too) had to be developed to carry these larger containers. In recent years domestic containerization has caught on so widely that piggyback to a large extent has faded from the scene.

While it was railroads and shipping lines that pioneered domestic containerization, trucking companies quickly moved into the business in the 1990s, led by the three biggest long-haul trucking companies, J.B. Hunt, Schneider National and Swift, all working in the truckload sector. These firms had already established extensive and sophisticated operations across the nation, and saw domestic containerization as a way to introduce greater efficiency to their systems. Whereas in the 1950s the container was often perceived as a means for railroads to take business from trucking, now the truckers realized it could play a role in their own operations; by contracting with a railroad company to cover the bulk of the distance, certain long-distance trips can be made less expensive. (Many drivers also appreciate being able to remain in one area and spend their nights at home, instead of living on the road.) The trucking firm still deals with the customer, organizes the overall journey, and takes care of pickup and delivery. Hence it is the major trucking companies, along with intermodal marketing companies (IMCs), that have become dominant in domestic containerization. (The IMCs, such as Pacer Stacktrain and Hub Group, own few assets but arrange with truckers and railroads to carry cargo in containers for customers.) This is in sharp contrast with the drayage of global containers, in which it is small and relatively weak firms that participate in the business. The key difference seems to be one of control, and ultimately profitability. In domestic containerization the trucking companies coordinate the entire trip and deal with the customers on both ends, while for global containers the truckers are minor and relatively powerless, subservient to larger companies (shipping lines, shippers, logistics providers, etc.) that are controlling the overall movement of goods.

Another consequence of the spatial difference between the global container and American trailer is the practice of transloading, which over the past decade has increased. (This is also discussed at greater length in chapter 11.) Transloading basically consists of the shifting of cargo from global containers either to tractor-trailer trucks or domestic containers, generally at a facility relatively near the port or at least in the same general region. Given that the greatest benefit of the global container is its ability to hold cargo all the way from origin to destination, transloading would appear inefficient. But the larger volumetric capacity of trailers and domestic containers (as already noted, just two domestic containers or trailers have a comparable capacity to three 40′

ISO containers) is sometimes enough to override the advantage of a seamless journey. Transloading also offers an opportunity to redistribute a container's cargo. Consequently in recent years transloading has grown popular, and so some global containers that otherwise would move deep into the domestic territory are instead only going a slight distance and then returning to port.

As the railroad companies increasingly engaged in transporting global containers between ports and inland intermodal terminals in the 1980s, the provision of trailer chassis at these terminals—where they were needed so trucks could haul the containers to their final destinations—was a challenge. This was especially the case since the shipping lines generally supplied the chassis for their own containers, so that even if plenty of chassis were available to carry a container the terminal could only use one belonging to the same line whose container it was. This would seem to negate the whole benefit of standardizing containers in the first place. Clearly such practices were inefficient, and with a pool of trailer chassis available to all—sometimes known as a "neutral" pool—the provision of chassis is less wasteful. In the 1980s the Burlington Northern Railroad was the first railroad to create such a pool, at its Cicero terminal in Chicago. Thus shipping companies could contract with the railroad to carry containers from the West Coast to Chicago without worrying about having to supply chassis in Chicago. The Atchison, Topeka and Santa Fe Railway (commonly known as the "Santa Fe") formed chassis pools at its intermodal terminals in Chicago and Los Angeles soon after, and some other railroads followed suit.[32]

But at ports it has remained, until very recently, standard practice for shipping lines to have possession of the trailer chassis, which they supply to drayage firms. This has been the case ever since the shipping industry, as opposed to the railroads, began to drive containerization in the late 1950s and '60s. In order to persuade American truckers to carry containers instead of using the trailers they preferred, the shipping companies agreed to supply the necessary chassis. Once this became customary it grew entrenched, even though in nearly all other countries the trailer chassis has long been supplied by a forwarder, logistics company, or the trucking firm itself.[33] Shipping lines gradually became discontented with this exceptional American system. A trade journal in 2003 noted that they "once viewed chassis as a marketing tool but now consider them an expensive headache."[34] The headache is particularly painful because the quality of trailer chassis is a constant point of contention between shipping companies and drayage firms; truckers often complain about the condition of the chassis they are provided with—a complaint that is frequently justified. As with the problem of overweight containers, described earlier, drayage truckers feel they lack the leverage to refuse a chassis in poor condition that is dangerous or illegal to use, but must risk the consequences. The question of legal responsibility for such chassis—which typically resides with the truckers—has been much debated. In general the

---

[32] McKenzie, North, and Smith, *Intermodal Transportation – The Whole Story*, pp. 180-184, 221.
[33] Joseph Bonney, "'Make 'Em Pay'," *The Journal of Commerce,* December 22, 2003; Joseph Bonney, "Not in the Cards," *The Journal of Commerce,* May 30, 2005.
[34] Bonney, "'Make 'Em Pay'."

drayage firms have been unable to alter the equation, but they enjoyed a rare victory when a 2002 California law made the provider of the chassis (i.e., not the trucker, but the shipping line or leasing company) responsible for its safe condition.[35]

In 2009 Maersk, the largest of the shipping companies, decided to retreat from owning chassis, and some other lines have since followed suit, triggering debate in the industry and uncertainty among drayage trucking firms. At present there are roughly 650,000 trailer chassis for global containers in the U.S., with about half owned by shipping lines and half by leasing companies that operate chassis pools. The role of these leasing companies—some of which are owned by or have links to shipping lines—is likely to grow as they increasingly supply truckers. Moreover many trucking companies may become more active in providing their own trailer chassis. All in all, this shift looks to be a further burden on drayage providers. While in some respects it is more logical for the trucking firms to take responsibility for the chassis, they would prefer to be adequately paid for it. Given how relentlessly the shipping lines, forwarders and others squeeze the drayage truckers, that is unlikely to be the case. Currently the price of a new trailer chassis is roughly $8,000 and it costs about $11-15 per day to rent one, so while it is not a major expense it can make a difference for a trucker on the edge of breaking even.[36] Consequently most drayage firms for obvious reasons would prefer the shipping lines continue to provide chassis. A few figures in the trucking industry have hypothesized, though, that it would be to their advantage to own the chassis and thus take complete control of the land-based segment of container movement.[37] It is hard to believe that in practice this would really work to the truckers' benefit, however.

In addition to container movement, the "globalization" of U.S. trucking also consists of regular tractor-trailer trucks passing over the nation's land borders. Growing trade with Canada and Mexico, generally not containerized though some of it does travel in domestic containers, has led to an increase in transnational cargo carried by trucks on American roads. In fact the largest trading partner of the U.S. has long been Canada—this remains true today in spite of the immense attention devoted to China—and Mexico is also very significant. In the wake of the 1994 North American Free Trade Agreement (NAFTA) between Canada, Mexico and the U.S. that reduced tariffs and other trade barriers, trucks have flowed more freely over the U.S. border to both the north and south.

The prospect of such traffic was used in the 1990s and 2000s to justify a proposed major highway, Interstate 69, running north-south through the American heartland from the Canadian border in Michigan to the Mexican border in Texas. I-69 already runs from Port Huron, Michigan to Indianapolis, but its enthusiasts envisioned this continuing all the way to southeast Texas. Due to the economic recession, severely limited government funds, and a general reluctance to engage in large-scale infrastructural projects, grand plans for I-69 have been abandoned. A few short

---

[35] Ibid.

[36] Oliver B. Patton, "Who Owns the Chassis?," *Heavy Duty Trucking*, Vol. 90, No. 8 (August 2011), pp. 64-67; National Cooperative Freight Research Program, *Truck Drayage Productivity Guide*, pp. 64-70.

[37] Bonney, "Not in the Cards."

segments were built in Mississippi and Indiana, and an existing parkway in Kentucky was designated part of I-69, but while construction does continue in southwest Indiana for the most part I-69 has been forgotten in the midst of more pressing matters. (The Indiana segment under construction, tying Evansville to Indianapolis, is now conceived as a regional project.) Though unlikely to be realized in the foreseeable future (if ever), I-69 is significant as perhaps the only major new highway of an entirely national scale to be seriously proposed in the past few decades, and as a project emblematic of a transnational agenda. As with any highway project many of its boosters saw it as a generator of growth in particular places, while others perceived it as a vital national connection on a larger scale. But the key additional aspect to I-69 was its transnational purpose, to move freight not just within the national territory but beyond it, so that the space of the nation-state would be a portion of a larger space, a giant territory spanning three nations. Indeed, some early proponents of I-69 labeled it "the NAFTA highway" as a selling point. This exercise in branding soon boomeranged on them, provoking an outraged reaction from Americans resentful of NAFTA and fearful of manufacturing jobs moving south over the border, and so the rhetoric of globalization disappeared from the arguments of I-69 enthusiasts.[38]

Such visions of transnational highways in the Americas are not new—since the 1920s some have promoted a grand Pan-American highway, though to little effect. In fact one of the main boosters of I-69 is the son of a man whose truck manufacturing company participated in early proposals for the Pan-American highway, sending a representative to the Pan-American Congress for Highways of 1925 in Buenos Aires.[39] Less grandiose but more practical ambitions often focus on a specific link between the U.S. and its neighbors, such as the projected new bridge between Detroit and Windsor, Ontario, that will supplement the existing privately-run Ambassador Bridge. Currently the annual flow of goods between Detroit and Windsor, comprising traffic on the current bridge, tunnel and ferries, is approximately $120 billion and represents about 25% of all trade between the two nations.[40] So there is plenty at stake in this particular border connection. The bridge is another example of how major new road-related infrastructure is likely to be global or transnational in nature. Meanwhile to the south Mexican trucks finally were cleared to enter the U.S. in October of 2011, a long-delayed and extremely controversial result of NAFTA. Here the significance of the change is not directly related to the infrastructure, but rather is of a regulatory nature. Nevertheless it is no less important, as it opens the likelihood of large numbers of Mexican trucks coming onto U.S. highways (and vice-versa), making the border in effect more porous and the domestic infrastructure more globalized.[41]

As is evident from these examples, the system of trucking consists not only of the trucks themselves but also the roads they move upon. The two are not as integrally connected as trains

---

[38] Matt Dellinger, *Interstate 69: The Unfinished History of the Last Great American Highway* (New York: Scribner, 2010), pp. 6, 75, 190.
[39] Ibid., p. 18.
[40] Bill Shea, "Canada and Michigan Make It Official: New Bridge Ends 10-Year Effort," *Crain's Detroit Business,* June 15, 2012 (modified June 18, 2012).
[41] Binyamin Appelbaum, "U.S. and Mexico Sign Trucking Deal," *The New York Times,* July 6, 2011.

and tracks, but are still linked and together form a freight infrastructure. Thus the impact of the shipping container on the trucking system is not confined to the trucks themselves, or the business of trucking, but extends to the highways and local roads, now traversed by innumerable containers moving on trucks. Given the massive amount of domestic freight that moves by trucking over the American road system, trucks hauling containers represent a small percentage of this vast network, and their impact is modest in most places. But on roads and highways serving ports the situation is different, and congestion has risen sharply at some of these bottlenecks due to the influx of containerized traffic. Consequently there have been many efforts to improve road access to ports, and in particular to assure good highway connectivity. This ambition goes back to the earliest days of the highways, long before modern containerization; when the Pennsylvania Turnpike was completed in 1940, with the prospect of war in the air, President Roosevelt and turnpike commission chairman Walter Jones were already discussing the possibility of extending it to the Philadelphia Navy Yard, and from there improving the roads to the Brooklyn Navy Yard in addition.[42] Such thinking was relatively rare at the time, however, and it was common for traffic to clog up the roads leading to the docks.

The rise of containerization put an emphasis on better connections at ports, and the new or expanded container ports of the 1950s, '60s and '70s were often located at exurban sites where they would be more directly accessible to highways. It was fortuitous that the Interstate highways were being built at approximately the same time, and the logic of connecting them to important ports—or siting ports near the new highways—was evident. Even at the beginning of Sea-Land's operations in 1956, Newark had the virtue of easy access to the newly built New Jersey Turnpike, a sharp contrast to the insufferable traffic and delays at the docks of Manhattan and Brooklyn. Likewise the port of San Francisco was congested and depended on severely constricted routes, being geographically isolated on its peninsula, while the east side of San Francisco Bay was convenient to the new Interstate highways, and so by the late 1960s Oakland had become the dominant port of the region. (Another reason for the creation of new ports in more distant locations was that containerized operations required far more space, especially given the increase in the total amount of cargo, and most of the old ports in their tight urban settings could not be easily expanded.)

In terms of port access, the Los Angeles region did not fail to live up to its reputation for highway infrastructure. Two key north-south highways connect the ports of Los Angeles and Long Beach with the rest of the highway network: the Long Beach Freeway and the Harbor Freeway, the latter revealing its purpose merely through its name. Each was built primarily in the 1950s and '60s, in large part to provide a connection to the ports, which were shifting to containerization in roughly the same period.[43] The presence of these new links was no minor detail, for an advertisement for the port of Los Angeles in 1966 highlighted the value of such highway access: "From dockside the famous high speed Harbor Freeway moves cargo inland

---

[42] Tom Lewis, *Divided Highways: Building the Interstate Highways, Transforming American Life* (New York: Penguin, 1997), p. 69.
[43] Levinson, *The Box*, p. 192.

over super highways. Eastbound, there's *not even a traffic signal* for 225 miles inland!... Remember, a direct route *is* available." The advertisement's fantastical drawing showed a ship moving along a highway, just to make the point of continuous movement more clear.[44] (This is an interesting counterpoint to a Sea-Land advertisement of about the same time, described in chapter 6, in which trucks were shown moving on an imaginary highway extended over the ocean. Containerization by its nature seems to invite such conceptions and metaphors of transport modes overlapping and passing through each other.) Today the Long Beach Freeway and Harbor Freeway fulfill their intended purpose all too well, as they are frequently overloaded with heavy traffic, much of it tied to the ports of Los Angeles and Long Beach. The Long Beach Freeway suffers in particular from this congestion, but proposals to expand or extend it in the early 2000s predictably ran into a storm of well-justified opposition from local communities and environmentalists, and went nowhere.[45]

For a much longer highway extension to a port in a very different part of the nation, North Carolina, public opinion was more favorable and political willpower stronger. Over the course of the mid- and late 1980s Interstate 40, which previously ended slightly east of Raleigh, was extended southeast about 120 miles all the way to Wilmington on the coast. This was meant to improve access to the southeast corner of the state in general, but better port access was a significant consideration, and it has helped Wilmington grow into a more prominent container port.[46] For shippers in North Carolina the new highway segment cut the cost of trucking to the port by roughly 25%.[47] Recently another port-related highway project in the Southeast has been under debate: a proposed highway in Georgia to connect Savannah with Augusta, possibly continuing all the way to Knoxville, Tennessee. Seemingly quite unnecessary (Savannah is already served by Interstate 95 running north-south and Interstate 16 going northwest to Atlanta), and with very little chance of being realized, the idea nevertheless attracted some interest. Georgia governor Nathan Deal was one of its supporters, and while campaigning in 2010 he argued that "with the deepening of the port of Savannah, we must improve our infrastructure so we can move goods from ships fast and efficiently to other parts of the state and throughout the Southeast."[48]

An important highway or road extension to a port can also be a very short link, where the distance is small but the gain in accessibility and convenience is substantial due to a difficult bottleneck being resolved. Unfortunately such an upgrade may be very expensive. An example

---

[44] *Distribution Age,* Advertisement for the Port of Los Angeles, Vol. 65, No. 1 (January 1966), p. 37.

[45] Steven P. Erie, *Globalizing L.A.: Trade, Infrastructure, and Regional Development* (Stanford, CA: Stanford University Press, 2004), pp. 166-168.

[46] Adam Prince, "To The Shore! - North Carolina's Struggle to Build Interstate 40 to the Atlantic Coast," *Welcome to All Things NC!!,* 2006 (http://www.gribblenation.com/ncpics/history/i40.html, accessed 10/29/11); David T. Hartgen and Michael A. McAdams, *I-40 Economic Impact Study: Impact of Interstate 40 on the Port of Wilmington* [Transportation Publications Report No. 49] (Charlotte, NC: University of North Carolina at Charlotte, October 1991).

[47] Hartgen and McAdams, *I-40 Economic Impact Study*, pp. 37-38.

[48] Larry Peterson, "Deal Likes Part of Proposal for New Interstate; Barnes Wants More Study," *Savannah Morning News,* August 26, 2010.

currently under construction is the Port of Miami Tunnel, a public-private partnership to build a tunnel under water to Miami's port on Dodge Island. The tunnel will supplement the port's existing bridge connection and provide a direct link to Interstate 395 (and via I-395 to I-95 only about a mile west) so trucks hauling containers will no longer need to travel on surface roads in downtown Miami. Thanks to the expansion of the Panama Canal, and dredging work to deepen the port's channel to 50', it is anticipated the port will soon be receiving an increase in containerized cargo. Critics claim the project is unnecessary and too expensive, and question whether the present access situation—actually only a few blocks through downtown—is really so bad. They also argue that the project's budget is likely to balloon beyond the current estimate of roughly one billion dollars.[49] Whatever the arguments for and against the tunnel, the most salient fact is that it (like other recent road and highway linkages to American ports), represents a tremendous effort and expense put forth for the sake of connecting the territory of the nation-state to the rest of the world, rather than binding that domestic territory itself more tightly together.

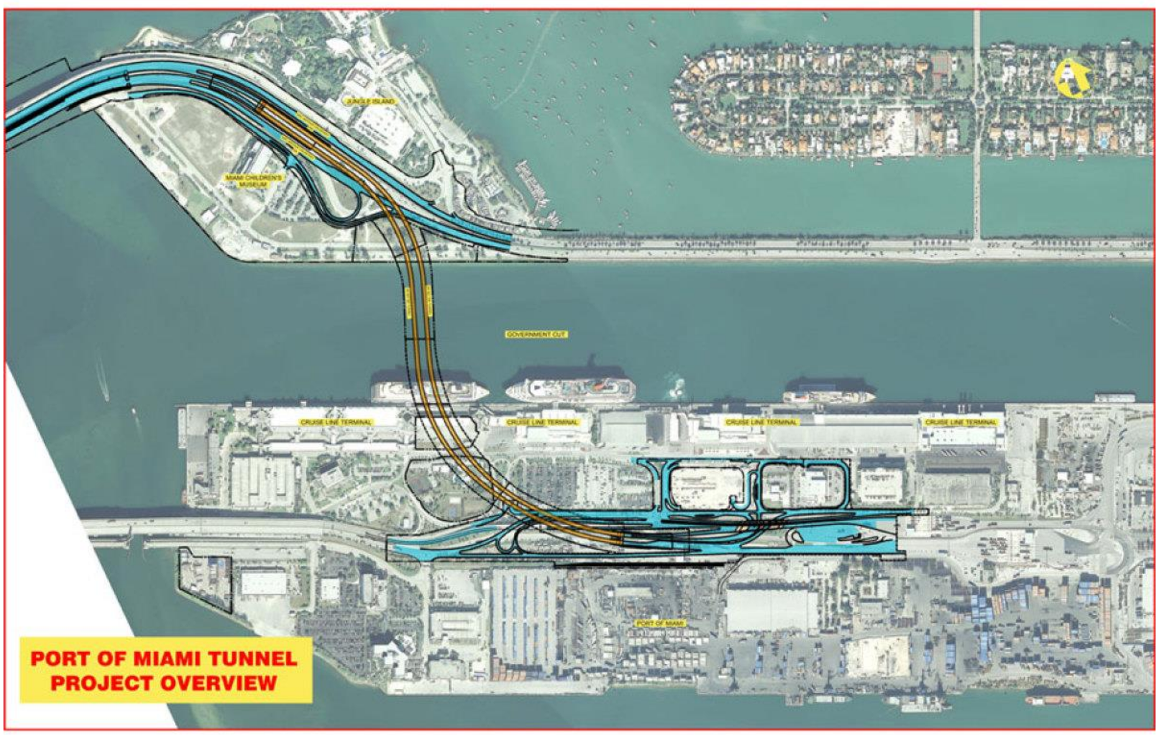

Figure 8.3: Port of Miami Tunnel

Source: *Huffington Post,* "Port Of Miami Tunnel Reaches Halfway Point," August 1, 2012 (http://www.huffingtonpost.com/2012/08/01/port-of-miami-drilling_n_1728059.html, accessed 12/15/12) (Image is #7 in slideshow)

[49] Wikipedia, "Port of Miami Tunnel." (http://en.wikipedia.org/wiki/Port_of_Miami_Tunnel, accessed 11/2/11); *Huffington Post,* "Port Of Miami Tunnel Reaches Halfway Point," August 1, 2012. (http://www.huffingtonpost.com/2012/08/01/port-of-miami-drilling_n_1728059.html, accessed 12/15/12)

Projects like the Miami tunnel substantiate Graham and Marvin's "splintering urbanism" paradigm in some ways. Certainly such projects, and the massive amounts of money spent on them, indicate the strength of the desire to more tightly link American infrastructure into the global flows of containerized freight. But it is difficult to see evidence of a splintering or fracturing of infrastructure in such efforts—while some domestic transport routes are indeed prioritized, the cohesion of the overall network is not threatened. While it may now be "globalized," the U.S. system of highways and roads remains an infrastructure of extraordinary extent and power, tying the entire nation together with great effectiveness. It has not at all been splintered or fragmented. Indeed, the success of the container is tied to such expansive networks; it flourishes by insinuating itself throughout a national territory and infrastructure, not by being limited in any way. Anywhere a truck can go, a container can go.

The alterations to American trucking wrought by the shipping container are not as significant as for the railroads. Where the rise of double-stacking led to a fundamental change in rail's spatial regime, the changes in trucking's spatial regime since the 1950s have transpired for reasons unrelated to the container. The impact of the container has been felt more in the vast quantity of them now hauled on American roads and highways, albeit often for distances that are only at a local or regional scale. The infrastructure essentially holds its character, one steeped in American history, practices and geography, even as the nature of the freight moving upon it changes radically. In this way the container carries out a quiet revolution, one all the more remarkable for being so unobtrusive. As with the railroad companies, it has largely been the trucking firms that have implemented this aspect of globalization, simply by carrying containers. But they have not invested much into it, nor profited greatly from it, being limited to short routes while rail makes the longer journeys and the shipping lines maintain their dominant power. (For domestic containerization the situation is somewhat different.) Some truckers have been able to broaden their activities into more parts of the supply chain, but for the most part in recent decades the trucking industry seems to have been put in its place with regard to containerization, and is rather constrained. Even as trucking moves an enormous number of containers all over the nation, and especially around ports and intermodal terminals, it finds itself changed to only a moderate extent. The preexisting infrastructural network of the nation-state maintains its character and basic qualities.

Chapter 9 ~ Sites of Transfer

Containerization within American infrastructure is not only a process whereby the railroad and trucking systems are altered, adjusted and reconfigured to accommodate the shipping container. Almost as crucial has been the creation and development of intermodal terminals where containers are transferred between these two transport modes. As use of the container typically involves the use of multiple transportation infrastructures, the points of transfer become critical nodes, and are expected to rapidly handle large quantities of freight. This is most evident in the radical changes to port design brought on by containerization—a port representing the most crucial transfer point, between oceanic (shipping) and land-based (trucking or railroad) transportation, that links the foreign and domestic. But the inland facilities for the transfer of containers between truck and train are also essential, and from the viewpoint of domestic infrastructure these facilities are of central importance; they are critical to the proper functioning of a containerized system within the nation-state, and also reveal the impact of globalization upon the national infrastructure. This chapter describes the development of these intermodal terminals over the years, and discusses their role in the American network of container movement. There are a variety of terms used for these sites, which are not traditional rail yards or depots, and no one title has become standard. Perhaps the most common is "intermodal terminal," or simply "terminal," and the dissertation follow this usage. Other phrases often used include "inland port," "intermodal facility," "intermodal yard," "container terminal," and "container yard."

The sites of these intermodal terminals are selected carefully, strategically located where the existing infrastructures intersect, typically at points along railroad main lines and close to highway exits. Furthermore they are usually in metropolitan regions, where a substantial flow of goods and quantity of interchange is assured. While some intermodal terminals are former rail yards that have been converted to this new purpose, and others are provisionally placed at locations with limited space and traffic congestion, the newer terminals are usually on vast greenfield sites about two miles long and half-a-mile wide, on the outer periphery of metropolitan areas. Giant interventions though these may be, it is significant that they are located at intersections of the rail and road systems; just as containerization generally works within those two existing infrastructures, so the new intermodal terminals are sited to exploit those infrastructures as they are currently constituted, rather than fundamentally reshaping them. It would be too difficult to build entirely new highways or railroad lines, and in any case it is not necessary. Here once again, globalization is carried through the working systems already in place, via the preexisting infrastructures. It does impact those infrastructural systems in some novel and unexpected ways, however, and its effects are by no means insignificant.

The intermodal terminals, and the transfers of freight that take place there, hearken back to older practices. During the nineteenth century, freight that moved by railroad was usually carried by wagon or cart on a local basis between the station, depot or spur and the actual origin or destination of the goods. This was known as local cartage or drayage, and in some places specialized carts known as drays were built for the purpose; these were often designed for easy access from the side rather than the rear, since they would be pulled up alongside boxcars for the actual transfer of cargo. (As noted in chapter 8, the term "drayage" has been retained and now applies to the business of moving containers by truck. "Cartage" is occasionally used to refer to trucking in general.) Manufacturers and warehouses sought to be as close as possible to railroad lines, or to have their own spur lines, but nevertheless a substantial amount of local cartage was necessary to serve them. In addition goods had to reach a multitude of businesses and residences scattered throughout cities and towns. So cartage played a key role in moving freight along local roads, in order to link all these users with the railroad depots.

In the late 1910s trucking began to gain use for short deliveries, and during the 1920s trucks, generally operated by small local companies, largely replaced wagons in the cartage business.[1] Initially this did not pose a threat to the railroads at all, and in fact some railroad companies actually joined the "Good Roads" movement and promoted better roads—paved roads in particular—as they perceived that if local traffic moved more easily it would benefit their own business. Trucking was seen as a local component of the movement of cargo dominated by rail, not as a long-distance alternative in its own right. This attitude changed over the course of the 1920s, as trucking tentatively entered into long-distance service and started to offer real competition to the train, but despite such inroads the railroads remained dominant until after the Second World War. Thus transfers of goods between train and truck, so the truckers could handle local deliveries and pickups for the railroads, were frequent. A design typology for the railroad freight depot developed to efficiently handle these transfers: a long low narrow building, with large doors and loading docks on both sides, alongside which the train (or at least a set of railcars, typically boxcars) would pull up on one side while trucks backed up to it on the other side. Such a building was typically known as a freight house (or freight station), and its purpose was to facilitate fast and easy transfers of freight from one mode to the other without a great deal of long-term storage. In some respects this design prefigures the layout of contemporary facilities for cross-docking, in which cargo is shifted from one truck to several trucks, or vice-versa, through a long low narrow building.

These buildings were utilitarian in nature and of simple construction, as one might expect, but in major cities they could be quite large and might become local landmarks. Freight houses were basically linear in their typology; they could be very long but were usually narrow and low-

[1] William R. Childs, *Trucking and the Public Interest: The Emergence of Federal Regulation 1914-1940* (Knoxville, TN: University of Tennessee Press, 1985), pp. 28-30.

slung. Smaller examples were often built of wood, but larger ones invariably of brick or masonry. Sometimes requiring freight to be shifted quickly, a major freight house typically had many large doors on each side.[2] The typology predates the motor vehicle, for buildings were also designed in this way to allow freight to transfer easily between trains and wagons. In the railroad hub of Chicago it is not surprising there were numerous freight houses, with the earliest built in 1850.[3] For many railroad companies freight houses were so common that a standard design existed, which could be adjusted for local conditions.[4] Some freight houses still stand, an example being one about 200 feet long in Ypsilanti, Michigan, built in 1878 by the Michigan Central Railroad.[5] A much larger facility in Kansas City, 500 feet long by 40 feet wide and built in 1877, has been renovated and now contains three restaurants.[6]

One particularly impressive example was the Santa Fe Freight Depot in downtown Los Angeles, built in 1907 by the Atchison, Topeka and Santa Fe Railway (widely known as "the Santa Fe"). The reinforced concrete structure, which still stands, stretches an astonishing quarter-mile in length but is only 40 to 60 feet wide (the width varying at different points) and 29 feet high; when in use it had 120 bays, each with doors opening to both sides.[7] Given the building's date of construction, horse-drawn wagons were obviously used in the beginning, but eventually trucks took their place. (The building is now known for housing the Southern California Institute of Architecture, which carried out extensive renovations to the interior.) Its long narrow footprint, maximizing the interface to trains on one side and wagons or trucks on the other, hints at the emphasis placed on the rapid transfer of great quantities of freight; the building was designed for interchange more than storage. A similar though smaller example, presumably intended for trucks from the beginning, was the Denver and Rio Grande Western Freight Depot in Pueblo, Colorado, about 400 feet long but relatively narrow and short, built in 1924 by the Denver and Rio Grande Western Railroad.[8] (The building now houses the Southeastern Colorado Heritage Center.) A few years later in 1929 the Santa Fe built another such depot—known locally as the Santa Fe Freight Depot (as with the earlier building in Los Angeles)—in downtown

[2] Walter Gilman Berg, *Buildings and Structures of American Railroads* (New York: John Wiley & Sons, 1893), pp. 205-208.

[3] David M. Young, *The Iron Horse and the Windy City: How Railroads Shaped Chicago* (DeKalb, IL: Northern Illinois University Press, 2005), p. 184.

[4] Berg, *Buildings and Structures of American Railroads*, pp. 214-219.

[5] Friends of the Ypsilanti Freighthouse [website], "History." (http://www.foyf.org/foyf/history/, accessed 3/1/12)

[6] Wikipedia, "Freight House (Kansas City, Missouri)." (http://en.wikipedia.org/wiki/Freight_House_(Kansas_City,_Missouri), accessed 9/26/12)

[7] Greg Goldin, "Open Doors: SCI-Arc Rediscovers Itself—and the City—Downtown," *LA Weekly*, September 12, 2001. (http://www.laweekly.com/2001-09-20/art-books/open-doors/, accessed 2/28/12); Wikipedia, "Santa Fe Freight Depot." (http://en.wikipedia.org/wiki/Santa_Fe_Freight_Depot, accessed 2/28/12)

[8] Southeastern Colorado Heritage Center [website], "Denver & Rio Grande Western Freight Depot." (http://www.theheritagecenter.us/freight_depot.html, accessed 2/29/12)

Phoenix close by the city's passenger train station, though this one (which still stands and has been converted into county government offices) was only about 300 feet long.[9]

In the postwar era long-distance trucking, supported by new highways, made facilities like these less essential, as the truck itself could go the entire distance from origin to destination, cutting out the train completely. But interchange between train and truck did not vanish. In fact some new terminals, designed and used along lines roughly similar to the old freight houses with boxcars accessing one side and trucks the other, were built in the postwar years. A description of one such building from the early 1960s notes that "the disparate freight…is passed out of the boxcars on to close-positioned dollies revolving on an electrically powered belt to waiting trucks."[10] Another new freight house, constructed in 1960 by the Union Pacific Railroad, was about 1,300′ long and 100′ wide (site constraints made it even more elongated than usual), entirely free of columns in its interior, and also had a mechanized circuit of moving dollies. Boxcars actually entered into the building on tracks along one side, while on the other side trucks had access on the exterior. The structure even had a distinctive architectural appearance, thanks to a series of 30 concrete barrel vaults, each running transversely, that comprised its roof.[11] But such buildings became the exception as interchange diminished between the two modes of transportation.

Another factor contributing to the gradual decline of these buildings was the intermodal practices of piggyback and containerization, both of which essentially began in the 1920s (as discussed in chapter 5). As trailers and containers hold their goods within them, no depots, warehouses or buildings of any sort are necessary at the transfer point. In piggyback the "circus loading" technique was used to move trailers on and off flatcars, while containers were shifted between truck and train by a crane or other mechanized device. In either case the transfer was typically done at a rail yard, or else a spur, siding or some other convenient location—there were no facilities specially designed for the purpose. Given that these practices were done at a relatively small scale and accounted for a trivial percentage of overall rail operations (and also considering that the trailers and containers were quite small compared to those of today), it is not surprising that in the 1920s and '30s they could be accommodated at existing sites, even if some new equipment had to be put in place.

At least one new facility was created to handle container transfers, however. This was a terminal in Enola, Pennsylvania, built in 1932 by the Pennsylvania Railroad for their containerized operations. The purpose of the facility actually was not to transfer containers between train and truck, but rather between different trains and/or railcars. This makes it quite unusual in the history of containerization, as container transfer facilities normally are primarily

---

[9] Tye Rabens, "Steaming Ahead," *Phoenix Magazine,* October 2010, p. 52 (http://www.phoenixmag.com/lifestyle/history/201010/steaming-ahead/, accessed 2/29/12); Glen Creno, "Historical Phoenix Freight Depot Gets New Life," *The Arizona Republic,* November 27, 2010. (http://www.azcentral.com/community/phoenix/articles/2010/11/27/20101127phoenix-freight-depot.html, accessed 2/29/12)

[10] Walter Guzzardi, Jr., "Freight Goes Forward with Forgash," *Fortune,* July 1962, p. 224.

[11] *Railway Age,* "Barrel Arches Top Big Terminal," Vol. 148, No. 20 (May 16, 1960), pp. 56-58.

designed for moving the containers between train and truck—if a container needs to be shifted from one train to another, a truck usually functions in an intermediate role. (The Pennsylvania Railroad's containers were rarely transferred to trucks anyway; unlike other containerized operations of the time and since, the containers usually remained on the flatcars to which they were firmly attached. The system was in this regard more comparable to an LCL operation, and not truly intermodal in nature.) In the Pennsylvania Railroad's containerized operation all containers were routed through Enola, which was already a major junction point for the railroad and geographically well suited for the purpose. Two gantry cranes specially designed for the facility spanned seven tracks, running back and forth (on their own rails) as they quickly shifted containers from one railcar to another. The terminal ran at all hours, as speed was of the essence for this sort of freight, and received 30 to 40 trains, with about 800 containers handled, each day.[12]

But the first generation of containers faded in the 1930s, and while piggyback gained momentum during that decade it then dropped off in the 1940s. Piggyback reemerged and began to flourish during the 1950s, but even then captured only a very small slice of domestic freight movement. For the most part the railroads and trucking went their own ways, and the businesses regarded each other with suspicion or outright hostility. The playing field was increasingly slanted in favor of trucking, as the popularity of the automobile led to massive road-building projects that were to the great advantage of truckers. The railroads found their operational flexibility limited by heavy regulations, imposed with good reason in previous decades but now outdated, while truckers enjoyed a more favorable regulatory environment. Locked in rivalry, the two sides had little motivation to work together, even in circumstances where it could be to their mutual advantage.

In addition, policymakers tended to stifle rather than encourage cooperation between modes. There were some exceptions. In 1923 the U.S. Chamber of Commerce issued a report urging collaboration between the transport modes, and specifically suggesting that railroads concentrate on longer journeys with truckers handling the shorter trips.[13] In the same year landscape architect Warren Manning, in his "A National Plan Study Brief," recommended that highways, railroads and waterways run parallel to each other where possible, and that "facilities for freight interchange" be created to exploit this multiplicity of transport modes.[14] In the late 1920s and early '30s the federal government got involved, as an ICC (Interstate Commerce Commission) researcher named Leo Flynn argued that the various modes of transportation, in particular the railroads and trucking, needed to cooperate more effectively. Further he recommended the railroads be freed from some of their overly burdensome regulations and truckers be more

---

[12] R. K. Stackhouse, "The Pennsylvania's Container Plan," *Railway Age,* Vol. 100, No. 3 (January 18, 1936), pp. 143-145; *Railway Age,* "P. R. R. Container Transfer Station at Harrisburg, Pa. [News]," Vol. 91, No. 25 (December 19, 1931), p. 954.

[13] Frank B. Norris, *Spatial Diffusion of Intermodal Rail Technologies,* PhD Dissertation, University of Washington (Geography), 1994, p. 51.

[14] Keller Easterling, *Organization Space: Landscapes, Highways, and Houses in America* (Cambridge, MA: MIT Press, 1999), pp. 87-89.

extensively regulated.[15] When the Interstate highways were being planned in the 1950s and '60s, once again a smattering of forward-thinking individuals argued for a less fragmented, more cooperative and holistic approach—in short, for intermodalism. But they had little success and such thinking would remain rare until the 1990s. (The evolution of intermodalism in policy and practice is covered in more detail in chapter 12.)

But there was one bright spot: the return of piggyback in the 1950s, and its success in subsequent decades. For many railroad companies, ever more desperate for business in these years of decline for their industry, the opportunity offered by piggyback was welcome. But the method of transferring trailers between truck and train, known as "circus loading" thanks to its origins in the 1800s when circus wagons were put on trains this way, was slow and cumbersome. (It was once regarded as advanced, and the German military was most impressed in 1901 upon witnessing circus loading carried out by the Barnum & Bailey Circus, touring Germany at the time.[16]) Trailers were generally moved onto a train by backing them up a ramp and along a series of railcars—the gap between railcars being temporarily spanned by a flat device called a bridge plate—into the correct spot. For removing trailers, the actions were done in reverse. Either way the process was laborious and slow, and loading was especially tricky as it involved the trailer being moved—in a perfectly straight line—by a truck tractor driven backwards for several hundred feet over multiple railcars. Using a crane or some other lifting device, known as "mechanization," made it much easier and faster, but this was rarely done time due to the expense of acquiring the equipment. As piggyback gained popularity a tremendous number of these transfer points were created in the 1950s and '60s all across the U.S., but usually they were not entirely new facilities but rather were at an existing rail yard or some other convenient site. Since ramps were used in the transfer process, the facilities themselves were often called "ramps." (The term is still widely used for piggyback facilities, even though they are now mechanized and no longer have actual ramps, and on occasion even for container terminals, which have never had ramps at all.)

Most of these facilities were small and somewhat provisional, and given the modest amount of traffic they typically handled there were no economies of scale to be realized from mechanized operations. But a few facilities grew large, consisting of numerous tracks each with its own ramp; the Southern Pacific Railroad's Los Angeles Transportation Center for example eventually expanded to 17 tracks and ramps. The time spent loading and unloading trailers was immense for such an operation. It was additionally awkward because the order of trailer movement was fixed; the last trailer put on a train had to be the first taken off (unless the railcars themselves were rearranged, but that was also complex and time-consuming). For such bustling sites of transfer the logic of mechanization was evident, as a crane or side-loading device could work far more efficiently and eventually justify its cost. The idea was hardly a radical breakthrough, for

---

[15] Stephen B. Goddard, *Getting There: The Epic Struggle Between Road and Rail in the American Century* (New York: BasicBooks [HarperCollins], 1994), pp. 138-145.
[16] Barbara W. Tuchman, *The Proud Tower: A Portrait of the World Before the War, 1890-1914* (New York: The Macmillan Company, 1966), p. 304.

cranes had been used for many years to transfer large objects and assemblages of goods, including containers, between train and truck. The first mechanized device specifically designed for moving trailers on and off trains may have been a lift crane built by the Paceco Corporation in 1961 for the Pennsylvania Railroad's facility in Kearny, New Jersey. In 1964 another such crane was put in place at the same railroad's 47th Street terminal in Chicago. In the mid-1960s cranes made by Drott and Le Tourneau also entered service for several railroads. Like most of the cranes intended for moving containers between train and truck, these were gantry cranes, albeit moving on wheels instead of rails. Another mechanized device for trailer transfers, a side-lift machine informally known as a "piggypacker," also came into use in the mid-1960s and quickly proved popular. The piggypacker is somewhat analogous to a massive forklift, and was adapted from devices used in the logging industry.[17] (In the 1950s the Pennsylvania Railroad apparently considered the possibility of shifting trailers sideways between railcars and platforms set at the same height, without mechanized lifting equipment, but it is unclear if this was ever carried out.[18])

As of the close of the 1960s mechanized piggyback terminals were still very much the exception, but it was recognized in the industry that for busy terminals mechanization was desirable, given the economies of scale associated with it.[19] Some of the larger and more successful terminals were swamped with traffic, and the traditional circus loading techniques simply could not keep up; a trade journal commented in 1973 that "for high-volume terminals, the circus-load/unload facility just can't be made to do the job."[20] By this time is was also evident too many piggyback terminals had been built, and that a more efficient approach would concentrate transfers at fewer facilities, each mechanized and capable of handling greater volumes. Over the course of the 1970s the railroads therefore closed numerous small transfer facilities and emphasized select larger ones that were mechanized with cranes or piggypackers. In addition to the advantages mechanized terminals offered, the railroad companies were realizing the benefit of sending dedicated trains long distances directly between major nodes, rather than stopping occasionally to load or unload a few trailers or add or drop some railcars. A system of hubs, in other words, was evolving.[21] These trends continued into the 1980s. The number of intermodal trailer facilities had reached an estimated 2,100 in 1965, with just 63 of them mechanized, but by 1990 the figure was all the way down to 231, of which 196 were

---

[17] David J. DeBoer, *Piggyback and Containers: A History of Rail Intermodal on America's Steel Highways* (San Marino, CA: Golden West Books, 1992), pp. 85-94.
[18] Herrymon Maurer, "New Signals for the Pennsy," *Fortune*, November 1955, p. 171.
[19] Gus Welty, "TOFC/COFC Terminals: Key to Service and Growth [Piggyback Gets Set for Bigger Things]," *Railway Age,* Vol. 166, No. 19 (May 26, 1969), p. 22; *Traffic World,* "Container Handling Systems at Rail Terminals Probed in Consulting Firm Study," Vol. 146, No. 13 (June 28, 1971), pp. 64-66.
[20] Gus Welty, "TOFC/COFC Growth: The End Is Nowhere in Sight," *Railway Age,* Vol. 174, No. 10 (May 28, 1973), p. 32.
[21] Frank Malone, "New Peaks for Piggyback," *Railway Age,* Vol. 179, No. 20 (October 30, 1978), p. 24; Robert Roberts, "Defining the Intermodal Terminal," *Modern Railroads,* Vol. 39, No. 7 (July 1984), pp. 21-22.

mechanized.[22] Moreover, these operations were larger and more sophisticated; a piggyback transfer facility was now often a large terminal specially designed and laid out for the purpose. Writing in 1989, McKenzie, North and Smith commented that:

> The pig [piggyback] ramp is gone, and has been replaced by the intermodal hub. The old piggyback hands that used to "chain 'em down" would scarcely recognize the new facilities. Spacious, paved, lighted and dominated by massive machinery, today's intermodal hubs have nearly become machines themselves, dedicated to achieving levels of efficient throughput unimagined by the most optimistic planners of the 1960s.[23]

Facilities for container transfer lagged behind in the 1950s and '60s, mainly because containerization itself did not gain much popularity with the railroads until the arrival of global containers in substantial quantities in the 1970s. As described in chapter 5, American railroads used small containers in the 1920s and '30s, and larger ones in the 1950s and '60s, but the practice though it gained a measure of success was not truly widespread and could not justify dedicated terminals. The transfer of containers was usually done at rail yards or other existing facilities, sometimes alongside circus loading operations, in a fairly ad-hoc manner. Mechanization—in the form of either cranes or side-lifters—was necessary from the beginning, since a container cannot be moved to or from a railcar otherwise. (There are two exceptions. First, a container can remain on a trailer chassis that is carried by piggyback and shifted by circus loading with ramps; this has been done on occasion and was especially common in the late 1960s and '70s when railroads began to move growing numbers of containers but lacked mechanized terminals at inland points.[24] Second, in the case of Flexi-Van and a few other containerization systems the container was transferred by sliding and/or rotation methods, without mechanization.) The cost of this mechanization helped discourage the railroads from implementing containerization in these years.

When marine containers entered the picture, thanks to the innovations of Sea-Land and Matson in the late 1950s, they were occasionally carried by train but not so often that large-scale specialized facilities were needed, other than at some ports. The lack of container equipment in general, especially mechanized devices to lift them, might be one reason the railroads did not pursue the container business with much alacrity at this time. Another obstacle was the need to ensure a trailer chassis would be provided at the inland facilities for each container arriving by train. For the few railroad companies that had developed containerization on their own, their container systems were usually incompatible with those of Sea-Land or Matson, or with the new ASA standards. One railroad that did take the initiative was Southern Pacific, which served several ports on the West Coast and Gulf Coast and showed an early interest in carrying the new

---

[22] DeBoer, *Piggyback and Containers*, p. 84.

[23] David R. McKenzie, Mark C. North, and Daniel S. Smith, *Intermodal Transportation—The Whole Story* (Omaha, NE: Simmons-Boardman Books, 1989), p. 191.

[24] *Traffic World*, "Container Handling Systems at Rail Terminals Probed in Consulting Firm Study," p. 65; McKenzie, North, and Smith, *Intermodal Transportation—The Whole Story*, p. 193.

shipborne container traffic. In the mid-1960s the railroad began using its own version of the piggypacker for transferring both containers and trailers at several different facilities.[25] But Southern Pacific was an exception, as most railroads resisted containers. This state of affairs continued through the 1960s—even as containerization made great strides in the world of shipping—but in the 1970s progress began to pick up and container traffic on the railroads rose significantly. Since mechanized terminals were coming into use for piggyback, railroads were no longer so reluctant to invest in similar equipment for container transfer. Still, in the 1970s and early '80s the transfer of containers between train and truck, though it was mechanized, was typically done in a rather ad-hoc way at existing facilities.

Intermodal terminals designed specifically for container transfer began to appear at inland sites in the American heartland in the late 1980s as containerization grew more widespread in the railroad industry. The need was growing for more efficient container transfer operations between train and truck not only at or near major ports (where such facilities generally already existed), but at inland locations. The rising prominence of double-stack railcars (and entire trains pulling such railcars, known as stacktrains) helped bring about this shift—containers were now being carried in such large quantities that bigger and more efficient facilities were necessary for interchange with trucks. As stacktrains grew more common and the economies of scale became evident, it made sense to build new terminals entirely designed to handle containers as efficiently as possible. The first was the Global I terminal in Chicago, built in 1986 by the Chicago and North Western Railway, in cooperation with Union Pacific and the shipping company American President Lines, on a site that had previously been the Wood Street rail yard.[26] The use of the word "global" in the terminal's name signaled the nature of the containerized goods passing through and was an acknowledgment of the transnational nature of this new node deep in the heart of the domestic infrastructure. The separation of the national and the global was subtly blurred by such a facility that extended the reach of high-volume container movement; a manager of the Chicago and North Western said in 1985 that Global I would be an "inland port,"[27] and a writer in a trade journal used nearly the same phrase soon after, stating that it would be "in effect, an inland container port."[28] Its location in Chicago was fitting, for as the historic and enduring center of the nation's railroad network that city had already secured a key place in the burgeoning container system; as of 1987 Chicago was on 17 of the 20 busiest U.S. intermodal (container or piggyback) rail routes.[29]

In 1990 the Chicago and North Western opened Global II, another terminal in Chicago designed for container transfer, next to its Proviso rail yard. But in spite of specialized new

---

[25] Norris, *Spatial Diffusion of Intermodal Rail Technologies,* p. 335.
[26] McKenzie, North, and Smith, *Intermodal Transportation – The Whole Story*, p. 199; DeBoer, *Piggyback and Containers*, p. 158.
[27] Frank Malone, "Trailers/Containers: Sizing Up Tomorrow's Fleet," *Railway Age,* Vol. 186, No. 3 (March 1985), p. 88.
[28] Gus Welty, "Intermodal Terminals: The Tempo Quickens [High-Tech Railroading]," *Railway Age,* Vol. 186, No. 11 (November 1985), p. 46.
[29] McKenzie, North, and Smith, *Intermodal Transportation – The Whole Story*, p. 198.

terminals like Global I, Global II and a few others—and aside from the facilities at or near ports—most container transfers in the 1980s and '90s continued to be at facilities that offered a mix of other operations as well, such as piggyback trailer transfers (by now mostly mechanized) and traditional railcar switching (as in a true rail yard). This was the case even for many of the largest nodes of container transfer: two examples in Chicago were the Burlington Northern Railroad's Cicero Yard and the Santa Fe's Corwith Yard. Eventually though these two facilities—and many others—would make the transition to being entirely dedicated to containerized operations.[30]

Figure 9.1: Container transfer at an intermodal terminal

Source: Joe Perry, *Chasing Steel* blog (http://www.chasingsteel.com/blog/2010/2/20/union-pacifics-ictf-an-amazing-complex.html, accessed 12/15/12)

As already noted, many ports had by this time already developed intermodal terminals either within or just outside their boundaries. A facility like this can arguably be seen as fundamentally a component of port operations, rather than the nation's internal domestic infrastructure, since in effect it allows containers to be transferred between ship and rail (with a short truck haul being necessary to make the connection). Such terminals nevertheless are certainly relevant to the national infrastructure because they play a key role in linking it to ocean shipping. Containers had been transferred between truck and train at (or near) ports since the late 1950s, albeit infrequently in the early years. At the Milwaukee Road's Stacy Street yard adjacent to Seattle's port, for example, an area for Flexi-Van transfers was built in 1959, and in the 1960s

[30] Brian Solomon, *Intermodal Railroading* (St. Paul, MN: Voyageur Press [MBI Publishing], 2007), pp. 14, 172.

facilities for both TOFC and COFC were put in place. By 1971 a piggypacker was operating, shifting both containers and trailers from truck to train for their rail journeys to destinations far east, most often Chicago.[31] By the mid-1970s such intermodal terminals close to ports were common, at least at the major container ports, but they were not especially large and not necessarily focused solely on containers. Such facilities grew more extensive in the late 1970s and especially the 1980s, and as they increasingly dealt exclusively with containers, and were designed and laid out for that purpose, they can be regarded as intermodal terminals. A terminal at North Bergen, New Jersey, near Newark, opened in 1985 and is of particular interest because it was built and operated by Sea-Land rather than a railroad or port.[32] As with American President Line's deepening involvement in the railroad industry at about the same time (described in chapter 7), the Sea-Land facility revealed the new desire of shipping lines to venture into the nation's domestic infrastructure, rather than adhering to their traditional role of only handling transportation over the ocean.

The more common practice was for these terminals to be created by the ports and/or railroads. One such case was the Intermodal Container Transfer Facility (ICTF) in Long Beach, California, jointly opened in 1987 by Southern Pacific and the ports of Long Beach and Los Angeles, which immediately enjoyed great success. At the time it was noted for its unprecedented size—some claimed it was the largest such facility in the world. Previously the port's containers were trucked all the way to and from railheads near downtown Los Angeles about 25 miles away from the two ports, often through heavy traffic, and the ICTF, just five miles away, made the transfer between ship and train far more convenient.[33] Like Chicago, the Los Angeles region was establishing itself as a key node in container movement by rail, seizing the opportunity made possible by the explosive growth in imports from Asia, the success of the two ports, and its historically important position in the American rail network. San Francisco's port made similar efforts, opening a smaller intermodal terminal in late 1986, but in the long run this drew little traffic since the port itself could not compete with Oakland across the bay. Oakland's port in fact opened an intermodal terminal soon after. Meanwhile in the Pacific Northwest the ports of Seattle, Tacoma and Portland were building and/or enlarging their own intermodal terminals in the mid- and late 1980s, in collaboration with either Burlington Northern or Union Pacific.[34]

---

[31] George H. Kronberg [Vice-President—Traffic, The Milwaukee Road], "Stacy Street, the Milwaukee Road Link Between the Orient and the Midwest," *Traffic World,* Vol. 146, No. 13 (June 28, 1971), pp. 30-32.
[32] Gus Welty, "Intermodal Terminals: The Tempo Quickens," p. 47.
[33] Richard Saunders, Jr., *Main Lines: Rebirth of the North American Railroads, 1970-2002* (DeKalb, IL: Northern Illinois University Press), 2003, p. 274; *Fairplay International Shipping Weekly,* "West Coast ICTFs Swell," Vol. 300, No. 5391 (January 29, 1987), p. 30; Carl Seiberlich, Interview by Arthur Donovan, June 21, 1997, Containerization Oral History Collection 1995-1998, Archives Center, National Museum of American History, Washington, D.C., pp. 11-12.
[34] *Fairplay International Shipping Weekly,* "West Coast ICTFs Swell," Vol. 300, No. 5391 (January 29, 1987), pp. 30-33; *Railway Age,* "BN's 'Seattle International Gateway' Yard Opens for Business," Vol. 186, No. 9 (September 1985), p. 23; *Railway Age,* "West Coast Ports Vie for Lead in Intermodal Race," Vol. 186, No. 2 (February 1985), p. 21.

Whether at ports or inland sites, these new terminals dedicated entirely to container transfers represent a new typology of rail operations, very different from traditional rail yards or freight yards, and also different from piggyback terminals. Generally they are characterized by multiple railroad tracks separated by wide lanes of pavement so trucks can move between them. The convergence of the two transport modes is expressed quite legibly in such a layout, as they are literally intertwined with each other. (Such a typology is not always present, as some small terminals are laid out on a less systematic basis—and in addition space constraints can distort the ideal layout.) Rolling cranes known as gantry cranes ("rubber-tired gantry cranes," strictly speaking, as gantry cranes traditionally move on rails) are able to pass over both trains and trucks and thus can shift containers from one to the other. Piggypackers and other side-lift devices may be used as well. There are also sometimes straddle carriers, which are similar to gantry cranes but much narrower in their dimensions and without the ability to move the container sideways.

From the early days of containerized terminals, a key issue has been the storage and organization of the trailer chassis used to carry containers by truck. There are a plethora of chassis to be stored at a terminal, including those that have brought containers to railcars and those waiting along the tracks to receive containers. In addition it was often the case that different shipping lines would provide their own chassis to the truckers they were contracting with to haul their containers, and so it was not allowable to simply use the most convenient chassis to carry a container; the container had to be carried by a chassis owned by the appropriate shipping line. This meant far more chassis than necessary were held at terminals. The problem has been largely resolved by the use of chassis pools (sometimes known as common pools or neutral pools), in which chassis are put in circulation for all users and a rental fee is charged accordingly. The other way the chassis space problem has been solved, or at least minimized, is through machines that flip the chassis into vertical positions and store them in racks designed for that purpose.[35] These are especially common at the more constricted urban terminals where space is at a premium.

Over the course of the 1980s and '90s the design and layout of these terminals gradually improved. This evolution was recorded in trade journals of the railroad industry and in government publications.[36] The result was not one fixed design, as the setup for each terminal depends on a multitude of factors like the space available, the way trains arrive and depart, how quickly containers will be picked up and dropped off, the budget available, the access roads, whether containers are to be stacked or stored on chassis, and the preferences of the railroad company. But the terminals did get more efficient as the learning process advanced, larger tracts of land were used, and the railroads were able to put more money into them. By the late 1990s the

---

[35] DeBoer, *Piggyback and Containers*, p. 97; McKenzie, North, and Smith, *Intermodal Transportation – The Whole Story,* p. 221.

[36] For a good example with detailed analysis and precise graphics, see David Vandeveer, "Intermodal Rail Facility Design for the Next Century," in: Transportation Research Board (National Research Council), *Intermodal Freight Terminal of the Future*, Transportation Research Circular, Washington, D.C., Number 459 (June 1996), pp. 88-98. (Papers from the National Conference on the Intermodal Freight Terminal of the Future, December 1994)

rough contours of terminal design were fairly well-established, just in time for a new wave of giant terminals to be built.

One commonality to virtually all the terminals has been the intertwining of rail and road; as already described, the railroad tracks alternate with lanes for the trucks to move, thus maximizing the points of contact and potential transfer between the two modes. This no longer holds true in a few brand-new terminals, however, which represent a significant change in terminal design. At these new facilities, located in Memphis and in North Baltimore, Ohio, and to be discussed in more detail shortly, a massive new type of gantry crane is used, one that is rail-mounted and extends over numerous railroad tracks and truck lanes, basically covering the entire area of interchange. Such cranes, dramatically higher and wider than the gantry cranes normally used at the terminals, make it unnecessary for rail and road to be interwoven; instead it is possible for the railroad tracks to run adjacent to each other, with several trucking lanes also clustered together, and the crane is able to span them all.

The design of the terminals reflects the spatial regime of the three infrastructures that must be accommodated. First, there is the container itself—the devices for lifting containers obviously must grip or attach to the container spatially, and containers must be stored, either on trailer chassis or on the ground (in which case they can be stacked). Usually both methods are used, with short-term storage on chassis and longer-term storage stacked on the ground. Second, there is the trucking infrastructure, as tractor-trailer trucks have a particular width, length and height, along with a minimum turning radius, that must be taken into account. Third, there is the railroad infrastructure, the least flexible of the three. Typically the railroads prefer to use stacktrains in the range of 5,000 to 9,000 feet in length, as such sizes maximize their economies of scale. The new terminals are laid out to accommodate such trains, and hence are almost two miles long. Their width can be far less, but is still substantial. A few terminals, such the one at Elwood, Illinois (to be discussed shortly), provide space for a train to turn around completely by making a semicircle, but since trains require a vast turning radius this is very rare. Instead most terminals are laid out adjacent to rail lines, so the trains need not turn around to exit but can pull into the facility and eventually depart by continuing forward or reversing direction. The width of such a terminal is generally between 1,500 and 2,000 feet.[37]

In the past decade most of the largest new container terminals have been built on fresh sites, often in exurban settings where more space is available but a metropolis is still close by. As early as 1980 this trend was envisioned by the trade journal *Railway Age*, which commented that "for some terminals—mostly those built close to city cores and with little if any room for expansion—the only solution may be to pack up the cranes and the sideloaders and go lay track and pour concrete out along an Interstate where expansion can be better accommodated."[38] Such sites are selected carefully at points served by both important rail lines and major highways, and in a

---

[37] All these terminals can be seen quite clearly on Google Maps, in the satellite view, and this reveals their overall layout and some of their interior workings.

[38] *Railway Age,* "Terminal Efficiency and Flexibility: The Key to TOFC/COFC's Future?" Vol. 181, No. 14 (July 28, 1980), p. 26.

sense the terminals act as junction points for these two domestic infrastructures, the railroad and highway networks. Their creation was long overdue, for the development of the Interstate highways was a missed opportunity in terms of intermodalism as opportunities for interchange and adjacency were ignored. This perpetuated a division already in evidence between the two transport modes whose coexistence was marked primarily by competition rather than cooperation. Key intersections of highway and rail corridors thus came about incidentally rather than by design, and some of these locations now possess an importance not previously anticipated, thanks to containerization.

Figure 9.2: Operations at a contemporary intermodal terminal

Source: CenterPoint Intermodal Center website (http://www.centerpoint-intermodal.com/providers.html, accessed 12/15/12)

The regions, cities and towns where the terminals are sited have their own histories and characteristics. Some have long possessed multiple and important infrastructural connections, as they lie along major transportation corridors. Their status is not random but rooted in American history, geography and topography, and those factors remain applicable in the new era of globalization. As emphasized in previous chapters, shipping containers travel over preexisting routes of movement. The sites where they pause to be transferred are also usually locales of some preexisting significance. A historical presence in the nation's railroad network is especially important, as it is too costly and time-consuming to build new rail lines. Just as containerization has led to a renewed stress on historically important rail corridors (as described in chapter 7), likewise it has put an emphasis on major nodes of the rail network. One journalist explains: "Railroads are generating development in the same way they spawned towns and industrial sites over a century ago. Warehouse complexes are popping up next to new rail yards [intermodal terminals] designed to load and unload trains carrying containerized goods."[39] A report for the real estate industry notes that "after decades of decentralization of industrial development encouraged by the trucking industry and the interstate highway system, a decided recentralization trend is resulting in a new clustering of industrial/distribution facilities in select U.S. markets with intermodal capabilities."[40]

The point should be qualified by noting that although this "recentralization" has benefited places with a prominent presence in the national rail network (Chicago, Kansas City, etc.), the new intermodal terminals—and most of the facilities associated with them—are usually sited on the periphery of such regions, not in the urban core or even the inner-ring suburbs. So they fit in well with low-density suburban or exurban sprawl, rather than the urban context traditionally associated with railroad hubs. In some cases in fact they actually drive sprawl; a new terminal might concentrate a set of facilities around it, but its greenfield site is likely to make the entire complex represent additional sprawl. So the renewed importance of rail nodes does not necessarily equate to a rise in traditional urban density (as would more likely be the case with passenger trains).

Several of these terminals are located on land previously used as military bases or for some military purpose. This is unsurprising given the need for a very large area available for development with good rail connections, combined with the gradual shuttering of many military sites that then become available for other uses. (Given the massive amount of goods and people the armed forces must move swiftly, they have always depended on having premium infrastructural access. It is easy to draw parallels between military practices and contemporary methods of freight movement, as both are so tightly coordinated and precisely organized; in fact the very word "logistics" has a military derivation.) The most prominent example is the giant BNSF facility at Elwood, Illinois, built on a site that was originally part of the massive Joliet Army Arsenal, a sprawling 23,000-acre complex where the army manufactured munitions from World War II through the Vietnam War. The arsenal was closed in 1976, commencing a long process of remediation and redevelopment for several uses, the terminal and its surrounding logistical and distribution uses representing only a small chunk of the entire territory.[41] The infrastructure and geography that made the place so valuable for the army were equally vital to this new use: "The

[39] Daniel Machalaba, "New Era Dawns for Rail Building," *The Wall Street Journal,* February 13, 2008.
[40] Urban Land Institute, *Just-in-Time Real Estate: How Trends in Logistics Are Driving Industrial Development* (Washington, D.C.: Urban Land Institute, 2004), p. 107.
[41] Jerry W. Szatan, "On Track: Two New Developments Are Helping Bolster the Chicago Region's Historic Role as a Freight Transportation and Distribution Center," *Urban Land,* Vol. 62, No. 6 (June 2003), pp. 66-68.

Army chose the location for the Arsenal in the 1930s based on its central inland position, rail access to both coasts, and nearby industrial suppliers—the same factors that shape its redevelopment."[42] There are other examples, albeit smaller: a recently-developed terminal in Kansas City, serving the Kansas City Southern Railway, is located at the former Richards-Gebaur Air Force Base, while a small new terminal in Marion, Ohio, developed for Schneider National trucking, was formerly a military supply depot. For these sites too, both rail and road infrastructure were already in place.[43]

As already noted, Chicago has long played a dominant role in the American railroad system and consequently today its metropolitan area is a prime location for intermodal terminals. It is worth rehearsing the history of the city, especially in relation to transportation infrastructure. It was founded in 1833, at a location where portage between the Great Lakes and the Mississippi River watershed was most convenient. In that time when inland waterways were the primary avenues of movement, Chicago was inherently well-situated. But it displayed great energy and initiative in attracting the next dominant mode of transportation, for the city was singularly successful in drawing new railroad lines to it. The first train arrived in 1838, and others quickly followed as the city surpassed Midwest competitors like St. Louis and Cincinnati by making itself into a great rail hub for both freight and passenger traffic. Chicago became a key node where the major railroad companies of both the east and west terminated, making transfer and interchange even more likely. By the early 1900s it had grown meteorically to become the nation's second-largest city. In the second half of the twentieth century it adapted fairly well to the declining status of the railroad industry, making itself a central point for the national highway and air travel systems also. With regard to the latter it was especially successful—for many years Chicago's O'Hare Airport was the busiest in the world.

When the railroad industry revived in the 1980s and '90s Chicago was well placed to benefit, as it had never lost its status as the nation's central rail hub. Since the six largest North American railroad companies (the Union Pacific Railroad, the BNSF Railway, the Norfolk Southern Railway, the CSX Railroad, the Canadian National Railway, and the Canadian Pacific Railway) meet in Chicago and nowhere else, its status is further reinforced. But the region has become a node of a somewhat different sort. Previously its primacy was in the domestic rail system, as the goods passing through were generally flowing along paths within the territory of the nation-state. This was fitting and seemed inevitable for a city so centrally located in the American heartland. (Even when freight had an ultimately foreign destination or origin, the railroads had little concern for that, as there was little coordination of movement on a global scale.) But today circumstances are altered, as containers trace their trajectories on a worldwide scale even as they move by train through places deep inside the national territory.

Hence Chicago is now a key node for containers that ultimately move and are coordinated globally, not just domestically. Admittedly containers are only one type of cargo the railroads

---

[42] Ibid., p. 68.

[43] David Warren, "Breaking Free of Intermodal Gridlock," *Area Development,* August/September 2006.

haul, and most of their other freight (including domestic containers) moves at a domestic scale. But the container does represent a substantial portion of the contemporary railroad business, and a particularly sizable percentage of its profits. In the process containerization has to some extent globalized Chicago's railroad operations, especially in its role as a site of interchange. Indeed, the Chicago area now handles an astonishing quantity of containers, more than any other such inland hub in the world. If the Chicago region were regarded as a port, the number of containers coming and going would rank it as the world's third-largest behind only Singapore and Hong Kong. The impact on the area's economy is tremendous; one estimate puts the number of people employed in the distribution industry (including freight transportation, warehousing, etc.) at 300,000. It is also estimated that buildings devoted to distribution-related uses (distribution centers, warehouses, etc.) in the area add up to 1.3 billion square feet of space.[44]

Three particularly large intermodal container terminals have been built in the Chicago region in recent years. The first, officially known as Logistics Park Chicago, was built in 2002 for the BNSF Railway in Elwood, a small exurban town about 30 miles southwest of the city. (Elwood is next to Joliet, a much larger town, and this terminal is sometimes identified with Joliet.) The second was built in 2003 for Union Pacific in Rochelle, a town roughly 70 miles west of Chicago, and is named Global III as it is the third terminal in the already noted sequence of Chicago-area terminals operated by Union Pacific. The terminal at Elwood was far more successful than that in Rochelle, however, and so Union Pacific in 2010 opened a terminal in Joliet, officially titled the Joliet Intermodal Terminal, only a few miles down the road from the BNSF facility in Elwood. The terminals of Elwood and Joliet have drawn a cluster of distribution centers and other freight-related facilities (warehouses, cross-docking operations, container storage, etc.) to the area, some of which are hardly less massive than the terminals themselves. Such a complex is clearly suited to a setting of exurban sprawl rather than an urban context.

The Elwood and Joliet terminals were both developed by CenterPoint Properties, a developer that specializes in such projects (though they are operated by the railroads). CenterPoint promotes the entire complex as the CenterPoint Intermodal Center. The entire site is about 6,000 acres, most of that space being not for the terminals themselves, which each cover about 800 acres, but assorted distribution, warehousing and logistics uses.[45] Some of the largest buildings are of staggering size. A group of seven giant rectangular buildings in Elwood adjacent to the terminal offer an extreme example: while their dimensions vary, the largest is roughly 2,600 feet

---

[44] Bill Mongelluzzo, "The Port Moves Inland," *The Journal of Commerce,* September 13, 2010; Szatan, "On Track," p. 66; Brian Klinksiek and Kristina Shih, "The Tortoise and the Hare: Comparing the Chicago and San Francisco Economies," *Urbanist*, Issue 452 (August 2006), pagination unknown. (published by the San Francisco Planning and Urban Research Association) (http://www.spur.org/publications/library/date/2006, accessed 4/15/10).

[45] CenterPoint Properties, "CenterPoint Intermodal Center – Joliet, Illinois: The Largest Master-Planned Inland Port in North America," publicity brochure, undated (probably circa 2009), pp. 2-3. (http://www.centerpoint-intermodal.com/pdfs/CICJ_brochure.pdf, accessed 4/1/12)

by 700 feet while the smallest is about 1,200 feet by 500 feet.[46] Two of these buildings serve as a massive distribution center for Walmart and together make up 3.4 million square feet.[47] Such facilities benefit from proximity to the terminals, as the length of the drayage trip—the movement of the container by truck—is minimized. In the case of Walmart, the developer reportedly demonstrated that the location would save the company about $15 million annually compared to another site farther off.[48]

The phrase "inland port," perhaps hyperbole when used for a typical intermodal terminal, seems accurate in the case of the Joliet-Elwood cluster of facilities. Most of the terminals are not surrounded by so many distribution-related buildings, nor are they generally needed. But any node where containers are transferred in large numbers from one transport mode to another still acquires some significance; it is a temporary pause, and this necessitates a large facility and also raises the possibility of further operations since the container's movement is being halted in any case. When that is combined with the additional work of unloading (or loading) the container, as at a distribution center, more possibilities emerge. The Joliet-Elwood area, as a part of the larger Chicago region, is exploiting precisely these opportunities, and has emerged as a giant hub for logistics and freight operations.[49]

Another notable "inland port" is the Alliance Global Logistics Hub in Fort Worth, Texas. While its intermodal terminal (served by both BNSF and Union Pacific) is not quite so large as those at Elwood and Joliet, the Alliance complex also contains its own airport, Fort Worth Alliance Airport, which is almost entirely dedicated to air freight. In addition there are numerous distribution centers and other logistics-related buildings clustered about. A similar though smaller example is the Rickenbacker Inland Port in Columbus, Ohio, which also has an airport (a former Air Force base) primarily dedicated to air freight, along with a rather modest intermodal terminal operated by Norfolk Southern and various buildings for distribution. So far these two developments are unique; inland ports are typically envisioned as junctions for just rail and road, especially since the business of air cargo has its own very distinct qualities and containers virtually never move by plane. (There are specialized containers for air cargo, but they are entirely different, much smaller, and do not shift to other transportation modes.) It should also be emphasized, again, that most of the intermodal terminals do not generate such a cluster of related developments around them, but only a few facilities. This is especially the case since many terminals, especially the older ones, are on sites hemmed in by existing neighborhoods and buildings. Often they were previously rail yards or freight depots, and are located in urban settings or simply at older sites surrounded by development around them. The new global

---

[46] The buildings lie just to the northeast of the terminal, and can easily be seen on Google Maps, in the satellite view. From these images their sizes can be estimated.
[47] Jeffrey Spivak, "Freight Finds Its Niche," *Planning*, Vol. 76, No. 5 (May/June 2010), p. 31; Mongelluzzo, "The Port Moves Inland."
[48] Spivak, "Freight Finds Its Niche," pp. 31-32.
[49] Mary Owen, "Joliet Seeks to Become the O'Hare of the Train-Truck World," *Chicago Tribune,* August 4, 2010.

infrastructure of containerization still must fit into settings that possess their particular historical contingencies, spatial constraints and geographical opportunities.

Often these historical factors are transportation-related. Just as Chicago has a prominent heritage of infrastructural connections, so Joliet possesses its own historical links to regional and national transportation systems. For Joliet the story begins with waterways, as it is located on the Des Plaines River and the Illinois and Michigan Canal was built through the city in the mid-1800s. Soon after the canal's construction the railroad reached Joliet in the 1850s, and its importance continues today in passenger transportation as both Amtrak and Chicago commuter rail have stops in town. The arrival of the automobile only furthered the city's provision of infrastructure, as both the Lincoln Highway and Route 66 ran right through, and later Interstates 80 and 55 were built giving direct access to the city. Clearly Joliet has a long history as a key point on transportation routes running southwest from Chicago, as well as routes running east-west that bypass Chicago by skirting its southern edge. From all these connections Joliet has derived a modest measure of importance, which has been furthered by its new status as a logistics center.

The sites of many other intermodal terminals lack this kind of historical legacy in transportation, however. Rochelle is an example. It is admittedly the case that the town has long been an infrastructural junction—it had the good fortune to have two major railroad lines crossing in the town, which are still important corridors. In the period of early highways it lay along the Lincoln Highway, like Joliet, and on Highway 51 going north-south, and today Interstates 88 and 39 run very close by. Thanks to all these routes intersecting at Rochelle, the town gave itself the nickname "The Hub City." It is indeed an impressive collection of infrastructure for a rural town of 10,000 people in the Illinois countryside. But it seems to have done little to boost the town itself, which is merely situated at the intersection of corridors connecting more important places. A similar example is North Baltimore, Ohio, where CSX recently opened a major new intermodal terminal. As with Rochelle, the North Baltimore site is unusual for such a terminal in being rural rather than exurban; it is not in or near a metropolitan area, though it is within 175 miles of Detroit, Cincinnati and Cleveland. The town possesses excellent highway links, with Interstate 75 running right past and the crucial Ohio Turnpike (jointly comprised by Interstates 80 and 90) only 30 miles away. Equally important is the rail access. A newspaper article explaining the town's appeal for CSX notes that "North Baltimore is strategically located along a CSX line that was once the Baltimore & Ohio Railroad's main line between Chicago and the East Coast. Three vital north-south CSX lines intersect that line within 15 miles to the east or west…"[50] Despite all this infrastructure, however, North Baltimore has derived little benefit from it and remains a small town.

What makes North Baltimore and Rochelle so ideal for the interchange of shipping containers between the railroad and trucking systems is their location at significant intersections of these two infrastructures. But what is of interest is that these are relatively accidental and unplanned

[50] David Patch and Alex Parker, "Metro Area Ripe for Shift Into Global Trade Portal," *The Blade*, May 18, 2008.

intersections. As Keller Easterling and others have commented, the Interstate highway builders did not think in intermodal terms, but rather laid out their system as a separate network with little thought for possible interchanges and transfers with the railroads. Likewise the railroad companies until recently gave little consideration to how their older network could link to the highways. So locations with good access to both infrastructures typically did not receive this as part of any plan, but simply by random chance or geographic fortune. (Of course major cities inevitably would receive premium connections to both, but that is not our concern here.) Only now do such sites gain an importance previously unforeseen, as the benefits of interchange between train and truck become evident. Despite the example of Rochelle and New Baltimore, such locations need not be in the countryside. In fact the more typical site is near a major city, where the intersection of infrastructures, suddenly now valuable because of their joint presence, is combined with the usefulness of proximity to a metropolitan area. (The need to find a giant greenfield or brownfield site available for development, and the desire to avoid traffic congestion, generally prevent these new terminals from actually being sited in the city.) An example is the new intermodal terminal operated by Union Pacific in West Memphis, Arkansas (technically in nearby Marion, but usually referred to as being in West Memphis). West Memphis as its name implies is just west of Memphis, across the Mississippi River; it lies at the crossing of Interstates 40 and 55, and a few railroad corridors run through or past it. This infrastructure is primarily tied to the bridges leading over the river to Memphis, and merely funnels through West Memphis on the way, but it put the town in a good position to attract an intermodal terminal.

Though large facilities like these are the crucial hubs of the intermodal freight system, there are also some small terminals scattered about the nation. One such minor terminal opened in 2010 in rural Minot, North Dakota, with the primary purpose of loading containers with grain grown in the Dakotas and bound for Asia. Grain typically does not move by container, but as these containers would otherwise return to Asia empty it makes a convenient cargo for the backhaul. The little terminal, known as the Port of North Dakota, has its rail service provided by BNSF while empty containers are relocated there under the coordination of the shipping line OOCL.[51] The case of Minot illustrates that intermodal terminals on occasion can be sited in remote locations. But even here infrastructural access matters: while Minot is about 75 miles from a highway, and is very far from any metropolis of significance, it is conveniently located along a BNSF mainline.

In addition to these terminals far inland, the terminals at or close to prominent ports are of great importance in the domestic container network, as obviously they are necessary for the transfer of containers from ship to train, or vice-versa. (As already discussed, containers are almost never shifted directly between ship and train, so a separate terminal must exist, ideally within the port's boundaries but more often close by.) The development of some of these

[51] Rip Watson, "Intermodal Projects Advance for Norfolk Southern Corp," *Transport Topics,* Iss. 3911 (September 6, 2010), pp. 8, 12.

terminals near ports in the 1970s and '80s, in particular the Intermodal Container Transfer Facility (ICTF) serving the ports of Los Angeles and Long Beach, has been described. Rising container quantities are putting pressure on such facilities, and so Union Pacific is actively planning to expand the ICTF. (Union Pacific bought out Southern Pacific, which originally ran the ICTF.) Meanwhile plans are afoot for an even bigger and more modern terminal named the Southern California International Gateway, to be built and run by BNSF (Union Pacific's main rival in the West), that will also serve the two ports. The projected cost for this facility, which has run into community opposition and lawsuits but nonetheless seems likely to reach fruition eventually, is an impressive $500 million.[52]

It is the railroad companies that generally build and operate the intermodal terminals. Even when the terminal is built and the land owned by a separate developer—CenterPoint Properties and the Allen Group being the most prominent developers that specialize in this business—it is still meant for a particular railroad company, which then operates it. The trucking companies, and various other logistics providers and IMCs (intermodal marketing companies), obviously use the terminals heavily, and logistics providers depend on them, but it is the railroads that directly run them. There does not seem to be any reason why this has to be the case—one could imagine trucking companies or shipping lines, or some third party, handling the terminals. But the railroads have a long tradition of operating rail yards, piggyback terminals, freight depots and other facilities where railcars are shifted or freight is loaded and unloaded, so container terminals are a logical continuation of this. And it is generally the railroads that have the most to gain—they are seeking to draw container traffic to them, which could otherwise move by truck over their entire land-based journeys. Furthermore they are large and well-capitalized corporations, able to invest in such terminals. But a recently built terminal in Marion, Ohio, is an exception, as it was created and is run by the trucking firm Schneider National. CSX and the Kansas City Southern Railway provide rail service to this small facility, which opened in 2006 and is strategically located near several manufacturers in northern Ohio.[53] It remains to be seen whether this is a harbinger of the future or merely an exceptional case.

The construction costs of the container terminals, and the associated complexes around them, are hefty and give an indication of how valuable they are to the railroads—and of the significance of the container's impact. Just as the railroad companies have spent hundreds of millions of dollars improving their corridors to accommodate stacktrains (as described in chapter 7), so they have paid comparable sums on their new terminals. The aforementioned CSX terminal in North Baltimore, Ohio, that opened in 2011 came at a price of $175 million.[54] CSX is spending $100 million on a terminal in Winter Haven, Florida, and Norfolk Southern is spending $130 million

---

[52] Jennifer Medina, "A Busy California Port Seeks to Grow, But a Neighbor Objects," *New York Times,* April 11, 2013; Dan Weikel, "Pollution Drop From Building Rail Yard Near L.A. Harbor Disputed," *Los Angeles Times,* October 21, 2012; Dan Weikel, "Council OKs Port Rail Yard But Lawsuit Is Threatened," *Los Angeles Times,* May 8, 2013.
[53] Warren, "Breaking Free of Intermodal Gridlock."
[54] Duane Ramsey, "CSX Terminal in North Baltimore Part of $842 Million Project," *Toledo Free Press*, November 19, 2010.

for one outside Memphis.[55] The planned Southern California International Gateway is expected to cost roughly $500 million, as already noted. Often the cost of the surrounding facilities is even greater, though much of it is not borne by the railroads. This was the case for the CenterPoint Intermodal Center, whose total cost (including both the Elwood and Joliet terminals and the many facilities in the vicinity) ran to the staggering sum of approximately $3 billion.[56]

Another way to gauge the importance of the terminals as functional nodes in the overall freight transportation system is by the number of containers transferred at them between train and truck. Each container transfer is conventionally called a "lift" in the industry. A typical figure for annual lifts at a terminal is somewhere between 100,000 and 400,000. While there are assorted minor terminals that shift fewer containers, the railroads generally aim for the economies of scale involved in larger ones, and so the bulk of the traffic goes to substantial terminals that shift at least 100,000 containers per year, and in many cases more than 300,000. The new terminal in North Baltimore, Ohio, for example, is projected to handle over 630,000 lifts yearly in the near future (though a small percentage of this may be trailers moving by piggyback rather than containers).[57] At the BNSF terminal in Elwood, probably the busiest intermodal container terminal in the world, approximately 800,000 lifts are done each year.[58] This astonishing quantity—about 2,200 container transfers daily—is actually comparable to a reasonably large port; it would probably rank somewhere between eighth and twelfth in a listing of the busiest American container ports. (An exact comparison is difficult because ports give container statistics by TEU [twenty-foot equivalent unit], and a TEU can represent either one 20′ container or half of a 40′ container, while a lift represents a container of any size.)

The intermodal terminals are in a sense an extension of the global network of trade deep into the interior of the nation-state's territory. The term "inland port," sometimes used as a synonym for a terminal, indicates the concept quite directly. Stacktrains bring massive numbers of containers from the coastal ports to these inland sites, which hence in a sense become subsidiary gateways, extensions of the real ports. The gateway function is not entirely new for such settings. Chicago for instance has long been a gateway for freight, due to the railroad in particular (a dynamic brilliantly described by William Cronon in *Nature's Metropolis*). But it previously occupied this role in the context of domestic territory, serving as a gateway between its Midwestern hinterland and the rest of the U.S. Now Chicago is increasingly a global gateway, positioned between its hinterland and the rest of the world. As theorists of "splintering urbanism" would argue, Chicago's infrastructure has been globalized. This process takes place within a rhetoric of globalization as well; the promotional materials for a particular terminal, or for a city or region's freight capability, invariably display a map with it at the center and arrows extending out to the rest of the world. No matter whether the place is important (Chicago) or

[55] Spivak, "Freight Finds Its Niche," p. 31.
[56] Spivak, "Freight Finds Its Niche," p. 31; Owen, "Joliet Seeks to Become the O'Hare of the Train-Truck World."
[57] Ramsey, "CSX Terminal in North Baltimore Part of $842 Million Project."
[58] Mongelluzzo, "The Port Moves Inland."

minor (Minot), it is imagined—at least by transportation and logistics providers, and perhaps local economic development officials—as a key node tied into global flows. Which in a sense it is.

But such visions of a vast global space, a smooth and unrestricted field of movement and dynamism, obscure the reality of what happens on the ground at specific locations. The supposedly "placeless" global flows must encounter particular places with their own qualities and histories. Just as previous chapters of the dissertation have argued that the specific qualities of the American railroad and trucking systems—their histories, topographies, practices, cultures, etc.—are of key importance in how the container moves on them, so the characteristics of the sites of intermodal terminals are also relevant. Such factors are perhaps even more applicable for the terminals because at these places the shipping container actually comes to a full stop, no matter how briefly. In this stop or pause, global movement loses its mythical status as a flow, and must confront a particular local reality. The rhetoric of globalization is obsessed with flows, but people and goods cannot be in motion forever—sometimes they must pause and occupy actual places.[59] The global network "touches down" at such locations, and gets entangled in issues of planning, local politics and culture.

The geographer Julie Cidell, in several articles on the exurban terminals outside Chicago, thoughtfully considers these issues. As Cidell notes, most of the large new terminals are sited in places envisioned by their residents as suburban or small-town locales. Typically people wish to hold to those identities, even as they (or their political leaders) hope for some development and growth. The developers of the terminals, and the railroads that run them, must deal with these various local forces:

> On the edges of metropolitan areas, suburban planners are dealing with the pressures of population growth, changes in land use, and the maintenance of a robust tax base. In a world of flows and networks, these planners work within bounded territories. As the basis for land use planning within the USA, these small territories are still highly relevant despite the supposedly placeless world structured by the global logistics network.[60]

The confrontation or cooperation that occurs between the global network and local places is affected not only by such practical needs and physical qualities, but also by how these localities imagine and conceive of themselves. Cidell uses the term "suburban spatial imaginary" to capture this dynamic. While Joliet and Elwood welcome growth and jobs, planners and residents have concerns about the traffic and oversized buildings that come with logistics-related land

---

[59] This notion of the "pause" versus the "flow" is taken from Julie Cidell, "Flow and Pauses in the Urban Logistics Landscape: The Municipal Regulation of Shipping Container Mobilities," *Mobilities*, Vol. 7, No. 2 (May 2012), pp. 233-245.

[60] Julie Cidell, "Distribution Centers Among the Rooftops: The Global Logistics Network Meets the Suburban Spatial Imaginary," *International Journal of Urban and Regional Research,* Vol. 35, Iss. 4 (July 2011), p. 832.

uses. Often they pursue retail and office development, which they see as more beneficial, with greater vigor.[61]

Global and local forces constantly reshape each other. Cidell describes how Will County (containing both Joliet and Elwood) was one of the nation's fastest-growing counties during the 2000s, as housing and other uses spread further and further outwards from Chicago. The logistics industry concentrated its activities on the county, driven by the need to find large plots of land available for development with good rail and road access. The history of Joliet's infrastructural connections, and its position close to Chicago, were obviously relevant. For the most part local politicians and policymakers do not woo logistics-related businesses to come, but do accept them. They generally do not associate an intermodal terminal with the glamour of being a vital node on a global network. The particularities are fine-grained as well—one part of town might be unsuitable for development because its parcels are too small, or because of probable traffic problems. Tax policies, municipal boundaries and zoning codes are all critical in their own ways.[62] Localities actively deal with this new type of industry, and regulate it as they see fit. Some modest new zoning rules for instance have been put in place to make the distribution centers and container storage facilities less unsightly, or to shield them from view. This may discourage the siting of some of these developments in Will County, but planners are not especially bothered by that possibility.[63]

The intermodal terminals are also entangled in local working conditions. Here the issue is generally not the terminals themselves but the distribution centers, warehouses and other facilities nearby which have become controversial for the low pay and shabby treatment of their workers, who are often classified as "temporary" employees. As with the conditions for port drayage drivers discussed in chapter 8, the workers in these facilities are often badly exploited in innumerable ways.[64] Yet potentially they do possess a certain amount of leverage, for the places where they work are crucial linchpins in the global logistics operations of particular companies. The grievances at Walmart's distribution center in Elwood, for instance, have recently grown so strong that lawsuits in relation to unpaid wages are ongoing and a protest (shutting down the facility for a short period of time) even took place, attracting media attention. The situation is complicated by the layers of companies involved—Walmart contracts with a logistics specialist to run the distribution center, which in turn uses temp agencies that actually hire the employees.[65]

---

[61] Ibid., pp. 832-851.
[62] Ibid., pp. 832-851.
[63] Ibid., pp. 845-846.
[64] For an account of the poor working conditions in distribution centers and warehouses in the Los Angeles region, though not necessarily those proximate to intermodal terminals, see Edna Bonacich and Jake B. Wilson, *Getting the Goods: Ports, Labor, and the Logistics Revolution* (Ithaca: Cornell University Press, 2008), pp. 225-240. For broader coverage of the issue in distribution centers, warehouses and some manufacturers, see Michael Grabell, "The 4 A.M. Army," *Time*, June 27, 2013. (http://nation.time.com/2013/06/27/the-4-am-army/, accessed 6/27/13)
[65] Paul Harris, "Walmart Supply Chain: Warehouse Staff Agencies Accused of Wage Theft," *The Guardian*, October 18, 2012.

The intermodal container terminals represent key points in the globalization wrought by the shipping container on the American transportation system. But where other impacts have been specific to a particular infrastructure, such as the railroads or trucking (or the inland waterways, subject of the next chapter), the terminals are at the intersection of those two systems and do not belong clearly to one or the other. The terminals differ also because they are not alterations carried out along routes passing through space, but rather are focused at particular points. As we have seen, though, these sites are closely related to the corridors of the rail and road networks. Thus they reflect the preexisting networks of the nation-state, but also the new dynamic introduced by containerization. Furthermore, in their siting the terminals inevitably become intertwined with a host of local and regional conditions, which the global network of containerization can never escape.

Chapter 10 ~ Slow Going on the Inland Waterways

For most of human history the easiest way to move cargo was by water. For this reason among others, rivers loom large in the history of humanity—the Rhine, Yangtze, Indus, Mekong, Amazon, Nile, and Mississippi are just a few of the names of great significance. Rivers were also crucial to agriculture and other purposes—for supplying drinking water, powering water wheels, and so on. Most of the world's great cities were founded on rivers, either inland or on the coast, even though their riverine origins are far less relevant today. Throughout history there were activities to alter flows of water, but in recent centuries people have been more aggressive in modifying rivers for transportation purposes, such as by dredging and building locks, and have also built canals of great length and size through the landscape. The United States is no exception. Rivers and canals played a vital role in the American transportation network before the coming of the railroad, and though diminished they retain substantial importance today. Furthermore in North America the Great Lakes represent an additional and unique component of the water-based network of movement. All these routes of transportation through the domestic territory—rivers, canals and lakes, often used in combination—are commonly grouped under the term "inland waterways."

This chapter describes the efforts that have been made to move shipping containers along the American inland waterways, a transportation system that despite its historical significance and continuing relevance for freight movement has had little success carrying containers. The idea of using inland waterways in the U.S. to move containers has been advanced frequently since the 1960s. Such an operation is often known as "container-on-barge," or COB, and can have advantages over trucking and railroads in both cost and sustainability. But despite efforts spanning several decades to put this network to use carrying containers, for a variety of reasons inland waterways are rarely used for that purpose in the U.S. Given the logical reasons for doing so, however, it is possible this may change in the future. Inspiration could also come from the European experience, as COB has been successful there for many years and continues to grow.

There is another type of shipping that also carries domestic freight: coastal shipping. This can be regarded as similar to the inland waterways not only because it serves domestic as opposed to transnational purposes, but also since its ships are often relatively small in comparison to those that travel the ocean. On the East Coast and Gulf Coast in particular the nature of the coastline (including the intracoastal waterways that extend for much of this distance) means that shipping is sheltered from oceanic conditions. This allows for a type of shipping similar to that moving on inland waterways, including barges and other boats of various sizes. As with inland shipping, the practice of coastal shipping has dropped off over time due to the growth of the railroad and trucking infrastructures, but it remains widespread for certain bulk goods. On occasion containers have moved by coastal shipping, but not often; as with the inland waterways there is the potential for that to be done on a far wider basis. Given these similarities and parallels with inland shipping, coastal shipping is also briefly covered in this chapter.

The early history of American expansion saw the use of inland waterways for transportation to a degree beyond most nations. The reason lay in the innumerable waterways in the eastern half of the country, which was the region of primary growth and development from the founding of the original British colonies into the early nineteenth century. Even as expansion continued into the West—which with its mountains and deserts lacks long navigable waterways, and was typically traversed by the railroad and stagecoach—the bulk of the country's people and economic activity remained in the East. This vast region, from the Atlantic Ocean to the edge of the Great Plains, contains many rivers that are wide and flow reasonably slowly without many rapids, and hence are ideal for transport. The most important are those of the Mississippi River watershed, primarily the Mississippi, Ohio, Illinois and Missouri rivers. Various smaller rivers along the Atlantic, like the Hudson, Connecticut and Delaware rivers, aided early colonization. The Great Lakes as already noted are a crucial addition to the riverine system, adding a massive series of waterways to the north that connect to the ocean via the St. Lawrence River. To this already impressive system of inland waterways numerous canals were added, the most important of course being the Erie Canal connecting the Great Lakes with the Hudson River. The resulting network represented an extraordinary system for the movement of both people and goods. A traveler in 1836 emphasized "the abundance of its [America's] vast and navigable rivers, its great bays, straits, and lakes, all of which contribute to a coherent interior navigation system incomparable to that of any other continent."[1]

Given this bounty of corridors providing for water-based movement, it was to be expected Americans would put them to good use. The poor condition of American roads was another factor in favor of the waterways. It was not long before some began dreaming of water-based movement across the entire continent; Thomas Jefferson, along with others of his time, had hopes that something of this sort was possible, albeit with a short portage at some point. The journey of Lewis and Clark from 1804 to 1806, commissioned by Jefferson while president, was done in part with the intention of locating such a route, but their portage of 340 miles between the Missouri and Clearwater rivers, much of it through rugged mountains, was far longer than had been hoped for.[2] Meanwhile there was a more immediate need to tie together the areas up and down the East Coast that represented the bulk of the nation's population, and also to connect them with the settlements expanding further inland on the other side of the Appalachians. In keeping with such goals the "Gallatin Plan" of 1808 (titled *Report on Roads, Canals, Harbours, and Rivers*), one of the foundational texts in American national planning, proposed a number of ambitious road and

---

[1] G.T. Poussin, quoted in: Wolfgang Schivelbusch, *The Railway Journey: The Industrialization of Time and Space in the 19th Century* (Berkeley: The University of California Press, 1977), p. 94.
[2] John Warfield Simpson, *Visions of Paradise: Glimpses of Our Landscape's Legacy* (Berkeley, CA: University of California Press, 1999), p. 74-75, 77.

canal-building projects. Albert Gallatin, author of the plan, was Secretary of the Treasury under Jefferson and clearly shared the president's visionary ambition, as he argued for the federal government taking the lead in the creation of this transportation infrastructure. Though the Gallatin Plan as such failed to gain support, in the long run many of its suggested routes would receive some kind of infrastructural connection (in some cases by railroad rather than road or canal).[3]

Americans began to build canals in the late 1700s. While a few were constructed, many more were suggested—some proposals being highly fanciful given the grade change or distance involved, while others were more realistic. One ambitious proposal that did come to fruition was the Erie Canal, whose completion in 1825 revolutionized American transportation and development. While the Gallatin Plan had envisioned a canal on a similar route through upstate New York, it was the state of New York and not the national government that built the Erie Canal. Up to then the predominant infrastructure of freight movement in the frontier region was the Mississippi River watershed, a vast network of rivers, including the Ohio, Illinois and Missouri as well as the mighty Mississippi itself, that ultimately flowed south to New Orleans. That city consequently saw tremendous growth and looked forward to an even brighter future, as did other metropolises on this far-flung riverine network like Pittsburgh, Cincinnati, Louisville, St. Louis and Memphis. The Erie Canal flipped the script, creating a connection through upstate New York that propelled the movement of goods and people throughout a vast network based on the Great Lakes, the rivers that linked them together, and the port of New York City. This did not eliminate the importance of the Mississippi River and its tributaries, which continued to flourish and whose cities kept growing, but dominance began to decisively shift north.

The Erie Canal brought development to a chain of cities in upstate New York, but more importantly it worked to the benefit of New York City, which was able to outstrip its eastern rivals (mainly Boston, Philadelphia and Baltimore) and grow into the nation's premier metropolis. It was also to the advantage of Chicago, well located at the point of shortest portage between the Great Lakes and Mississippi River watershed. (The Illinois and Michigan Canal, completed in 1848 to connect the Chicago River with the Illinois River, eliminated even this portage.) In short, the Erie Canal helped further national infrastructural unity, but it also reshaped that unity to the advantage of certain cities and regions which possessed both inherent geographical advantages and entrepreneurial vision. Economically, the canal's importance was tremendous. Upon its opening, the rate for a ton of freight moving between Albany and Buffalo dropped from $100 to $10. The efficiency of the canal, and of water-based travel in general in these pre-railroad days, was evident from its impact on patterns of freight movement. For example, it was cheaper to move goods between Philadelphia and Pittsburgh by using the canal and other water-based routes, a long circuitous trip geographically, instead of going directly

[3] Robert Fishman, "1808 - 1908 - 2008: National Planning for America," Rockefeller Urban Summit, July 2007, pp. 1-6; Ronald E. Shaw, *Canals for a Nation: The Canal Era in the United States, 1790-1860* (Lexington, KY: University Press of Kentucky, 1990), pp. 22-24.

overland. The sheer quantity of freight on the canal grew to an astonishing extent; as of 1854 it carried 83% of American grain being shipped.[4]

In these years the transport of goods on rivers was mainly downstream, as they could be easily floated in that direction on flatboats and rafts, while getting cargo upstream was a challenge. (On canals and lakes this was not an issue, of course, as there was no flow of water to contend with.) Such freight was usually natural resources like timber and grain, and this was a good fit with the economic and geographic pattern of the time, as the American interior was essentially a giant territory exploited for natural resources (by agriculture, logging, etc.) and relatively thinly settled. But one-way movement imposed limits on growth. The invention of the steamboat, which put the steam engine of the Industrial Revolution to good use, changed the situation. Following Robert Fulton's success with his *North River Steamboat* (widely but incorrectly known as the *Clermont*), introduced on the Hudson in 1807, steamboats—sometimes termed riverboats when they traveled on rivers—began to appear on rivers and lakes, and were widespread by the 1830s. Rapid growth followed, especially at key waterside sites like New Orleans, Cincinnati, Buffalo, St. Louis, Chicago, and Memphis. Larger steamships that could move along the coast—and across the ocean—came into use slightly later. This new infrastructure of steam-powered water-based movement was only dominant for a short time before the railroad began to cut into its traffic in the 1850s, but in its heyday its importance was undeniable. It also took a place in the cultural imagination of the nation, as the writings of Mark Twain and movies like *Showboat* reveal. For Americans lengthy trips by water were the default mode of transportation, and a lively sociability sprang up on steamboats and canal packets.[5] Some of the grander steamboats were positively palatial in their accommodations and furnishings.

The success of the Erie Canal stimulated efforts to build other canals, as areas with insufficient water access sought to better their situation. In addition to canal-building a wide range of projects were carried out to improve shipping on natural waterways, such as constructing locks to deal with falls, and dredging to ensure sufficient depth. By the 1840s the railroads were starting to gain a foothold, and the advantages of that new technology were becoming evident to some, but the construction of canals continued in many places. Like Jefferson before, some dreamed of a national territory bound together by an infrastructure of inland waterways. In 1846 the prominent politician Thomas Hart Benton (not to be confused with the painter of the same name, his great-nephew) proposed that the U.S. be tied together from coast to coast by a series of waterways, with canals making connections where needed.[6]

The paucity of waterways in the West and Great Plains made such visions untenable. Such waterways as did exist were often not navigable, being either too rapid, excessively shallow, or overly subject to fluctuations in their flow. The Platte River, for example, extends across most of

---

[4] K. Jack Bauer, *A Maritime History of the United States: The Role of America's Seas and Waterways* (Columbia, SC: University of South Carolina, 1988), pp. 138, 140.
[5] Schivelbusch, *The Railway Journey*, pp. 107-109.
[6] Ibid., pp. 111-112.

Nebraska, and proved useful to settlers for drinking water and irrigation, but is too shallow for navigation. Ultimately the Missouri River, which Lewis and Clark used for a sizable portion of their journey, did not prove especially useful for navigation either (though it is navigable for some of its length). Closer to the West Coast, on the other side of the Rockies, there are a few rivers of value for navigation, such as the Columbia and Snake rivers in the Pacific Northwest and the Sacramento and San Joaquin rivers in California. But they do not reach far inland, and a vast geographic space—the mountains and plains—separates them from the waterways of the East. Yet even if the concept of using water-based infrastructure to bind together the entire territory of the nation proved impractical, the ambition was noteworthy. Though they could not reach into a vast extent of the country, the waterways played a vital part in stringing together many parts of the nation, and creating an infrastructural unity in its eastern regions. Development and prosperity often followed.

In addition to the lack of navigable waterways in the western regions, the more important factor reducing the importance of water-based movement, and ending the impetus to build canals, was of course the railroad. Rail in particular had a substantial edge in speed, and so it quickly took passenger travel, and goods that needed to move quickly, including mail and packages, away from the water. Trains had the all-important edge of not being bound to the water, and so the flexibility of the domestic transportation network was greatly increased by their growing presence. However, for most freight movement rail was actually no cheaper than the steamboats and canal packets that were so well established. For cargo that did not need to travel quickly, bulk goods especially, the inland waterways remained competitive. This was also the case for coastal shipping, which continued to be important. Over time the ships that moved along the coast and on the lakes grew bigger and more efficient, while on rivers and canals the steamboats were gradually replaced by barges pushed in groups by towboats. The growing size of these carriers meant that many of the older and narrower canals, the Erie Canal in particular, became obsolete.

The late 1800s and early 1900s were a period of more sophisticated efforts to alter inland waterways, as technological advances allowed engineers to reshape and "improve" rivers to make them more amenable for transportation. While canal construction had for the most part ended, the process of transforming waterways was just hitting its stride. Transportation was not the only goal of such alterations, as flood control, agriculture and municipal water systems (i.e., drinking water) were also factors. Government involvement increasingly came at the federal level, as issues involved multiple states and the engineering challenges were best met by federal expertise. This actually dates back as far as the 1820s, when the U.S. Army Corps of Engineers, at the behest of national legislation, first became involved in such work. In the 1870s Congress began to enact legislation on a somewhat more regular basis that appropriated funds to improve waterways and harbors.

Progress was slow for the next few decades, however, and so in 1907 the Inland Waterways Commission was set up, followed by the U.S. National Waterways Commission in 1909. The latter organization worked particularly hard to encourage cooperation between waterborne transportation and railroads—an early effort towards intermodalism. World War I deepened government involvement in the entire transportation infrastructure, including waterways, as private enterprise proved utterly inadequate to the demands of wartime logistics. This led to the establishment of the Inland Waterways Corporation in 1924, founded and run by the federal government, which operated the inland water carrier Federal Barge Lines.[7] (The viability of such an operation eventually proven, Federal Barge Lines was sold to private interests in 1953.) In addition, the waterways were not neglected by those far-sighted transportation planners in the 1920s and '30s who promoted cooperation and intermodalism between the various transport modes. While their main focus was on the railroad and the automobile, they routinely mentioned waterborne transportation as well.[8]

As with the railroads and highways, then, the inland waterways transport network has long been a national system, planned and implemented with many national concerns in mind, and functioning at least to some extent at a national scale. It can best be compared to roads and highways, perhaps, in that its routes of movement have been built, improved and maintained by the government, while private enterprise (with the exception of Federal Barge Lines) is responsible for actually hauling goods. Of course rivers and lakes are not "built" by anyone, but the government has altered and maintained them to such an extent that the comparison is reasonable. With railroads in contrast the actual construction has typically been done by the corporations, though government involvement is still by necessity very heavy, most notably for the taking of property by eminent domain (or through land grants) in order to make rail corridors possible.

The changes to rivers done for the purpose of allowing or improving navigation generally fall into two categories. The more modest type of alteration is to improve river channels through dredging, widening and removing obstacles, but not to construct dams or locks. In this case an open channel remains and the river is regarded as free-flowing. This is the case with the Mississippi River between St. Louis and New Orleans, for instance. The more dramatic alteration, for a river with rapids, difficult obstacles, or that simply flows too quickly, is to "canalize" the waterway. This typically means building a series of dams and locks (and perhaps some canals, though not necessarily) so water can continue to flow, changes in elevation can be accommodated, and ships or barges can move easily and safely. The Ohio River, the Illinois River, and the Mississippi River north of St. Louis are all canalized, as are many other rivers across the nation. While canals were built in the nineteenth century to get around particular rapids and waterfalls, the practice of canalizing long stretches of river did not become feasible until the early 1900s. In 1910 the federal government initiated work to canalize the Ohio River all the way from Pittsburgh to its confluence with the Mississippi at Cairo, Illinois; the project was finally finished in 1929. Work to canalize the Upper Mississippi (north of St. Louis) was begun in

---

[7] *National Waterways Study – A Framework for Decision Making – Final Report*, U.S. Army Engineer Water Resources Support Center, Institute for Water Resources, January 1983, p. I-19.
[8] Stephen B. Goddard, *Getting There: The Epic Struggle Between Road and Rail in the American Century* (New York: BasicBooks [HarperCollins Publishers], 1994), pp. 101, 142, 150.

1934.[9] Such early projects were generally overhauled and greatly improved by another round of more technologically advanced dams and locks in the post-World War II period.

The Ohio and Illinois rivers flow into the Mississippi River, as does the Missouri River which despite its great length (and its own history of engineered alterations) is not as heavily used for transportation as those others. Many less important rivers of course also flow into these rivers. The Mississippi River's watershed therefore represents, in the tremendous extent of its waterways, the greatest pathway for waterborne inland movement in America. The main means of freight movement over this system is now generally by barge, often with multiple barges connected together and pushed by a towboat. (The terminology is confusing, as a towboat does not in fact tow or pull barges behind it but rather pushes them in front.) Just as the railroad and road infrastructures have spatial dimensions that are crucial to their workings—spatial regimes, as I have called them—so do the inland waterways. For the many waterways of the Mississippi watershed, the one most crucial dimension is the minimum depth of nine feet that is put in place and constantly maintained by the work of the Corps of Engineers. This depth applies to the entire navigable extent of these rivers: the Mississippi all the way to St. Paul, the entire Ohio (up to its origin in Pittsburgh), the entire Illinois (including the canals connecting it to Lake Michigan), and the Missouri up to Sioux City, Iowa. The importance of this particular depth can be gauged from the name of the project done from 1927 to 1940 by the Corps to improve navigation on the Upper Mississippi: the Nine-Foot Channel Project.

Obviously such a dimension is directly tied to how low a fully loaded barge, ship or boat can rest in the water. On many of these waterways a minimum width of 300 feet is maintained, which of course controls how wide a barge, or group of barges held together (that being the more common situation), can be. The size of locks imposes an additional constraint, though a tow of multiple barges can go through a lock in stages—the barges being disattached from each other and then reattached. But obviously a single barge can be no larger than the lock. On the Upper Mississippi the typical lock is 110′ wide and 600′ long, meaning the largest barge could be just a bit smaller in each dimension. Most barges are not nearly so large, however—the most common size is 195′ in length and 35′ in width. These dimensions are linked to the lock size, as a connected group of such typical barges, if it is composed of three barges by three barges, measures out to a 105′ width and 585′ length, just able to squeeze within a 110′ x 600′ lock.

Such uniformity in the spatial regime helps convert a series of local and regional waterways into a larger system that approaches a national scale. It would be an exaggeration to say the spatial regime of inland waterways is comparable to the uniform track gauge of the railroads, or the minimum lane width of the highways, for the waterways are not unified at the national level and do possess variations. But it is significant nonetheless. To be able to use the same barge on voyages all the way to and from the distant points of New Orleans, St. Paul, Chicago and Pittsburgh is a formidable advantage, and it is a standardized spatial regime that makes it possible. This type of standardization is of course not limited to the U.S. As early as 1810 a

[9] *National Waterways Study*, U.S. Army Engineer Water Resources Support Center, p. III-40.

commission of the Corps des Ponts et Chaussées argued, in the rationalistic tradition of French bureaucracy, that their nation's rivers and canals required waterways of uniformity so as to knit together a national network: "Since these divers waterways make up one and the same system, they must accommodate the same boats… so their locks must be of a uniform size."[10] As with the railroads, the word "gauge" can be applied to such standardized dimensional systems for inland waterways, though the term is rarely used in this context in the U.S. In 1879 the Freycinet gauge (named after Charles de Freycinet, French Minister of Public Works at the time) was introduced in France, and gradually most of the canals and locks across that nation would be built to this standard of a 128′ (39 m) length, 17′ (5.2 m) width, 7′-3″ (2.2 m) depth and 12′ (3.7 m) clearance above the water.[11]

Improvements to the Mississippi, Missouri, Ohio and Illinois have continued in the postwar era and up to the present, both to maintain the channels and to allow for larger barges. Given the dominance of trucking and the railroads for freight movement, however, the need for expensive construction projects is often questioned, and they are frequently condemned as subsidies or "pork." In 1978 barge operators for the first time began to pay a fuel tax into the Inland Waterways Trust Fund to cover a portion of these costs. In the 1980s a nascent environmental awareness entered into the decision-making process; this did not reduce the desire to modify the rivers, channels and canals, but added new concerns to be heeded.[12] The Corps of Engineers, ever more dedicated to satisfying the barge industry and politicians in the region, got embroiled in a scandal in the early 2000s over the quantitative methodology it was using to justify new construction on the upper Mississippi. The result was not the elimination of the project, though, but its expansion to deal more thoroughly with environmental factors.[13]

The dominant role of the Mississippi and its tributaries should not obscure other inland waterways of importance, such as the Mobile River, the Tennessee-Tombigbee Waterway, the Hudson River, the Chesapeake and Delaware Ship Canal, the Columbia River, the Snake River, the Sacramento River and the San Joaquin River. Equally important are the intracoastal waterways that run along most of the Gulf Coast and also much of the East Coast. But most significant is the giant system of inland navigation formed by the Great Lakes. These massive lakes, interconnected by a series of rivers and canals and linked to the sea by the St. Lawrence River, constitute a massive system that reaches from the Atlantic Ocean deep into the North American heartland of both the U.S. and Canada. Like the Mississippi Watershed it occupies a vital place in American history and in the geography of the nation's transportation—and has also been of great importance for Canada. While lakes have been used for waterborne transportation in many places throughout history, there is no parallel to the Great Lakes system, in terms of its

[10] Cecil O. Smith, Jr., "The Longest Run: Public Engineers and Planning in France," *The American Historical Review,* Vol. 95, No. 3 (June 1990), p. 660.
[11] Wikipedia, "Freycinet gauge." (http:// http://en.wikipedia.org/wiki/Freycinet_gauge, accessed 6/18/12)
[12] Daniel McCool, *River Republic: The Fall and Rise of America's Rivers* (New York: Columbia University Press, 2012), pp. 140, 145.
[13] Ibid., pp. 145-152.

extent and size, anywhere in the world. This network of water movement has a character very different from other inland waterways, for conditions on the giant lakes can be rough and consequently real ships are needed, rather than the barges with their flat bottoms that move on rivers and canals.

While the Great Lakes have long been used for waterborne movement, their connection to the ocean was more tenuous. The St. Lawrence River provides a natural corridor, as it flows from Lake Ontario to the Atlantic, and allows for deep-sea access as far inland as Montreal. But the river contained rapids that were not navigable between Montreal and Lake Ontario. In addition, the link between Lake Ontario and Lake Erie was made more challenging by that minor obstacle known as Niagara Falls. The construction of the Welland Canal in 1829 created a route in Canada between those two lakes, avoiding the falls. A few years earlier the Erie Canal had established the revolutionary connection between Lake Erie and the Hudson River, thus tying the Great Lakes to the U.S. East Coast. But over time the canal's limitations in size became an issue—ships or barges of substantial size could not move through, and so transfers of freight at Buffalo (and sometimes Albany) were necessary. It was enlarged several times to accommodate larger barges, but making such a long corridor deep enough for the big ships of the Great Lakes was out of the question.

The solution lay with the St. Lawrence River. During the mid-1800s it had become navigable, as the Beauharnois and Lachine canals were built from 1842 to 1848 to provide a way around the river's rapids. The Great Lakes were now open to direct traffic with the Atlantic, but the canals and locks were insufficiently large to accommodate most ocean-going ships—an issue that would recur over time. Likewise, the ships that plied the lakes generally did not venture into the ocean. Expansions and improvements were made to the St. Lawrence's channels and canals in the early 1900s but this problem remained, although shipping on the lakes and river was greatly boosted by such improvements and some ocean shipping did come.[14] Finally in the 1950s the most dramatic expansion yet was carried out: the St. Lawrence Seaway, finished in 1959 to great fanfare. The seaway itself extends from Montreal to Lake Erie, and its existence in effect allows large ships to traverse the entire system of the Great Lakes and St. Lawrence River, all the way from northern Minnesota to the ocean. This incidentally put an end to what little freight traffic the Erie Canal still possessed.

The channels and locks of the St. Lawrence Seaway allow for ships with maximum dimensions of a 730′ length, 75′ width and 25′-6″ depth. (As it is ships that move on the lakes the depth required is far greater than for a river or canal, upon which barges move.) At the time this seemed adequate to attract many ocean-going ships, but it would not be that way for long as ship sizes steadily got larger and by the 1970s the seaway was clearly undersized. Proposals for additional expansion have gained little traction since that time, and the ocean-going traffic on the seaway and lakes is modest. Another drawback with the seaway is that it freezes over for a few months in the winter (as do many northern inland waterways). Today only about 10% of the Great Lakes' traffic consists of oceanic craft, called "salties," while the other 90% are "lakers" that

[14] Bauer, *A Maritime History of the United States*, pp. 202-203.

stay within the lakes and rivers. The lakers that traverse the entire extent of the seaway are of course limited in size to the same extent as the salties. But those lakers that stay on the upper lakes (Superior, Michigan, Huron and Erie) can be somewhat larger, as their size is controlled by the Soo locks on the St. Marys River between Lake Superior and Lake Huron, whose dimensions are more generous than the locks of the seaway. (The Welland Canal is part of the seaway and its locks impose the same limits as the rest of the seaway, so these larger lakers cannot reach Lake Ontario.)

Given the dimensional limits for depth, today there is no question of major ocean-going ships entering most inland waterways. There are a few exceptions, but they are rare and do not extend far. On the Mississippi River a 40′ depth is maintained up to Baton Rouge, Louisiana, a distance of 234 miles. The Sacramento River Deep Water Ship Channel connects that city with San Francisco Bay; it is 30′ deep and runs 43 miles. There are some other similar examples. These depths, though superior to that of the St. Lawrence Seaway, are still too shallow—except for the Mississippi to Baton Rouge—for the largest ships. Furthermore ship lines generally prefer to reach their ports as soon as possible so they can unload, reload and turn around, so they are reluctant to go far inland anyway. (Some major ports for ocean-going vessels, such as Philadelphia and Portland, are actually located on rivers a very short distance upstream from the sea, and so the distinction between a coastal port and inland port can be blurry. In general—and for our purposes—the topic of inland waterways does not include these short waterways of substantial depth that lead to major ports serving ocean shipping, and these ports are regarded as coastal ports rather than inland ports.)

The failure or impossibility of oceanbound container ships to reach into inland waterways has obviously made it more challenging to move containers on these waterways. In addition the transport of freight by inland waterways is very slow compared to trucks and trains; this is not such an issue with bulk goods, which are not on tight schedules (and are much harder to move by truck or train given their massive quantities and/or weights), but for most freight it is a drawback, especially in an era of tightly managed just-in-time supply chains. The failure of inland ports to develop container facilities has been another strike against them. But the basic issue has little to do with the shipping container, since even before containerization the inland ports generally were not receiving much in the way of direct ocean-going freight. Actually the container offers a way to improve the situation: since it makes transfers between transportation modes easier, it becomes feasible to shift freight between ocean-going ships and the barges or small ships of inland waterways. (With breakbulk packing methods this would be too time-consuming and expensive—the logical choice is to put the freight straight into trucks so it is only transferred once.) While the lack of speed is an issue, it should not be an absolute roadblock. Not every container must move quickly (with supply chains sometimes reliability is actually more important than mere speed), especially those carrying bulk goods or empty ones being repositioned. Furthermore some inland waterways are quite short and so the time lost would be insubstantial, while getting beyond the traffic slowdowns of the port's metropolitan region could be beneficial.

The situation in the 1970s was complicated by the existence of a cargo-carrying system for ocean shipping that seemed highly amenable to the use of inland waterways: Lighter Aboard Ship, better known by its acronym LASH. Through LASH operations, ships carried unpowered barges (known as lighters) directly on board the ship, and used a shipboard crane to place them in or remove them from the water. The freight was carried on these barges, which when properly towed or pushed could move between the ship and the port terminal, with the advantage of being able to handle very shallow depths which also allowed them to move on inland waterways. (Thus the ship itself did not need to dock in port, and that was especially helpful if modern terminal facilities were lacking.) By its very nature then LASH was well suited to the use of inland waterways. LASH has faded away, and today is almost entirely obsolete except for certain specialized purposes, but in the 1970s and early '80s many LASH ships were built and put into use, and the practice seemed poised to become a significant part of the shipping business. A similar system known as Seabee was introduced by the Lykes Brothers shipping line; Seabee differed from LASH in that the barges were larger, and they were brought onto the ship by means of an elevator-like device at the stern, rather than a crane. The LASH and Seabee systems were not entirely incompatible with the use of containers, and in fact occasionally carried them (an example will be described shortly), but in general they were perceived as being in competition with containerization, and their eventual failure cleared the way for the container to completely dominate non-bulk cargo shipping.

As the use of shipping containers grew in the 1960s and '70s, there were hopes that some of the Great Lakes ports would handle this new cargo. But the trend toward building ever larger container ships, some too large for the St. Lawrence Seaway's locks, made this difficult. Furthermore the practice of container shipping increasingly concentrated on the rapid turnaround of ships and on maximizing their ocean crossings, so there was a reluctance to serve ports any more distant than necessary. Cruising all the way down the seaway and through some of the lakes did not fit with this new shipping paradigm; it was more logical to use coastal ports and then trucking or rail overland to reach the Midwest. Nevertheless some efforts were made. The British shipping company Manchester Liners had established trans-Atlantic service to a few Great Lakes ports in the early 1950s before completion of the seaway, using relatively small ships carrying breakbulk freight. In the late 1960s and early '70s shipping over the Atlantic was rapidly switching to containerization, and so in 1971 the company began the first container ship service on the Great Lakes, running routes across the Atlantic and stopping at Detroit and Chicago. This proved uneconomic and was soon modified, with the ocean-going ships of Manchester Liners terminating at Montreal and feeder vessels continuing into the seaway and lakes.[15] This feeder operation could be regarded as domestic in nature, as it linked two points within North America (though strictly speaking across the national border between the U.S. and Canada). But it did not last long either, especially as the Great Lakes ports failed to develop better facilities to handle

[15] J.R. Whittaker, *Containerization* (2nd ed.) (Washington, D.C.: Hemisphere Publishing [John Wiley & Sons], 1975), pp. 211-212.

containers. Since that time there has been little container transport on the Great Lakes or St. Lawrence Seaway.

It appears the first regular container transport on the Mississippi River was initiated by the Lykes Brothers shipping company in 1971. As already noted Lykes Brothers introduced the Seabee system of barges carried on ships, and this operation was used to carry containers on the river. Containers were transported on Seabee barges between St. Louis and New Orleans, where the barges were placed on ships headed to Europe. The amount of traffic was modest, for only about 4,000 TEUs (twenty-foot-equivalent units, i.e., one 20′ container or half of a 40′ container) shipped annually. The Seabee barges held 24 containers, though they could be reconfigured to hold 32 containers when necessary. A few normal river barges, able to hold 36 containers, were also used. Most of the freight consisted of diapers, exported by an American manufacturer to Europe. But when the company decided to construct a factory in Europe for making the diapers there, this cargo was no longer available and not enough alternative freight could be found to replace it. The operation ended in 1973.[16]

In 1981 another COB operation was planned on the Mississippi, with the intent of using St. Louis as the inland port once again. But the Illinois Central Gulf Railroad responded to the projected service by lowering its rates on container transport, and the idea was abandoned. In 1983 Tricontinental Shipping and Terminal Services, known as Tricon, and the Riverway Barge Company started up a service, using terminals at several locations on the river, but this failed as Tricon went into bankruptcy. Alter Barge Lines briefly continued the service, but chose to terminate it in 1984. In the very same year Leaseway Transportation briefly initiated its own COB operation, only to drop it near year's end. Once again rate-cutting by the Illinois Central Gulf Railroad made it hard to achieve profitability. But larger issues probably cut deeper. Located at the mouth of the Mississippi, New Orleans was the key to the system, the point where containers were transferred from barge to shore and then onto the larger ships of the ocean. But the city never established itself as an especially important container port in the first place, and the growth of landbridge container transport by rail, from the West Coast to the eastern portion of the country, meant that Gulf Coast ports were not in a competitive position.[17] For shipping companies the logical approach was to utilize either East Coast or West Coast ports—going into the gulf made the voyage longer with no compensating benefit.

Another effort at COB service on the Mississippi River was launched in 2004, this time by the barge company Osprey Line, which also sought to run barges carrying containers on the intracoastal waterway of the Gulf Coast. Osprey's main operation on the Mississippi went between New Orleans and Memphis, but it sometimes extended further north on the Mississippi, and Louisville on the Ohio River and Chicago reached by the Illinois River were also occasionally accessed. The containers were primarily global containers carrying international freight; attempts

---

[16] *Container Transport by Inland Waterways,* Ports and Waterways Institute, Louisiana State University, February 1987 [Prepared for U.S. Department of Transportation, Maritime Administration, University Research Program, Final report under contract DTMA91-85-C-50116], pp. 13-14.
[17] Ibid., pp. 15-17.

to interest domestic shippers in using the service did not bear fruit. The service apparently was modestly successful for a few years, but ended in 2009, though the line's COB along the Gulf Coast is still offered on an inducement basis (i.e., not regularly scheduled, but available to interested shippers).[18] Various ports in the Mississippi River watershed sporadically express interest in COB, and proposals for a special terminal to handle COB in New Orleans have been floated, but so far little seems to come of it.

While efforts on the Mississippi have faltered, a COB operation on the other side of the nation has thrived. The western regions of the nation, as already discussed, are not generally conducive to movement by inland waterways. There are a few exceptions, but even these are not comparable in scale or importance to the great waterways of the East. One is the system in the Pacific Northwest comprised by portions of the Columbia and Snake rivers, which extends from Lewiston, Idaho, to the Pacific Ocean. This navigable segment, while quite long in its own right, is only a modest part of the overall course of these two lengthy rivers. The Columbia begins in British Columbia and makes its way southward into the U.S. where it enters Washington and continues south for a time before abruptly turning westward and demarcating the border between Washington and Oregon as it makes its way to the Pacific Ocean. The Snake originates in Wyoming and flows west through Idaho, north along the border between Idaho and Oregon, and then west into Washington where it enters the Columbia. The rivers do have a history as a transportation corridor, but not one comparable to the major eastern waterways. Their role has loomed larger in hydropower and irrigation, and the many dams built since the 1930s also had the effect of eliminating certain rapids once present and thus helped create a channel more amenable to shipping. Of course shipping requires locks to get past the dams, and these are provided along the navigable segments of the rivers. The port of Portland functions as the gateway for the Columbia-Snake system, and is the point where cargo is transferred between the barges that ply the rivers and the ships of the ocean. (Portland is actually on the Columbia River 105 miles inland from the ocean, but it is accessible to ocean shipping as that portion of the river is sufficiently deep.)

During the late nineteenth and twentieth centuries various projects were carried out to make the Columbia and Snake rivers more easily navigable. Frequently the transformations came through dam construction, in which the main objective was irrigation and/or hydropower but navigation was also accommodated. The Columbia-Snake system gained its present form in 1975 upon completion of the Lower Snake River Project. The route is 465 miles long in total, but its extent of inland navigation runs 360 miles from Lewiston to Portland (the remaining 105 miles being the deeper channel from Portland to the ocean), with a minimum depth of 14'. The

---

[18] John Frittelli, *Can Marine Highways Deliver?* Congressional Research Service [CRS Report for Congress], January 14, 2011, pp. 4-5, 7 (Also available online at http://www.fas.org/sgp/crs/misc/R41590.pdf, as of 6/19/12); National Cooperative Freight Research Program, *North American Marine Highways* [NCFRP Report 5] (Washington, D.C.: Transportation Research Board [The National Academies], 2010), pp. 20, 62 (Also available online at http://onlinepubs.trb.org/onlinepubs/ncfrp/ncfrp_rpt_005.pdf, as of 6/9/12); Zoe Double, "Shortsea Shortchanged?," *Containerisation International*, Vol. 37, No. 10 (October 2004), pp. 44-47.

waterway has grown into a prominent corridor for the movement of bulk goods by barge, especially wheat exports from Oregon, Washington, Idaho and Montana. More surprisingly, it has continuously carried shipping containers through COB service since the 1970s, in quantities that (while small in the overall scheme of things) have risen over time. This is far and away the most successful example of moving containers on an American inland waterway. Initiated in late 1975, just 130 containers were carried that year, but in 1976 the operation ramped up and 6,330 TEUs were transported, and by 1985 the annual quantity reached about 30,000 TEUs.[19] It has plateaued at roughly 40,000-50,000 TEUs in recent years. Currently about one quarter of the containers exported through Portland reach the port through this COB service, so its role is significant.[20]

Figure 10.1: COB on the Columbia-Snake river system

Source: *Port Dispatch* [Port of Portland website] (http://www.portofportland.com/publications/PortDispatch/post/Locks-Reopen-Following-Extended-Closure-for-Maintenance.aspx, accessed 12/15/12)

The success of COB on the Columbia-Snake system is due to several factors. The port of Portland worked hard to support the concept, doubtless seeing its own prosperity as linked to the rivers that are such a valuable transportation link to it. For instance, the port sold surplus container cranes to some of the inland ports for nominal prices. Portland, the inland ports, and the barge lines cooperated extensively in building up the network and setting rates. The key factor is probably the nature of the freight, as the cargo in these containers is not time-sensitive

[19] *Container Transport by Inland Waterways,* Louisiana State University, pp. 4-5.

[20] Pacific Northwest Waterways Association, “Columbia Snake River System” [slide presentation], Portland, OR, undated [circa 2005-2012], p. 11. (http://aapa.files.cms-plus.com/SeminarPresentations/05_Shallow_Draft_Meira_Kristin.pdf, accessed 6/20/12)

and is of low value, so a few extra days of transit on sluggish barges is not an issue. Most of the cargo is similar to bulk in nature, consisting of items like forest products, potato products and hay cubes. An important cargo in the early years was paperboard.[21] Most of the containers returning upriver are empties being repositioned. The barges with containers are grouped with other barges carrying bulk goods, and the assemblage of barges is pushed by a towboat. If it were only the container barges being transported the arrangement might not be profitable, but since these barges can "tag along" in larger groups the additional expense is modest. A number of barge lines provide the service. The barges are loaded and unloaded at Terminal 6 in Portland, the same terminal where deepwater ships dock, so this adds more convenience and makes the transfer of containers easy.

One way to achieve better cooperation between transportation modes is to form alliances or mergers, or for corporations powerful in one mode to pursue business in the other. Previous chapters have discussed how the railroad and trucking industries pursued these goals on occasion. Shipping lines also following this logic at times—the extent of American President Lines' involvement in rail operations during the 1980s is described in chapter 7. Perhaps the most notable effort came from a railroad that bought a shipping company, having already (with less fanfare) purchased a barge line as well. As described in chapter 7, the railroad company CSX in 1984 took a controlling interest in the major barge company American Commercial Lines, a transaction that had to be approved by the Interstate Commerce Commission. The potential for efficient joint containerized operations seemed strong, especially when CSX made the blockbuster move in 1986 of acquiring Sea-Land, the shipping company formerly run by Malcom McLean that had been pivotal in the development of the shipping container. But having made this apparent commitment to intermodalism, CSX was unable or unwilling to follow through. In 1998 CSX spun off American Commercial Lines into an independent company (and in 1999 sold Sea-Land to Maersk, the giant Danish shipping line), and so its possible involvement in COB went unrealized. As with the railroads and trucking, corporations ultimately chose not to aim for the synergies of controlling multiple modes, but rather to focus on their core specialties. Cooperation, often achieved only gradually over time and with difficulty, must happen between different companies, sometimes thanks to pressure exerted from intermediaries or institutions. It is fair to say that in the U.S. this sort of cooperation between modes, and the supporting presence of institutions, is still being developed for COB.

In addition to the movement of freight on inland waterways, there is also shipping that takes place along the coast. As noted earlier such coastal shipping is in many ways comparable to that of inland waterways, as it is domestic rather than transnational. Along much of the American coastline, especially the East Coast and Gulf Coast, there are routes largely sheltered from ocean conditions—the intracoastal waterways already mentioned—and so barges can even be used. Malcom McLean's original Sea-Land container service was an example of coastal shipping, as it

---

[21] *Container Transport by Inland Waterways,* Louisiana State University, pp. 5, 7-8; National Cooperative Freight Research Program, *North American Marine Highways*, p. 33.

ran between New York and ports in the Southeast. Likewise the pioneering container operations in the Pacific Northwest during the 1950s were coastal in nature. (Technically a few of these were international rather than domestic, as they traveled between American and Canadian ports, but they were certainly coastal at any rate.) But by this time coastal shipping was in decline for the most part, as railroads and trucks were taking away its traffic. After Sea-Land abandoned container transport along the coast to focus on the more profitable global business, there was little if any coastal shipping of containers.

In recent years a few modest efforts have been launched to build up some coastal shipping of containers. Generally the objective is to serve minor ports where the ocean-crossing container ships do not stop. This brings containers closer to their final destination or point of origin, resulting in much shorter container trips by truck or train, which is a positive in terms of the environment and traffic congestion. Unfortunately it has been difficult to make the concept pay off. The case of Osprey Line's activity along the Gulf Coast has already been mentioned. Another example was the Port Inland Distribution Network (PIDN) centered around the New York region and supported by the Port Authority of New York and New Jersey. Initiated in 2002, the PIDN consisted of railroad operations and movement on an inland waterway (the Hudson River, linking to Albany) as well as projected coastal shipping by barge to small regional ports like Bridgeport, Connecticut, Providence, Rhode Island, and Camden, New Jersey.[22] But within a few years the program disappeared. A more longstanding operation, one that appears to be moderately successful, is that of Columbia Coastal Transport, which since 1990 has been using barges to shuttle containers back and forth between various Northeastern ports. While the specific points served have varied over time, the company's general practice has been to connect major container ports. Hence it differs from what the PIDN was seeking to achieve, but the underlying benefits in terms of the environment and reduced road traffic still apply.[23]

While COB has seen repeated failures in the U.S. the situation is quite different in Europe. In the early 1970s COB service was established on the Rhine River by the barge line European Waterways Transport, which began the operation with just two barges each carrying about 50 TEUs. Cranes were installed at the inland ports of Mannheim, Strasbourg and Basel along the river. The service grew steadily; as of 1977 the volume of container movement on the Rhine was 40,000 TEUs per year, and by 1985 it reached 220,000.[24] By the late 1990s about 25 barge operating companies were carrying containers. The average barge capacity was 180 TEU, and

---

[22] *Port Inland Distribution Network [Fact Sheet],* The Port Authority of New York and New Jersey, New York, March 2006 (http://www.panynj.gov/doingbusinesswith/seaport/html/port_inland.html, accessed date unknown, circa 2010, link no longer active); National Cooperative Highway Research Program (Transportation Research Board), *Rail Freight Solutions to Roadway Congestion—Final Report and Guidebook* [NCHRP Report 586] (Washington, D.C.: Transportation Research Board, 2007), pp. 58-59.
[23] Joseph Bonney, "Columbia Coastal Expands Container-Barge Service," *The Journal of Commerce,* March 13, 2012; R.G. Edmonson, "Columbia Coastal Halts NJ-Boston Service," *The Journal of Commerce,* August 25, 2010; National Cooperative Freight Research Program, *North American Marine Highways*, p. 60.
[24] *Container Transport by Inland Waterways,* Louisiana State University, pp. 9-10; G. Van Den Burg, *Containerisation and Other Unit Transport* (rev. ed.) (London: Hutchinson Benham, 1975), p. 183.

approximately every two hours a barge departed from the port of Rotterdam, heading up the Rhine towards any of the 32 inland ports in place by that time.[25] Since the 1990s the practice has expanded further, and spread to other European waterways. From 1995 to 2005 the volume of containers transported annually on European waterways grew from roughly 500,000 TEUs to about 4 million TEUs. Traffic on the Rhine accounts for approximately half of this. At the ports of Rotterdam and Antwerp, two of the largest ports in the world, as of 2005 about 25% of the containers passing through were transferred to or from barges. Barge capacities vary greatly but are generally between 30 and 200 TEUs; the extremely large new JOWI-class barges however can hold around 500 TEUs.[26] The European barges are usually (though not always) self-powered, as opposed to the American system of using a towboat to push several barges.

Figure 10.2: COB on the Rhine

Source: Rhinecontainer website [News], "Transbox extends fleet," January 9, 2012 (http://www.rhinecontainer.nl/en/news/60/Transbox%20extends%20fleet, accessed 12/15/12)

COB has grown rapidly on French waterways since the late 1990s, with the Seine River benefiting most thanks to the presence of Paris inland and the major port of Le Havre at the

[25] Adrian Bascombe, "Europe's 'Green' Arteries," *Containerisation International,* Vol. 30, No. 6 (June 1997), p. 79.
[26] *COLD: Container Liner Service Danube,* Via Donau in cooperation with Constanta Port Authority and Mierka Donauhafen Krems, Vienna, August 2006, pp. 11-12. (available online at http://www.via-donau.org/fileadmin/group_upload/5/projektseiten/cold/COLD_Final-Report-___Annex.pdf, as of 6/15/12)

river's mouth. (A large amount of COB service in France is also provided by the Rhine, as already described, since that river runs along the nation's eastern border for a substantial stretch.) 130,000 containers journeyed on barges into and out of the Ile-de-France (the greater Paris region) in 2009.[27] Several inland ports along the Seine have expanded and acquired cranes and equipment to handle containers, the largest being at Gennevilliers, and more are under development. By one estimate, 13% of the merchandise brought into the Ile-de-France now comes by barge.[28] An important new waterway project that is just beginning construction in northern France, the Seine–Nord Europe Canal, will (if completed) create a better connection between the Seine and the waterways of northern France and Belgium, which in turn tie into the Rhine. (It would be very hard to imagine such a major inland waterway project being attempted in the U.S. nowadays.)

It is not only major European waterways that now move containers by barge—smaller ones are getting into the picture. The Manchester Ship Canal in England is just 36 miles long, running from Liverpool on the coast to Manchester inland. It was a massive infrastructure project of its time, opened in 1894, that allowed the largest ocean-going ships to access Manchester directly. As ships grew bigger the canal became obsolete, but recently its fortunes have revived through the use of barges that ply the waterway carrying freight between the port of Liverpool and points inland. While most of the freight is in bulk goods, COB has also been introduced; the idea came from the success of COB in continental Europe and the barges were acquired from the Netherlands. As of 2011, 10,000 containers moved on the canal annually, roughly 5% of Liverpool's container traffic. As elsewhere, the environmental benefits of this transport mode are highly touted, but the service is also competitive economically. Though the distance may seem trivial, there is an advantage to getting beyond the local Liverpool traffic and slightly inland, including savings in fuel consumption.[29] The time lost, in comparison to truck or train transport, is relatively inconsequential; as one importer of wine points out, "it takes six hours for the journey, but considering the wine has taken six to seven weeks to get here, that's a small percentage in the overall lead time in the supply chain."[30] Currently there is talk of implementing COB on other British canals, and generally of exploiting the nation's waterways more effectively. London in particular offers possibilities, with the appealing option of taking some trucks off its clogged roads and moving their cargo instead by the city's little-used canals and rivers.

It is hard to pin down the reasons for the diverging fates of COB in Europe and North America, but several factors are notable. The giant ports of Rotterdam and Antwerp both possess direct access to the Rhine, Europe's most important waterway for freight movement, making

---

[27] Anne Rohou, "Voie d'Eau, Voie d'Avenir," *Direct Matin/Ile-de-France* ["*Le Monde* pour *Direct Matin*"], No. 731, September 15, 2010, p. 8.

[28] Olivier Razemon, "Gennevilliers, Le Rungis Fluvial," *Direct Matin/Ile-de-France* ["*Le Monde* pour *Direct Matin*"], No. 840, March 8, 2011, p. 6.

[29] Nick Glass, "Historic Canal Reborn as Low-Carbon Cargo Route," CNN website, August 17, 2011. (http://articles.cnn.com/2011-08-17/world/canals.carbon.transport_1_historic-canal-canal-network-british-waterways?_s=PM:WORLD, accessed 8/18/2011)

[30] Ibid.

COB a logical choice to pursue. This contrasts with the largest North American container ports, which generally have no access to significant waterways. As distances are not far in Europe, perhaps the difference in time between barge and truck or train is not so significant as in the U.S. As of the late 1980s, in fact, European COB was actually competitive with both trucking and rail with regard to speed.[31] While barges obviously do not move as swiftly, various issues slowed the other two modes down. Problems with traffic make trucking less appealing, and the various national railroads have not done well in coordinating freight movement across borders. The overwhelming environmental advantages of COB are also appealing to Europeans, who display more concern for sustainability than Americans. Perhaps once a system is well established and has gained a critical mass, further gains are easier. In certain European countries the shipping companies, shippers and port authorities are motivated to use COB and do not view it as anything unusual, whereas in the U.S. it has just never gained a foothold outside of the Pacific Northwest.

At present some renewed attempts are being made to put COB in place on American inland waterways. With roadways so congested the option of inland waterways looks brighter, especially as the nation's reluctance to build new infrastructure puts a priority on using existing systems more efficiently. There is definitely capacity for more cargo transportation on the waterways. Another advantage of carrying containers by barge or ship is that there is no limit on the weight of a loaded container (other than what the container itself is certified to hold). This is also the case for rail, but trucks are limited in their total weight and thus the weight of the containers they haul. The high price of oil also works in favor of water-based movement, and so does a general consciousness of environmental problems. The environmental advantages of waterborne transport are overwhelming—not so much because the engines that power barges are particularly efficient or non-polluting, but due to the economies of scale involved in one barge holding so much cargo. The amount of energy required to move freight by inland waterway is about 60% that of rail, and only about 15% that of trucking. (The figures for coastal shipping are even better than for inland waterways.) On one gallon of gasoline a ton of freight can be carried 50 miles by truck, 202 miles by train, and 514 miles by barge. In terms of polluting emissions, barges possess a similar advantage, being slightly ahead of trains and far better than trucks—although barges do have one drawback, high emissions of sulphur dioxide.[32] Perhaps most important of all, many calculations show that moving containers by barge or ship, if a reasonably direct inland water route is available, is slightly cheaper than truck or train.

But the slow speed of movement on inland waterways is a drawback for American COB, for as already noted contemporary supply chains are typically predicated on speed. Consequently the best freight for containers moving on waterways tends to be bulk goods, or cargo similar to bulk in its nature (as with the COB on the Columbia-Snake river system), which need not move so quickly. Some American shippers of bulk goods are showing a new interest in using

---

[31] *Container Transport by Inland Waterways,* Louisiana State University, p. 12.

[32] Anastassios N. Perakis and Athanasios Denisis, "A Survey of Short Sea Shipping and Its Prospects in the USA," *Maritime Policy Management,* Vol. 35, No. 6 (December 2008), p. 603.

containers, in fact, since so many containers otherwise return to Asia empty that it makes sense to fill them with something. Another niche COB can fill is the repositioning of empty containers, which must get to where they will next be filled. Such "empties" typically need not move quickly. While this might seem a trivial matter, the transporting of empties accounts for a substantial percentage of container movements. It should also be noted that speed is not invariably crucial in supply chains—sometimes reliability and consistency count more heavily. So while American COB has generally failed thus far, there is some justification for the new round of initiatives.

One modest new operation is 64 Express, a COB service on the James River in Virginia that travels the 90 miles between the port of Hampton Roads and Richmond. (The name refers to the highway the river runs parallel to, Interstate 64, but despite the term "express" the barges of course move more slowly than trucks.) The James River's depth is maintained at 25 feet and so it is only accessible to moderately sized ocean-going ships—most of its traffic is now by barge. It was once an important transportation corridor for Virginia, and George Washington was involved in a project to build a canal that would extend its waterway further west, a segment of this ultimately being built as the James River and Kanawha Canal. If fully completed this effort would have connected the James with the rivers on the other side of the Appalachian Mountains that flow into the Mississippi River watershed. This would have given the river a national significance—but as it fell short the James has been limited to a minor regional role ever since. Using just one barge at its inception in late 2008, 64 Express is run by James River Barge Line and transported about 6,000 containers over its first 12 months. The primary shippers using the service are paper and packaging maker MeadWestvaco, which has a factory in Virginia from which it exports products, and cigarette maker Altria which imports tobacco.[33] A government grant of $2.3 million helped the project get off the ground, and while margins are evidently tight—"we have exceeded expectations in every way except for the economics,"[34] commented the owner of the line—volumes have grown slightly over time.[35]

A similar example are the COB operations currently under development that will run in Northern California between the port of Oakland and the inland ports of Stockton and West Sacramento. As with the James River the distances are short, each location being within 80 miles of Oakland. But traffic on the highways from Oakland inland (Interstates 80 and 580) is especially heavy, so while the distances are not great the advantage of getting beyond the Bay Area and into the Central Valley of California is substantial. In some of the publicity the projected service is

---

[33] Philip Newswanger, "Container Barge Service from Norfolk to Richmond Is Still in Business," *The Virginian-Pilot* (*PilotOnline.com*) [In partnership with *Inside Business*], December 21, 2009. (http://hamptonroads.com/2009/12/container-barge-service-norfolk-richmond-still-business, accessed 10/1/10); Steve Szkotak, "Reviving Marine Highways," The Associated Press [64 Express website], February 23, 2009. (May have been originally published in *Daily Press*, newspaper for Hampton Roads) (http://www.64express.com/news--events/reviving-marine-highways.aspx, accessed 6/13/12); Peter T. Leach, "Virginia Container Volume Jumps 12.6 Percent," *The Journal of Commerce*, June 12, 2012.

[34] Newswanger, "Container Barge Service from Norfolk to Richmond Is Still in Business."

[35] Leach, "Virginia Container Volume Jumps 12.6 Percent."

called the M580/I80 Marine Highway Project, so as with 64 Express the notion of it as an alternative to road transport is made explicit. A grant of $30 million, part of the Transportation Investment Generating Economic Recovery (TIGER) program, made it possible to begin the project by helping the ports do the necessary work on their terminals, including buying new container cranes. The two barges were purchased by the ports, but the service will be run and marketed by a private operator.[36]

Stockton and West Sacramento are accessible to ocean shipping by a combination of river and canal, but as with the James River the channels are not sufficiently large for the ships now typically used. Inland movement on waterways was significant to the history of Northern California, with the San Francisco region being connected to Sacramento (and points further north) by the Sacramento River, and to Stockton (and points south of it) by the San Joaquin River. (These rivers have also been critical to the vast irrigation projects of the Central Valley.) For transportation the rivers were never as important as the major eastern waterways, especially since their distances are not comparable and furthermore the railroads were already developed by the time of large-scale settlement in California. Nonetheless they had some value, and over the twentieth century were gradually improved through a combination of dredging and canal construction into the Sacramento Deep Water Ship Channel and the Stockton Deep Water Ship Channel, which the container-carrying barges will ply. Again it is evident that the routes of the containerized global infrastructure are built upon older corridors with their own character and legacy, embedded in the history and geography of the nation as well as specific local and regional factors.

The principal rivers of Alabama are not especially noteworthy and for a long time were limited to a minor role in transportation. This changed in 1984 when the Tennessee-Tombigbee Waterway, often referred to as the "Tenn-Tom," was completed after a lengthy period of construction that began in 1972 and cost roughly $2 billion. While the idea of such a connection had been contemplated as far back as the 1800s, by the 1970s the building of new canals was rare indeed. Nevertheless President Nixon approved the project as part of his "Southern Strategy" to boost the fortunes of the Republican party in the Southeast. Essentially a combination of canal and enlarged rivers, the Tenn-Tom stretches 234 miles through Alabama and Mississippi, and links the main rivers of Alabama, which flow into the Gulf of Mexico in Mobile, to the Tennessee River, which flows into the Ohio River and hence is part of the Mississippi watershed.[37] It was a massive undertaking often described as the largest earth-moving project ever, with 310 million cubic yards of soil excavated—by way of comparison, the figure for the Panama Canal was 210

---

[36] R.G. Edmonson, "Stockton-Oakland Barge Service to Ship Containers," *The Journal of Commerce*, December 5, 2011; Port of Oakland, "Green Trade Corridor Marine Highway (Oakland-Stockton-West Sacramento)," Port of Oakland Website – Projects. (http://www.portofoakland.com/maritime/grcmh.asp, accessed 6/22/12)

[37] Tennessee-Tombigbee Waterway Website, "History of the Tenn-Tom," http://tenntom.org. (http://history.tenntom.org/, accessed 6/22/12)

million cubic yards.[38] Widely regarded as a boondoggle, the Tenn-Tom has over the years gained at least a semblance of a respectable amount of traffic. With this modern canal in place, its dimensions sufficient for contemporary barges, the rivers of Alabama have gained a heightened value for inland navigation. Given the canal's existence, and the opening of a container terminal at the port of Mobile in 2008, COB became a logical possibility, and in 2010 a federal grant of $1.67 million was issued to initiate a COB operation between Mobile and Itawamba, Mississippi, an inland port on the waterway. The money is intended to pay for purchasing nine barges and converting them to carry containers.[39] It remains to be seen if and when the service will begin.

If COB actually does happen on the Tennessee-Tombigbee Waterway, it would represent a relatively new waterway taking a role in the global infrastructure of containerization. While the globe-spanning networks of container movement depend on the existing infrastructures of the nation-state, in the process those domestic infrastructures can be reshaped and their relative importance altered. Similar cases have been discussed in previous chapters (such as the burgeoning container traffic on the rail corridors leading out of the Los Angeles region). For inland waterways the impact of containerization so far has obviously been far less than for railroads and trucking, so it is presumptive to expect comparable transformations. Yet similar patterns and shifts may emerge. The possibility that COB operations could be in place on the Tenn-Tom and not the Mississippi, Illinois or Ohio rivers would seem an unusual prospect, given the relative importance of these waterways historically. Likewise it is interesting that the only COB service with long-term success has been on the Columbia-Snake rivers, a waterway that is substantial but can hardly match the longer and more heavily-used ones of the East.

The idea of carrying containers on the Great Lakes and St. Lawrence Seaway continues to percolate. As part of the proposed Atlantic Gateway project to improve infrastructure and build one or more new ports in Novia Scotia, there was discussion in 2008 and 2009 of moving containers on the lakes and seaway. Some of the lake ports, such as Oswego, Toledo, Buffalo and Toronto, began positioning themselves for the possible traffic, and in 2010 Toledo acquired versatile cranes that can handle containers among other types of cargo.[40] But since that time little has been heard of the project, though it seems to be still on the drawing board. A less ambitious but perhaps more practical initiative was that of the Canadian company Great Lakes Feeder Lines, which in 2008 began services with the *Dutch Runner*, a ship capable of holding various cargoes including containers. The hope was to move containers between various Great Lakes ports and Montreal or Halifax, where they would be transferred to or from ocean liners, or else as

---

[38] Tennessee-Tombigbee Waterway Website, "Construction [History of the Tenn-Tom]," http://tenntom.org. (http://history.tenntom.org/construction-process/, accessed 6/22/12)
[39] Frittelli, *Can Marine Highways Deliver?* pp. 2, 7; *America's Marine Highway Update,* North Atlantic Ports Association – Short Sea Shipping Committee ["Prepared by Kristin Decas, Committee Chair"], September 2010, pp. 1-2. (http://eastfire.gmu.edu/gmu-consortium/marine-highway/document/AMH%20Update%20092910%20Final.pdf, accessed 6/22/12)
[40] Duane Ramsey, "Container Shipping Terminal Remains Possibility for Port," *Toledo Free Press,* August 22, 2008; Peter T. Leach, "Toledo Port Gets New Cranes," *The Journal of Commerce*, June 18, 2010.

a feeder between Halifax and Montreal.[41] In 2010 an agreement was announced between Great Lakes Feeder Lines and the Port of Cleveland to use that port for containerized operations that would connect with Montreal.[42] The ship's versatility provided for other options, however, and perhaps that was fortunate; it is unclear if the *Dutch Runner* ever carried containers in a regular service, but the idea definitely did not become a long-term success and it is not moving containers currently.

The movement of containers by inland or coastal waterways is not merely a matter of functionality and economics. The imaginative conception of local places, and their role in a globalized present that is somewhat mythologized, cannot be ignored. As with the intermodal terminals (described in chapter 9) where containers are switched between train and truck, an inland port that handles containers—no matter how few—can fancy itself a key node on global networks. The prestige can also accrue to a waterway carrying containers. In websites and brochures such visions recur, often accompanied by maps decorated with arrows and concentric circles showing how a particular corridor or location supposedly represents a vital link in world trade. The sentiment is reflected in a quote from the CEO of the Cleveland-Cuyahoga County Port Authority when prospective (but apparently never-to-be-realized) container operations were announced for Cleveland's port in 2010. He stated that "Cleveland would be the first city on the Great Lakes that will have a pin on the global map when it comes to container service."[43]

The modest recent burst of COB activity reflects federal encouragement, as the Obama administration, through the efforts of Secretary of Transportation Ray LaHood (who served in that post from 2009 to 2013), has steered money and support to intermodalism and more energy-efficient options. This has occurred both on the passenger side of things—where it understandably gets more publicity, as with high-speed rail for instance—and the freight side. While the railroads have received the lion's share of the funding, LaHood emphasized the benefits of inland and coastal shipping as well. In 2010 the Department of Transportation's Maritime Administration (MARAD) created the America's Marine Highway program, which since that time has been a source of funding for projects (including several of those already described). Given the congestion on the nation's highways and the available capacity on waterways, in addition to the environmental advantages of water transport, this emphasis is eminently logical.[44] But it is of course in contrast to the typical U.S. policy in recent decades—

---

[41] Chris Gillis, "Breaking Into the Jones Act," *American Shipper*, Vol. 50, No. 9 (September 2008), pp. 71-73.
[42] Pat Galbincea, "Cleveland Port Close to Becoming U.S. Home Base and Lone Great Lakes City for International Container Service," *The Plain Dealer*, October 22, 2010.
[43] Ibid.
[44] John D. Boyd, "DOT Says Freight 'Hierarchy' Favors Water, Rail," *The Journal of Commerce,* March 24, 2010; Ray LaHood, "America's Waterways, Poised to Deliver the Goods," *Welcome to the FastLane: The Official Blog of the U.S. Secretary of Transportation,* April 8, 2010. (http://fastlane.dot.gov/2010/04/americas-waterways-poised-to-deliver-the-goods.html, accessed 4/29/10); Ray LaHood, "America's Marine Highway System: Delivering Goods More Efficiently, Reducing Dependence on Foreign Oil," *Welcome to the FastLane: The Official Blog of the U.S. Secretary of Transportation,* April 8, 2011. (http://fastlane.dot.gov/2011/04/americas-marine-highway-system-delivering-goods-more-efficiently-reducing-dependence-on-foreign-oil-.html, accessed 6/23/12)

especially during Republican administrations—which has prioritized road construction and motor vehicle activity.

The need for attention to inland waterways is acute, as they have been long neglected and the condition of many is deteriorating. While moving containers by waterways is optional (though desirable), many bulk goods are transported in massive quantities over these waterways, and so the nation is more dependent on them than is commonly realized. As of 2008, 11% of American freight, as measured in ton-miles, moves by inland waterways or coastal shipping.[45] If measured by value rather than weight the figure is much lower, as bulk goods are typically heavy and of low value, but the statistic nevertheless indicates the waterways' great importance. For certain freight like grain and other agricultural produce, and also for coal, timber, gravel and metal ore, the waterways are crucial. Over half of American grain exported abroad, for instance, moves by barge on waterways in order to reach ports where it is transferred to ocean-going ships. The rivers of the Mississippi watershed are especially critical to these grain shipments; when traffic on a stretch of the Lower Mississippi was briefly closed due to flooding in 2011, one representative of corn farmers lamented that "when it [the Mississippi] shuts, there's really no alternative."[46] The reverse problem loomed in December of 2012 as a drought led to extraordinarily low water levels on the Mississippi that threatened barge shipping because the nine-foot depth was no longer assured.

Only time will tell if these vital waterways, or the coastal shipping lanes, can gain a share of the vast traffic of shipping containers moving on domestic routes within their longer global journeys. Another intriguing option, untried so far, would be to move the larger domestic containers (that only move within North America) by waterway. Considering the amount of bulk freight transported on inland waterways, it would seem reasonable for containerized freight to follow suit. Given the importance of the inland waterways in American history, and their continuing role in freight transport, it would be fitting as well. This is what has transpired in the railroad and trucking industries, which gradually have been adjusted—in some ways transformed—to carry the container. The particular characteristics of barge shipping, especially its slowness, do represent an obstacle; this is exacerbated by the sheer size of the U.S. and the length of its major waterways. But if and when COB gains a stronger presence and truly takes hold, it will do so for the most part within the infrastructure of the nation-state that already exists, and will move along the country's well-established paths of movement.

---

[45] Perakis and Denisis, "A Survey of Short Sea Shipping and Its Prospects in the USA," p. 603.

[46] Alan Sayre and Holbrook Mohr, "Flooding Hinders Shipping on the Mississippi River," *Yahoo! News [Associated Press],* May 18, 2011. (http://news.yahoo.com/flooding-hinders-shipping-mississippi-river-145142826.html, accessed 5/18/11)

Chapter 11 ~ The Emergence of the Domestic Container

Most early versions of the shipping container, from the turn of the century to the mid-1950s, were intended to work within the national scale. There were a few exceptions, containers designed to move by ship across the ocean as well as overland, but they were unusual cases. By the early 1960s the situation was reversed, as containerization henceforth was driven primarily by the shipping industry, not railroads or trucking. The idea of container use became implicitly global, even though it was not until the mid-1960s that container ships would actually start to make transnational journeys. Likewise in the 1960s the ISO managed to reach agreement on a standard for the now-global container. In the meantime domestic container systems, introduced by several American and Canadian railroads from the 1920s through the 1950s, did a slow fade. They were of course largely replaced by the new global ISO containers, but in terms of purely domestic freight intermodalism they were superseded by piggyback operations in which truck trailers were carried by train. The idea of using a container to carry cargo moving entirely within the U.S. essentially disappeared, as piggyback proved more successful and easier to implement. Even as the railroad lines began to haul global containers in the 1970s and '80s, they had little interest in using them for domestic freight except occasionally on backhauls where they would otherwise travel empty. This finally started to change in the late 1980s when domestic containerization reemerged, featuring containers larger than the standard global containers. The trend has continued since, with so much success in recent years that it is now piggyback that is becoming rare. The rise of this domestic container system, spanning the U.S. and Canada, is the subject of this chapter.

While domestic containers are larger than global containers, they are essentially designed to work within the systems that by now are so well developed for carrying those global containers within the national infrastructure. As such, the rise of domestic containerization represents an interesting reversal. The global container took its dimensions from American containers developed in the 1950s and '60s, which in turn were spatially derived from the spatial regime of American trucking—in short, from the domestic national infrastructure. With the overwhelming popularity of the container over subsequent decades, by the 1980s the domestic infrastructure was being reshaped to serve the container (as has been detailed in previous chapters). With a network of trains, trucks and intermodal terminals now in place to move containers, it made sense for domestic freight to utilize this system also. So the global container generated the conditions that made domestic container operations feasible. Where global containerization had previously come largely from an American template, now a new American system was following in the footsteps of the global. Yet the rise of the domestic container also points to an opposing trend: a divergence between global and national systems, and in particular their spatial regimes. The overwhelming success of the standard global container did not prevent an alternative, domestic design from flourishing. What drove this separation, above all, was the growing difference between the spatial regime of the global container and the American truck trailer—the former remained unaltered, while the latter changed. Consequently the nation's container network has become less, not more, homogeneous, as separate global and domestic container systems now exist. They overlap in some ways, and are distinct in others.

The use of containers to carry domestic freight in the 1920s and '30s, and again in a second round of larger containers in the 1950s and '60s, has been covered in earlier chapters, so only a brief account is given here. While such containers of course moved by both train and truck, it was typically the railroad companies that introduced them and coordinated their movement. The containers of the 1920s and '30s were generally not large, being 5′ to 10′ long in each dimension. Those of the 1950s and '60s were bigger, typically 20′ to 40′ long and about 8′ wide and high—the Flexi-Van container of the New York Central Railroad was the most prominent and widely used example. But these domestic container systems eventually failed; even as shipping lines increasingly ventured into containerization in the 1960s, railroads were switching away from it (at least with regard to domestic freight) in favor of piggyback.

But even as domestic containerization faded over the course of the 1960s, the railroad companies were getting involved, albeit in halting steps, in carrying the containers brought to and from ports by shipping lines. The development of "bridge" operations (i.e., landbridge, minibridge and microbridge, as described in chapters 5 and 7), in which railroads carried these global containers overland, was especially important, as it involved long distances where the advantage of trains over trucks was undeniable. These containerized rail movements gradually expanded over the 1970s, and motivated some railroads to reconsider the container's possibilities for domestic freight. As early as 1970 the Missouri Pacific Railroad announced a new domestic container service called Containerpak, which used 24′-long containers; the system was meant to provide the option of linking into ocean shipping, but its primary purpose was for domestic operations.[1] Containerpak did not gain much traction, though, and disappeared quickly.

Rather than trying to establish containerization for domestic freight, a more promising strategy at this point in time was to use otherwise empty containers on their backhaul routes. Containerized global freight generally moved in only one direction by rail, for it was hard to find cargo that replicated a particular route in the opposite direction. This was especially the case with the rapidly growing Asian imports in the 1970s, as the U.S. was sending little back to Asia in return (a problem that of course would only worsen in subsequent decades). Hence the railroads were stuck with empty containers on their long backhauls to West Coast ports. (Truckers hauling containers faced a similar issue, but as their routes were shorter—typically local or regional rather than national in scale—the problem was not as pressing.) The solution was obvious: to

[1] H. G. Becker, Jr., "…The First Domestic Container Program," *Handling & Shipping,* Vol. 11, No. 7 (July 1970), pp. 45-47.

carry domestic freight going west in these containers. Given that the containers had to move anyway and would otherwise carry nothing, it made sense to offer extremely competitive rates for domestic traffic so as to get some benefit out of them. The first to do so was the Canadian Pacific Railway. (The major Canadian railroads have a tradition of involvement in multiple modes of transportation, and also the advantage of networks that reach from coast to coast across North America.) In the early 1970s Canadian Pacific began carrying domestic freight, retail goods in particular, in containers moving westward in backhaul from Toronto and Montreal to Vancouver.[2]

Once domestic freight was being carried in this way it was only logical to consider using larger containers, ones that would exploit the maximum allowable dimensions for domestic movement rather than being limited to the global standard. The idea was slow to reach fruition in actual practice, presumably in part because the previous generation of domestic containers had failed during the 1960s. As of 1973, a trade journal commented that "domestic containerization in the U.S. is, for the most part, a concept, an idea, with probably fewer advocates than it has foes."[3] Finally in 1979 Canadian Pacific, evidently persuaded by the success of its backhaul operation with global containers, introduced a domestic container. It had a length of 44′-3″, nine inches less than the 45′ maximum length of a Canadian trailer at the time, and hence was larger than the standard 40′ global container and also any previous domestic container. (It was also slightly lighter than a global container, as it did not need to endure shipboard travel or the uncertainties of other nations' road and rail infrastructures.) By 1981 Canadian Pacific had over 1,000 of these containers in use, and its executives were proclaiming—perhaps prematurely—that boxcars would soon be replaced by railcars holding containers. The railroad also briefly put a 29′-5″ long container, designed for carrying heavier bulk goods, into domestic use. Both types of domestic containers were carried on the same flatcars Canadian Pacific used to transport global containers.[4]

In the meantime the struggles of American railroads continued for much of the 1970s, and they were slow to follow Canadian Pacific's lead. Finally in the late 1970s the remaining companies, now better organized and with reduced workforces, began to forge a modest recovery, which accelerated in the 1980s in the wake of deregulation. The transport of global containers was a significant part of rail's improved fortunes, especially once double-stacking emerged in the 1980s. Continuing growth in piggyback operations also provided a boost. All in all, intermodalism (i.e., carrying trailers and containers) was working well for the railroads: in

---

[2] Robert D. Bartley, "TOFC and COFC: There's Big New Growth Ahead for Both," *Railway Age,* Vol. 174, No. 20 (October 29, 1973), p. 30.
[3] Ibid., p. 28.
[4] Frank Malone, "CP Rail Moves Toward Domestic Containers," *Railway Age,* Vol. 182, No. 22 (November 30, 1981), pp. 26-28; David R. McKenzie, Mark C. North, and Daniel S. Smith, *Intermodal Transportation—The Whole Story* (Omaha, NE: Simmons-Boardman Books. 1989), p. 216.

1970 it had accounted for only 5% of total rail carloads, and by 1985 the figure reached 15%.[5] In the late 1970s the shipping company American President Lines (APL) began working with the freight forwarding company Transway to get domestic cargo for its returning westbound containers, which were being hauled by rail across the U.S. In 1984 APL commenced stacktrain operations and once again partnered with Transway to find domestic cargo for the backhaul. Within a year most of APL's containers heading west by rail were carrying cargo, primarily domestic in nature, and soon APL abandoned its partnership with Transway and began offering domestic freight services on its own. APL was perhaps the shipping line that most enthusiastically embraced container movement by rail in the U.S., especially double-stacking, albeit in partnership with the railroad companies that did the actual hauls. Still it was surprising that a shipping line rather than a railroad seized the initiative, and reveals that APL perceived the former boundaries of global versus domestic shipping had become less relevant thanks to containerization. Deregulation also helped make this blurring of the global and domestic possible.[6]

Several other Pacific shipping lines and western railroads followed suit in the mid-1980s, working to fill their backhaul containers. The practice aroused controversy in the freight industry, as the low rates undermined truckers and even at times the railroads themselves. Nevertheless a variety of trucking firms and forwarders were eager to seize the opportunity; in some cases they sent freight that otherwise would have moved over the road, while in other circumstances they switched from piggyback. For trucking companies hauling freight from certain major cities in the eastern half of the country—such as Chicago, Houston, New York, Atlanta, etc.—to a western destination, the economics of using a container and putting it on a stacktrain could be compelling. A trade journal in 1986 reported the price of moving a container by rail from Chicago to the West Coast as approximately 54 cents per mile, while carrying the same freight by truck cost roughly 70 cents per mile. The train also had an advantage in speed, since stacktrains typically go from origin to destination without stopping.[7]

The container system was growing pervasive within the U.S. territory and infrastructure, impacting not only the railroads and trucking but also leading to the creation of more and better intermodal terminals. This burgeoning network was set up to handle global ISO containers, but once in place was amenable to domestic freight also. The benefits originally envisioned for domestic containerization—that trains would haul freight long distances, while trucks concentrated on pickup and delivery—had been carried out mainly through piggyback instead

[5] James W. Downs, "Domestic Containerization: A Preliminary Feasibility Study," National Conference of State Railway Officials [American Association of State Highway and Transportation Officials, 72nd Annual Meeting Proceedings], 1986, p. 136.
[6] Frank B. Norris, *Spatial Diffusion of Intermodal Rail Technologies*, PhD Dissertation, University of Washington (Geography), 1994, p. 289; Brian Solomon, *Intermodal Railroading* (St. Paul, MN: Voyageur Press [MBI Publishing]), 2007), p. 89; John Niven, *The American President Lines and Its Forebears, 1848-1984* (Newark, DE: University of Delaware Press, 1987), pp. 269-270.
[7] Kurt Hoffman, "Phenomenon or Flash in the Pan?" *Chilton's Distribution*, Vol. 85, No. 10 (October 1986), p. 112.

since the early 1960s. But now containers were shuttling across the nation in large quantities, driven by global trade and shipping lines, with an entire system set up to serve them and domestic freight often moving inside them on their backhaul runs. Indeed, as of 1985 it was estimated that of the containers headed westward by rail that contained freight (i.e., not counting empty containers), 80% of this freight was domestic rather than foreign. (The statistic appears to be for coast-to-coast container moves, so it may have been less for shorter journeys.) The figure for freight going east was 100% foreign, indicating that the network remained fundamentally oriented to international trade, with domestic freight serving only as backhaul cargo.[8] It seemed logical, as Canadian Pacific had already deduced, to introduce containerized services entirely for domestic movement. Aside from Canadian Pacific, though, no railroad or other operator attempted to move domestic freight in containers expressly intended purely for that purpose. But interest was growing, especially since stacktrains were starting to make containerization more economical than piggyback. The Association of American Railroads commissioned a study on the topic from the consulting firm of Temple, Barker & Sloane, released in 1986, that came to generally optimistic conclusions about the feasibility and potential profitability of domestic containerization.[9]

Since the dimensions of American trailers had grown larger over the years (as described in more detail in chapter 8), such domestic containers potentially could be bigger than global ISO containers. The national and global spatial regimes had essentially fallen "out of sync," an ironic turnabout given that the dimensions of the ISO container derived largely from American standards of the early 1960s. Domestic containers could also be lighter than global containers, in spite of their greater size, since they did not need to endure the rigors of shipboard use and being stacked five-high. This meant slightly more weight in cargo could be held. The logic was compelling, and eventually it was APL that once again stepped forward, introducing domestic containers near the end of 1985. They were 48′ long, 9′-6″ high, and 8′-6″ wide, and thus larger than standard global containers (most often 40′ long, 8′-6″ high and 8′ wide) in all three dimensions. (A global container can also be 9′-6″ high, in which case it is called "high-cube"; this was relatively rare in the 1980s but is common today.) Several container leasing firms, including Transamerica, Itel and XTRA, introduced similarly sized domestic containers soon after.[10]

The decision to go with the 48′ container for domestic use represented a key shift in the evolution of containerization in the American context, as the national system made a break with the spatial regime of the global system. The 40′ ISO container, along with the 20′ container that functioned in a modular way with the 40′ unit, had become the unchallenged global standard, but the American (and Canadian) national network would not remain in sync with it merely for that reason. Even though American shippers were already filling 40′ containers with domestic

---

[8] Frank Malone, "Trailers/Containers: Sizing Up Tomorrow's Fleet," *Railway Age,* Vol. 186, No. 3 (March 1985), p. 43.

[9] Temple, Barker & Sloane, Inc., *Domestic Containerization: A Preliminary Feasibility Study,* Prepared for the Association of American Railroads [AAR Report R-622], Washington, D.C., March 1986.

[10] Norris, *Spatial Diffusion of Intermodal Rail Technologies,* p. 290.

cargo, as part of their backhaul movements on longer global journeys, the global standard still did not prove sufficiently powerful to be imposed for purely domestic purposes. Since the mid-1980s global containers and domestic containers have coexisted and both systems have flourished; differentiation has emerged rather than being stifled.

Yet in spite of the divergence between the two systems, domestic containerization owes its existence in large part to the global system. It was the emergence of global containerization, extending deep into the national territory and transforming American infrastructure, that laid a path (and to some extent a template) for the domestic container. Double-stacking, originally developed to haul global containers, is arguably the key factor that makes the container more cost-effective than piggyback for intermodal domestic freight. The terminals where domestic containers are transferred between truck and train are generally the same as where global containers are handled (a few exceptions will be noted later), and most were built primarily for such global cargo. So the domestic container to a substantial degree moves within a network put in place for the ISO container, to handle global trade. This applies at a more minute scale as well; domestic containers have corner castings (i.e., points for connection) not merely at their corners, but also at the same locations where standard global containers have corner castings. Even though domestic containers are 6″ wider than global ones, these castings are nevertheless configured so as to make connections possible between the two container types. This means a domestic container can be attached to a global container, with one stacked atop the other, which is especially valuable in stacktrain operations. Likewise the cranes and other equipment for moving containers at intermodal terminals generally can also handle domestic containers. Of course some important alterations are necessary to make the system work for domestic containers, and these will be noted. But in general the overall system need not dramatically change.

Following APL's lead, many others adopted the 48′ domestic container in the mid- and late 1980s, and its use began to catch on. This included Canadian Pacific, which finally dropped its unique 44′-3″ container and switched to the 48′ unit in 1989.[11] It was necessary to introduce new and larger trailer chassis to carry these containers when they moved by truck, but that was not a major hurdle. For movement by rail the new double-stacking techniques were quite convenient, as it was possible to put a domestic container on the upper level of a double-stack railcar, where it could extend further in each direction beyond the 40′ container (or two 20′ containers) below it. As already noted, two such stacked containers can be attached together by twistlocks despite their different sizes, since the castings (connection points) line up. Soon Trailer Train, the most prominent maker of intermodal railcars, began work on developing a larger railcar for double-stacking that would able to hold a 48′ container on the bottom as well. In 1988 APL became the first to use trains (operated by railroad companies) composed entirely of cars holding only

[11] *Railway Age*, "CP Adopts Longer Domestic Containers," Vol. 190, No. 9 (September 1989), p. 29.

domestic containers.[12] 48'-long domestic containers were also brought into service in the late 1980s by the Burlington Northern Railroad. Burlington Northern worked to establish their use and maintain control and quality, founding a subsidiary unit in 1988 called BN America to offer domestic container service. The CSX Railroad, having bought out Sea-Land in 1988, created CSX/Sea-Land Intermodal (CSLI) and began domestic container operations in 1989. CSLI entered into agreements with other railroads, notably the Southern Pacific Railroad, in order to extend this network as far as possible.[13] Government-owned Conrail also acted quickly, for in 1990 its trucking subsidiary Conrail Mercury placed an order for domestic containers.[14]

Trucking firms were not far behind. In 1989 J.B. Hunt Transport Services announced a partnership with the Atchison, Topeka and Santa Fe Railway (widely known as the "Santa Fe") to offer piggyback services. At the time it was unprecedented for a large trucking company like J.B. Hunt to engage wholeheartedly in piggyback; the typical piggyback arrangement was for a railroad to work with minor truckers who specialized in hauling the trailers at the local level. What J.B. Hunt had in mind was quite different, as it sought to replace some of its well-established long-distance truck routes with an intermodal approach. This was a significant shift, as major trucking companies since the 1930s and '40s typically moved their freight by trailer all the way from origin to destination. (One exception had long been United Parcel Service, which engaged in piggyback on a regular basis, but it represented an entirely different business model from an ordinary trucking firm.) But J.B. Hunt recognized the railroads' superior efficiency over long distances. Labor costs, and difficulties in getting and keeping truck drivers, were another motivating factor. J.B. Hunt and the Santa Fe gave their partnership the futuristic title Quantum, and actual operations started in 1990 and gradually expanded, leading J.B. Hunt to cut similar deals with other railroad lines. Its competitors initiated similar services, with the trucking company Schneider National entering into cooperation with Southern Pacific and Conrail. All these operations were still piggyback, however. Finally in 1992 J.B. Hunt introduced its own domestic container service, purchasing a large quantity of 48' containers along with the necessary trailer chassis. Working with the railroads, J.B. Hunt established containerized operations that functioned as a substitute for some of its longer trucking routes.[15] The business proved successful in the years ahead, and other major trucking firms eventually emulated it.

---

[12] Norris, *Spatial Diffusion of Intermodal Rail Technologies,* pp. 290-291; McKenzie, North, and Smith, *Intermodal Transportation—The Whole Story*, pp. 105, 218.
[13] McKenzie, North, and Smith, *Intermodal Transportation—The Whole Story*, pp. 218-220; Norris, *Spatial Diffusion of Intermodal Rail Technologies,* pp. 290-291.
[14] U.S. General Accounting Office, *Intermodal Freight Transportation: Combined Rail-Truck Service Offers Public Benefits, But Challenges Remain,* Washington, D.C., Report #GAO/RCED-93-16, 1992, pp. 53-54; David J. DeBoer, *Piggyback and Containers: A History of Rail Intermodal on America's Steel Highway* (San Marino, CA: Golden West Books, 1992), p. 168. Conrail Mercury is referred to in some sources as Mercury Motors.
[15] Marvin Schwartz, *J.B. Hunt: The Long Haul to Success* (Fayetteville, AR: University of Arkansas Press, 1992), pp. 112-116; Agis Salpukas, "When Trucks and Trains Unite," *New York Times*, June 21, 1992; Gus Welty, "Truckers Are Some of Our Best Customers," *Railway Age,* Vol. 195, No. 4 (April 1994), pp. 33-38; Christian H. Voigtleander, *Intermodal Freight Transportation – An Integrated Analysis of Strategy and Operations,* Thesis

In a book published in 1992, *Piggyback and Containers: A History of Rail Intermodal on America's Steel Highway*, David DeBoer carried out various calculations to evaluate which domestic intermodal method was preferable out of several options. DeBoer had a lengthy background in the railroad industry, particularly intermodalism, so his calculations though not highly complex doubtless reflected these experiences and were well grounded in the reality of rail operations. He put forth six options; the nuances are not relevant here, but they comprised two different ways of carrying trailers on railcars, two different ways of carrying containers single-stacked on railcars, a combined trailer/boxcar known as RoadRailer (to be discussed further shortly), and the double-stacking of containers on railcars. It was assumed that the unit being hauled, be it trailer, container or RoadRailer device, was 48′ long. DeBoer laid out his results in terms of the cost of moving one unit 1,000 miles on a 6,000′-long train, and concluded that double-stacking was definitely the cheapest choice at $312, with all the other options lying in a fairly tight range of $400 to $430.[16] (Incidentally, DeBoer found that the overall train cost was actually greatest for double-stacking—what made it most economical on a unit basis was the dramatically greater number of containers carried.) A study done slightly earlier in 1984 by the Association of American Railroads came to similar conclusions, comparing several options and finding that double-stacking had the lowest cost by a wide margin.[17]

Time has borne out these findings, for since the 1990s the trend has been steadily, albeit slowly, towards offering domestic intermodal services in the form of double-stacking containers. Piggyback's arc has been gradually downward: it continued to flourish in the 1990s, did only moderately well in the first decade of the 2000s, and lingers today on some routes. Likewise the transport of containers by rail in the older single-stack arrangement has been reduced. But in the early 1990s these developments were still in the future; for the moment piggyback dominated domestic intermodalism and the rapid growth in double-stacking was primarily meant to accommodate global containers.

One important change in the 1990s was the shift in domestic container length from 48 feet to 53 feet. 53′-long containers had actually been introduced in 1988 by APL, but at the time could only be used in a few states that were allowing 53′-long trailers. By the mid-1990s the 53′ length for trailers was in place nationally (as described in chapter 8), and 53′ domestic containers logically followed. These 53′ containers gradually replaced their 48′ brethren, and today remain the standard for domestic containerization (as the 53′ trailer remains the national standard for trucking). As with 48′ containers, 53′ containers are 8′-6″ wide and 9′-6″ high. Their widespread adoption made it necessary for the railroads to develop a new round of even bigger railcars able to hold them in double-stacking, and larger trailer chassis also had to be developed. But as domestic containerization was still finding its footing in the mid-1990s, moderately successful but

---

(M.S. Operations Research), Massachusetts Institute of Technology, 1994, pp. 14, 64-72; DeBoer, *Piggyback and Containers*, p. 169.

[16] DeBoer, *Piggyback and Containers*, pp. 169-173.

[17] The study is mentioned in Temple, Barker & Sloane, *Domestic Containerization: A Preliminary Feasibility Study*, pp. 32-33.

not yet prevalent, the changeover to the 53′ container was not too burdensome. The tremendous growth in domestic containerization that has emerged since has been carried out through the 53′ container.

One other method of domestic intermodal freight transportation, the RoadRailer, merits a brief mention. This is a combination of a trailer and railcar, able to function either way; it has wheels with tires for normal road movement, but also possesses steel wheels, which retract upwards when not in use, for travel on rails. A RoadRailer unit also has the connections to link into a truck tractor as part of a tractor-trailer or another RoadRailer unit as part of a train. (Connecting RoadRailers to other railcars is trickier, though, and so RoadRailer units typically travel as a group at the end of a train—or else the entire train consists only of RoadRailers.) In theory the use of RoadRailers should result in savings, but in practice it has rarely worked out that way, as the technology tends to be unwieldy and does not fit well with normal railroad operations. The concept may appear powerful in its versatility, but in reality requires too many features and functions awkwardly because it must do too much on its own. (It is instructive to contrast this with the elegant simplicity of the shipping container, which instead depends on specialized railcars and trailer chassis.) Consequently the RoadRailer has gone through cycles of use and abandonment.

The concept was first implemented under the name "Railvan" by the Chesapeake and Ohio Railway in the 1950s and early '60s on certain routes in Michigan. It faded in the mid-1960s, but reemerged in the late 1970s thanks to the efforts of a former New York Central Railroad employee named Robert Reebie, who founded the Bi-Modal Corporation to develop a new version of the Railvan. In 1978 Bi-Modal introduced the RoadRailer, which was tentatively used in the early 1980s by a variety of railroads; evidently most of them were unimpressed since they did not stick with the new technology for long. The RoadRailer's greatest success was with Conrail, which used it on the Water Level Route in upstate New York for 19 months. This too was dropped in 1984, but in the same year Bi-Modal came out with a new version of RoadRailer, which featured steel wheels that were set up between the units and could be removed for trailer operation. In 1986 the Norfolk Southern Railway introduced its Triple Crown service, which used RoadRailers extensively and quite widely during the late 1980s and 1990s. A few other railroad and trucking companies also tried RoadRailer, but did not stay with it for long. In the late 1990s Amtrak even used RoadRailers for a few years, hitching them behind passenger trains, but this was terminated in 2004. Norfolk Southern continues to operate RoadRailers to this day, but in relatively small numbers.[18] Ultimately RoadRailer has never been truly successful, and perhaps ranks as an idea more clever than practical.

J.B. Hunt's enterprising move into domestic containerization in the early 1990s was a forerunner of things to come; since the 1990s it has been trucking companies—along with intermodal marketing companies (IMCs), to be discussed shortly—that have played a leading role in running the domestic container network. The railroad companies are of course still

[18] Solomon, *Intermodal Railroading*, pp. 144-155; DeBoer, *Piggyback and Containers*, pp. 54-55, 129-133.

important, since they carry the goods most of the distance, and with complete ownership of their particular corridors can negotiate from a strong position. In addition the railroads proudly publicize their role in domestic containerization, promoting its environmental credentials and role in reducing traffic on roads. Nevertheless they generally are not running the operations (with some exceptions that will be noted), but rather contracting to haul cargo a certain distance for a trucking company or IMC. The trucking firms coordinate the operation, deal with the shipper, and use their trucks to handle pickup and delivery at each end. This was starting to become evident as early as the mid-1990s. One researcher, analyzing the evolving trend in in 1994, commented that trucking carriers would continue to "hold themselves accountable for every mile of service and handle all shipment status reports, billing and claims themselves. The role of the railroads in the intermodal shipment is downplayed to one of silent partner, and the emphasis is on seamless service. Thus, truckers make intermodal part of *their* service portfolio."[19]

In the 1990s the other two dominant long-haul trucking carriers, Schneider National and Swift Transportation, followed J.B. Hunt by also entering into domestic containerization. The container services of these truckers, which have grown steadily over the years, generally follow the model detailed above, where they take responsibility for the overall operation and then contract with the railroads for the segments the trains will cover. The containers themselves are owned by the trucking companies, and emblazoned with their logos. These operations are large in scale and very significant to the major firms; it was estimated that as of 2010 over half of J.B. Hunt's revenue derived from intermodal movements.[20]

In the late 1990s another major presence in domestic containerization came on the scene: the intermodal marketing companies (IMCs). Working with shippers to coordinate intermodal freight movement across railroads and trucking, the IMCs account for a substantial portion of the domestic container business. They work extensively with the railroad companies, on whom they depend. IMCs are "asset-light" and their value is in coordinating overall movement rather than operating either of the transport modes, but they generally do own or lease the containers and chassis at least. The two largest IMCs are Pacer Stacktrain and Hub Group. The latter has existed in some form since 1971, but its role as an IMC took off in 1998 when it introduced the "Hub Group Fleet" and acquired 2,000 containers.[21] Pacer Stacktrain is a subsidiary of Pacer International, which was founded in 1997 by Don Orris, who as an executive at APL had been crucial in the original development of stacktrains in the early 1980s. In 1999 APL chose to spin off its stacktrain business, which Pacer International snapped up and rebranded as Pacer Stacktrain.[22]

---

[19] Voigtleander, *Intermodal Freight Transportation – An Integrated Analysis of Strategy and Operations,* p. 72.
[20] Deborah Lockridge, "The Changing Face of Trucking Part 2: Riding the Rails," *Truckinginfo ("the web site of* Heavy Duty Trucking *magazine"),* June 16, 2010.
[21] Hub Group [website], "History." (http://www.hubgroup.com/history/, accessed 9/13/12)
[22] Zoe Double, "The Pacemakers," *Containerisation International*, Vol. 37, No. 9 (September 2004), pp. 66-67; Pacer International [website], "History." (http://www.pacer.com/OurCompany/History.aspx, accessed 9/13/12)

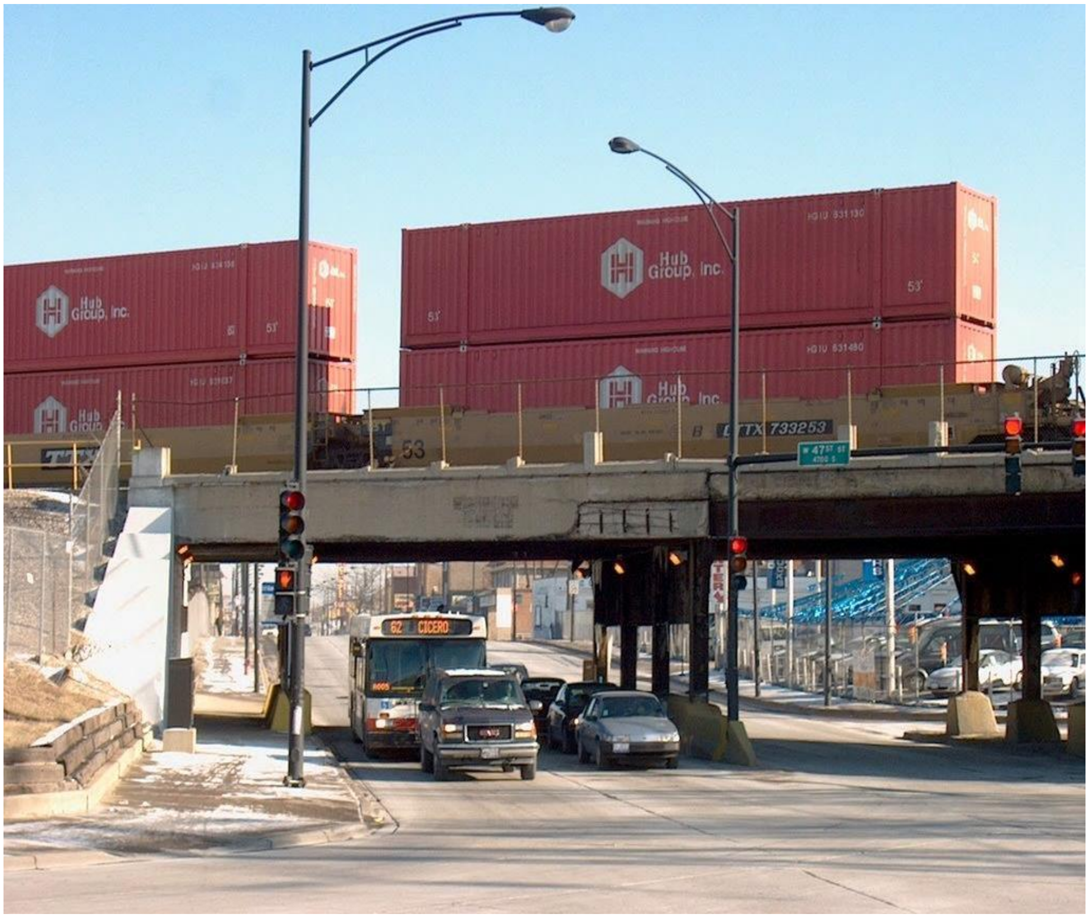

Figure 11.1: 53’ domestic containers moving by stacktrain

Source: *Eddie’s Rail Fan Page* website (http://eddiesrailroad.blogspot.com/2007/01/bnsf-railways-corwith-yard-south-hump.html, accessed 12/15/12)

In recent years the practice of domestic containerization has been so successful that many major trucking lines, such as Knight, U.S. Xpress, Marten, Con-way and Averitt, have entered into it. For any but the largest companies, however, the economies of scale in containerization are difficult to achieve, and if they proceed into the business they tend to use containers supplied by railroads or IMCs.[23] The trucking firm NFI, for example, bought 500 containers only to find the quantity was insufficient. As one of NFI’s executives commented, “if you’re going to own your own assets, 500 containers just doesn’t give you enough density, unless you decide you’re just going to operate from Point A to Point B and back again. What we really needed in order to get our foot into the ballgame was somewhere between 3,000 and 5,000 containers…”[24] So NFI chose instead to use containers and trailer chassis made available by the railroads.

In addition to the truckers and IMCs, some railroad companies offer domestic container services of their own. CSX runs the largest of these systems, and also advertises its “green”

[23] Lockridge, “The Changing Face of Trucking Part 2.”
[24] Ibid.

credentials most heavily to the general public. In addition two of the largest IMCs, UMAX and EMP, are jointly run by groups of railroads. UMAX is offered by CSX and the Union Pacific Railroad, while EMP is offered by Norfolk Southern and Union Pacific, with cooperation from several other railroads. It is puzzling to some that the railroads do not run more of the domestic intermodal network themselves, considering their central position within it. But the railroad business revolves around volume, and railroad companies prefer dealing with large customers who can provide substantial amounts of freight. The typical shipper cannot do so, but major trucking companies and IMCs are able to amass bulk volumes from an agglomeration of individual customers. So the railroads rarely deal directly with intermodal shippers or coordinate logistics for them, leaving such tasks to trucking firms and IMCs. As one railroad manager puts it: "The railroad companies provide wholesale transportation. They sell it cheaply to the trucking companies, providing them with bulk rates. The trucking companies do logistics while the railroads do not, which is why we [the railroads] end up selling transportation wholesale."[25]

The way domestic containerization has played out in American trucking is in sharp contrast to the industry's involvement with global containers. As detailed in chapter 8, global containers are handled by a sector of the trucking industry known as drayage, and drayage firms are a minor link in much longer chains of movement over which they have virtually no power. Drayage truckers generally contract to haul containers relatively short distances, and do not control or have any involvement in the container's overall movement. They have little or no contact with shippers, and are often small and unsophisticated operations that compete on price, being largely at the mercy of the shipping lines or logistics companies that hire them. In the realm of domestic containerization the situation is quite the reverse. Here it is often the major trucking firms that dominate the business and control a container's entire journey. The truckers deal with shippers, trace the container's movement, take care of both pickup and delivery, carry out the billing, and contract with the railroads for certain portions of the journey. For the railroad industry on the other hand the difference between handling global and domestic containers is not dramatic. In either case the railroad has little concern with what goes on beyond its own tracks, but simply contracts to haul a particular quantity of containers on a specific route and to carry out container transfers at an intermodal terminal. For global containers the railroad usually contracts with a shipping line or logistics provider, while for domestic containers it is likely to be with a trucking company or IMC, but the situation is comparable either way.

There are a few railroad corridors especially suited to domestic containerization, and some of these have been improved by the railroad companies. One example is the Crescent Corridor, a series of routes under the control of Norfolk Southern running from the Northeast to the Southeast and Gulf Coast that is currently receiving clearance work so it can handle double-stacking. Unlike the Heartland Corridor and the National Gateway, two other major rail corridors in the East that have seen their clearances raised to accommodate stacktrains mainly

---

[25] Edna Bonacich and Jake B. Wilson, *Getting the Goods: Ports, Labor, and the Logistics Revolution* (Ithaca: Cornell University Press, 2008), p. 111.

carrying global containers, the Crescent Corridor is primarily oriented to domestic containerization. In particular it is expected to reduce truck traffic on Interstate 81, running from Pennsylvania to Tennessee, as more freight should be carried by containers going by rail instead.[26] In a case such as this the railroad company is honing its strategy with domestic containerization in mind. Likewise the railroads have created a few intermodal terminals that only serve domestic containers, such as the BNSF Railway's facility in San Bernardino, California.[27] But these are atypical cases—in general global and domestic containers move on the same routes (often on the same trains), and are transferred at the same terminals.

A recurring issue with domestic containerization has been the interior dimensions and volumetric capacity of the container in comparison to a standard truck trailer. The typical American trailer, as used in a normal tractor-trailer setup, contains a volume that shippers have become accustomed to. This volume, in all three dimensions, has become intertwined in a relationship with the size of pallets, packing crates, boxes, and so forth. With such a spatial regime in place, a variation of just an inch can be critical. That is especially the case as shippers and truckers relentlessly work to exploit the available volume, seeking to fit as much as possible into it. If domestic containerization is to work as a substitute for long-haul trucking, clearly the ideal situation would be for the interior of the container, in terms of all three of its dimensions, to be identical to that of a standard trailer. It seems unlikely this goal is reachable, however.

While the domestic container is the same length and width as a trailer, structural differences (a container must be of stronger construction) mean it is difficult to make the inside dimensions of length and width identical. The castings at the 40′ points (i.e., not at the corners, but placed to align with the corner castings of an ISO container) are also an issue, as they may intrude slightly into the interior, especially at the ceiling. Generally the interior height, rather than width or length, has been the key problem. Because of construction details, and since a trailer is one unit while a container and chassis are two units attached together, it is very difficult to get uniformity in height. The differences do not seem significant, but in such a competitive business a tiny drop in volume can motivate truckers or shippers to use trailers rather than containers. As of the mid-1980s the volume of a 48′ domestic container was 3,470 cubic feet, while that of a 48′ trailer was 3,556 cubic feet.[28] A government document from the early 1990s, also referring to 48′ domestic containers, noted that while a standard trailer had a 9′-2″ internal height (usually expressed as 110″, a figure that has remained the same to the present, though models from different manufacturers can vary slightly), the figure for domestic containers was 8′-11″.[29] Since that time the lengths of containers and trailers have gone to the 53′ dimension, but in spite of new (and presumably improved) container models the volumetric discrepancy of roughly 100 cubic feet remains. Current information from various sources gives a volume of about 3,900 cubic feet for a

---

[26] Mark B. Solomon, "Rails Try New Route to Intermodal Growth," *DC Velocity*, July 4, 2011; Daniel Machalaba, "New Era Dawns for Rail Building," *The Wall Street Journal*, February 13, 2008.
[27] Bonacich and Wilson, *Getting the Goods*, p. 110.
[28] Temple, Barker & Sloane, *Domestic Containerization: A Preliminary Feasibility Study*, p. 70.
[29] U.S. General Accounting Office, *Intermodal Freight Transportation*, p. 21.

domestic container, and 4,050 cubic feet for a typical trailer.[30] (The importance of the height issue, incidentally, is revealed by the text now prominently placed on the back of most Pacer Stacktrain containers, proclaiming their 110" inside height.) So a shipper can be sure a domestic container has about the same volume as a trailer—but not quite.

On the other hand, the difference between the volume of a global container and a domestic container (or trailer) is very substantial. Two 53′ domestic containers (or 53′ trailers) hold approximately the same volume as three 40′ global containers. This is due not merely to the greater length of the domestic container, but also its edge in height and width. The disparity gives logistics providers a powerful motivation to transfer the goods that arrive by ship in 40′ containers into larger 53′ units, which may be either trailers or containers, for their overland travel. This is known as transloading, and offers the additional advantage that freight can be redistributed at the same time. (A global container usually carries just one type of freight, and it may be advantageous to redistribute its contents into smaller batches that join loads headed to various places. This sort of redistribution is frequently desirable anyway once a container reaches the U.S. or gets to a distribution center, so transloading can logically take place at such a point.) The practice also allows global containers to be quickly returned to ports, where the shipping lines are eager to get them back as soon as possible. Transloading is not actually done at ports, but usually at facilities close by or in the same metropolitan region.

Transloading has expanded over the past decade or so, though it is still carried out for a relatively small percentage of the global containers entering the country. The practice works in favor of the trucking industry, for as freight moves from global containers to domestic containers it is taken out of the networks coordinated by shipping lines and generally shifted into the domestic systems—whether containerized or traditional—run by trucking firms. Transloading is especially common in the Los Angeles region, as the massive amount of incoming containerized freight is handled by a multitude of distribution centers, warehouses and other facilities where goods are unloaded, stored, redistributed and reloaded.[31] (For cargo transloaded to domestic containers, the region also offers many intermodal terminals where those containers can be transferred to stacktrains.) The phenomenon of transloading seems to contradict the basic premise of global containerization, that containers would move seamlessly deep into national territories, and across transportation modes, all the way from origin to destination. To some extent it can even be seen as a reversal of the process of global containerization that has transformed worldwide freight movement, and reached so deeply into American space, since the 1960s. (Such transloading is less common elsewhere, for the simple reason that aside from the U.S. and Canada few nations have domestic containers and/or trailers that are so much larger

---

[30] Pacer International, "History"; YRC Freight [website]. "Semi-Trailer Dimensions." (http://www.yrc.com/shippers/semi-trailer-dimensions.html, accessed 9/16/12); Jean-Paul Rodrigue, "Carrying Capacity of Containers (in Cubic Feet)," *The Geography of Transport Systems* website, http://people.hofstra.edu/geotrans/, undated. (http://people.hofstra.edu/geotrans/eng/ch3en/conc3en/containerscubic.html, accessed 9/29/11)

[31] Bonacich and Wilson, *Getting the Goods*, pp. 108-109, 100-115.

than ISO containers.) This counters some of the more simplistic notions of globalization; the supposedly placeless, undifferentiated terrain of the global is revealed instead to be variegated, with particularities of place and nation that possess significance. This does not invalidate the power and importance of global networks, but rather reveals their nuances in more detail.

Over the years domestic containerization has flourished and become a very significant business in its own right, one that has altered the nature of domestic freight transportation. The efficiency of the overall containerized system, a process largely fueled by the growth of the global container network within American infrastructure, was a key factor in this. But the divergence of two key spatial regimes—the global container versus the American trailer—has been crucial in causing the domestic container to be distinct from the global standard. Even as the national infrastructure was globalized by the presence, at times transformative, of the global container, its own qualities, practices and ongoing history were instrumental in creating a separate domestic standard. The practice of domestic containerization, in turn, is part of a larger trend towards intermodalism in both passenger and freight transportation, to which the next chapter is dedicated.

Chapter 12 ~ Intermodalism as Transportation Policy

The shipping container is an example of the intermodal approach to transportation. Intermodalism is the idea of viewing a journey as composed of a series of transport modes, and seeking to improve the entire journey rather than just the separate segments. This often involves special attention towards points of interchange where a passenger or cargo shifts from one mode to another. During the past 20 years or so intermodalism has become a significant part of transportation policies and practices in the United States. As the American transportation infrastructure is increasingly built out, and there have not been recent technological advances in speed, the value of thinking intermodally is more evident. (The technological improvements affecting transportation in the past few decades have been oriented more to efficiency and comfort than speed, such as air-conditioning, guidance systems, improved safety, etc.) It is not enough simply to concentrate on improving specific transport modes—one must consider the entire journey, and hence the transfers between modes. This becomes all the more the case as the dominance of the motor vehicle is gradually reduced and other modes gain at least a modest share of use. The shipping container has provided an additional impetus, on the less noticed freight side of transportation, for the development of intermodalism, as it can be shifted easily between modes without the loading and unloading of its cargo. (In fact, in the American freight business the term "intermodal" is now usually synonymous with containerization.)

In terms of both passenger and freight movement, intermodal thinking tends to mitigate against the ingrained American preference for the motor vehicle. When one moves by car, or moves goods by truck, the natural tendency is to go directly all the way from origin to destination in this one mode. Indeed, the extraordinary power of the motor vehicle lies largely in its unique ability to do this, to handle an entire trip on its own. But there are inefficiencies, along with social and environmental costs, associated with an over-reliance on motor vehicles, and intermodalism encourages a more balanced approach that maximizes efficient use of the available infrastructure. Clearly there is a social and political dimension, not hard to parse in the American context, tied to intermodal transportation. This is more obvious with regard to passenger movement, where the intermodal approach generally promotes public transit (though not to deny car use, but merely to put it in its proper place). But in freight also the intermodal option is recognized as a more progressive and environmentally sustainable path.

In a broad historical perspective, transportation of substantial speed is a recent phenomenon, commencing with widespread railroad use in the nineteenth century. With the coming of the railroad and steamship, and especially once the automobile and airplane were added to the mix, the speed of movement rose so dramatically that the time required for transfer between modes became a bottleneck. But the issue that initially reared its head was actually that of coordinating between various providers of the same mode. The classic example was the rise of the "Union Stations"; during the early decades of the railroads it was common for each railroad company to build and operate its own station in a city or town. In most small towns only one railroad provided service anyway, but in larger metropolises there would be several stations, each serving its own particular railroad, resulting in burdensome transfers from one to another. (The term "Penn Station," most famously applied to the station in New York but also to many other stations, derives from this; a Penn Station served the Pennsylvania Railroad.) The inefficiency inherent in this situation grew obvious, and cities strove to persuade or force railroads to unite their operations at one station, typically termed a "Union Station." Consequently a plethora of Union Stations emerged in the U.S. in the late 1800s and early 1900s—the most famous being in Chicago, Washington, D.C., and Los Angeles—many of which endure to the present day. Similar efforts were later made in some cities to bring together diverse bus services at one main station, the classic example being the creation of the Port Authority Bus Terminal in New York City in 1950.

On occasion emphasis was also placed on transfers between different transport modes. In the early twentieth century railroad companies often owned or otherwise controlled bus lines, and hence had a vested interest in making interchange convenient between train and bus—at least for their own passengers. An example was the Pennsylvania Greyhound Bus Terminal in New York, built in 1935 and located across the street from Penn Station; as the Pennsylvania Railroad had partial ownership of Pennsylvania Greyhound Lines, the adjacency of the two stations was logical. Greyhound finally and with great reluctance relocated its operations to the Port Authority Bus Terminal in 1962, and the Greyhound station was demolished not long after (though it did outlast Penn Station, which tragically met the wrecking ball in 1962). Greyhound's shift to Port Authority made train-bus transfer more difficult for those interchanging between Greyhound and the Pennsylvania Railroad, even as it improved transfers between Greyhound and other bus lines.[1] Another instance of convenient transfer between modes, from an even earlier period, were the many combined train and ferry terminals on the west side of the Hudson River across from Manhattan that existed around the turn of the century. These were particularly important in the years before the construction of the rail tunnels under the river, as any train trip to New York from the west necessarily involved a ferry ride.

But in general such synergistic thinking was lacking with regard to the linkages between diverse modes of transportation; instead the tendency was for each mode to deal with its own functioning, and to work only towards its own improvement. A few farsighted thinkers, however, began to push for a different and more holistic vision. One was Warren Manning, a landscape architect who in 1923 published "A National Plan Study Brief," which called for transcontinental highways that in places would run parallel to railroads and waterways. He

[1] Christopher Gray, "A Bus Terminal, Overshadowed and Unmourned," *The New York Times,* November 3, 2011.

proposed that highways and trucking should function, in relation to the railroads, "as feeders rather than competitors."[2] In the same year the U.S. Chamber of Commerce published a report that urged cooperation between the various modes instead of "wasteful competition," and suggested the railroads concentrate on longer journeys while truckers focus on shorter trips.[3] In 1926 and again in 1930 an employee of the ICC (Interstate Commerce Commission) named Leo Flynn was sent out across the nation to collect testimony about transportation problems, with a particular focus on the flagging fortunes of the railroad companies and the issues created by the unregulated state of trucking. Flynn concluded that railroads should have less regulation and more freedom to drop unprofitable lines, and that a regulatory framework was needed for the trucking industry. Furthermore he argued for better cooperation among the various types of transportation, and though his main focus was on railroads and trucking he also took into account waterways and newly-emerging air travel. His report caused a stir in Washington, D.C., and he was called to testify at a hearing of the Senate's Interstate Commerce Committee in 1932. The chair of the committee was James Couzens, a senator from Michigan who had previously worked for Henry Ford; predictably biased for the truckers and against the railroads, he criticized Flynn severely. Some of the other senators were more sympathetic.[4]

An important voice for transportation coordination was Harold Moulton, an economist who specialized in transportation and the first president of the Brookings Institution. In the early 1930s Moulton assembled a committee, chaired by former president Calvin Coolidge and including several other major figures, to examine the nation's transportation system. It concluded that better coordination, and a more systematic national transportation policy, was needed. By the early 1930s most transportation experts agreed, broadly speaking, with this diagnosis. The troubles of the Depression, especially for the railroad industry, created a heightened a sense of urgency about the troubles of the transportation industry.[5] But since these problems afflicted the railroad companies most particularly, the impetus for greater coordination tended to come from them, or from those sympathetic to their concerns. Even when such suggestions came from neutral sources, they would have had the effect of boosting the railroads. As with Leo Flynn, there were many who supported lessening the regulatory burden of the railroads, while creating some regulations for trucking. In particular some suggested the railroad lines should be allowed to provide transportation, of both freight and passengers, by motor vehicles and on inland waterways.

---

[2] Keller Easterling, *Organization Space: Landscapes, Highways, and Houses in America* (Cambridge, MA: MIT Press, 1999), pp. 87-89.

[3] Frank B. Norris, *Spatial Diffusion of Intermodal Rail Technologies,* PhD Dissertation, University of Washington (Geography), 1994, p. 51.

[4] Stephen B. Goddard, *Getting There: The Epic Struggle Between Road and Rail in the American Century* (New York: BasicBooks [HarperCollins], 1994), pp. 138-145.

[5] Mark H. Rose, Bruce E. Seely, and Paul F. Barrett, *The Best Transportation System in the World: Railroads, Trucks, Airlines, and American Public Policy in the Twentieth Century* (Columbus, OH: The Ohio State University Press, 2006), pp. 55-56.

Some regulation of trucking was inevitable—even some of the truckers supported it, as they saw their legitimate business undermined by fly-by-night "gypsy" truckers—and it finally began at the federal level with the Motor Carrier Act of 1935. Making the appropriate adjustments to the regulations surrounding the railroad companies was more difficult, however, given the animus felt so strongly, and by so many, against them. The government meanwhile poured ever more money into road and highway construction, and Americans took to their automobiles with enthusiasm. Manufacturers and other businesses increasingly were free to move away out of the urban cores and away from railroad lines in general, as trucking provided a new flexibility. Governmental efforts to assist the railroads, and to encourage a more coordinated and balanced transportation system, were half-hearted, and the railroad industry continued to decline. This was briefly reversed in World War II, as mobilization led to massive use of the rail network (and substantial profits for the industry), especially given the shortages of rubber and gasoline that limited motor vehicle use. But the respite was only temporary, and the postwar years saw more suffering for the railroad companies.

The development of the Interstate highways was the *coup de grace*, as it allowed long-distance trucking to be carried out on a massive scale across the entire country—as well as longer and faster automobile trips by ordinary citizens. Yet a few individuals envisioned the new highways as components in a well-coordinated transportation network, linking to other transport modes at transfer points. The planner Lawrence Halprin and industrial designer Egmont Arens were among these figures, though their ideas could be on the fanciful or overly futuristic side. The more practical Wilfred Owen was a bureaucrat who advocated for intermodalism and cooperation between modes over a long career as a transportation expert. An earlier 1944 government report titled *Interregional Highways* had also recommended an intermodal approach.[6] Sadly such ideas gained little attention, and the various modes of transportation remained largely separate and uncoordinated, with the motor vehicle and airplane steadily ascendant while the railroads declined.

Lamenting the lost opportunity to generate interchange between modes, Keller Easterling condemns the Interstate highway system as a "dumb network with dumb switches" that cannot take advantage of "multiplicity, differentiation and diversity."[7] She argues that multiple transport modes "increase the possibility of switching between systems to produce a better fit between task and carrier. The system is rich with these potential switch sites for interchanges and urban terminals."[8] While Easterling's techno-jargon can be problematic, she makes a valid point. Transportation planners showed a lack of imagination as they built roads and highways across America. The private sector was equally confined in its vision of what transportation could do, as competition rather than cooperation was the order of the day. The rise of containerization in the 1950s, '60s and '70s helped break down some of these divisions, at least in terms of freight movement, for the container by its workings encouraged the use of multiple modes. But it was

---

[6] Easterling, *Organization Space*, pp. 98-109.
[7] Ibid., p. 77.
[8] Ibid., p. 78.

the dramatic increase in container transport by rail in the 1980s and '90s that really propelled freight intermodalism.

Another trend, also starting in the 1980s, made people in the industry more aware of the benefits of coordinating various modes of transportation. This was the development of express package delivery services offered by companies like United Parcel Service (UPS) and Federal Express (FedEx), who typically took direct control of every segment of their transportation networks, which primarily consisted of trucks and airplanes. To this physical involvement they added an emphasis on information, taking advantage of the evolving digital revolution to coordinate and track their packages as had never before been done. From their American origins, UPS and FedEx have built up extraordinary global networks in which multiple infrastructures are exploited with the goal of moving packages most quickly and efficiently from point A to B. The focus is ultimately on the package itself, and the various transportation systems are simply a means to its delivery. One can easily draw analogies with the container, or with the individual human being in passenger transportation.

Use of the phrase "intermodal" with regard to transportation began in the late 1960s—earlier instances are rare indeed—and took off over the 1970s and '80s.[9] In the 1980s the concept started to become a significant focus of attention for people in transportation, including those in both business and public policy. This is reflected in a rising number of government reports, scholarly writings, and articles in trade journals that deal with the topic of intermodal transportation and refer to it by name. Clearly the success of the shipping container (and also piggyback) had much to do with the new interest in intermodalism. But this new awareness was happening for passenger transportation too—without a doubt, a broader comprehension of the issue was emerging.

The need to use existing infrastructure more efficiently, to better leverage the assets already in place, was becoming evident. This led to a particular focus on places where transfers are made between transport modes—on the creation of such nodes, and improving access to them. It also reflected a realization that the construction of major new transportation projects was now less likely. By the early 1990s the American transportation system was essentially "built out," with the Interstate highway network for the most part completed and few other construction projects ongoing. While road-building has been constant since then, in parallel with the continuing expansion of sprawl (until the past few years of recession), such projects are generally at a local or regional level, do not involve the construction of new highways, and mean little at the national scale. The railroad industry has experienced growth (as has Amtrak), but that has not involved the creation of new rail corridors. Few new airports have been built, though many have expanded.

In short, the era of national infrastructure construction was fading, as the impetus of the nation-building project (and perhaps the unity of the nation) was in decline. It had arguably

[9] This is evident from performing searches for "intermodal transportation" in Google Books and Google Scholar while restricting the search results to specific periods of time. Use of the term clearly begins in the late 1960s, with only the rarest exceptions. The term gradually becomes more common in the 1970s and '80s.

reached its peak with the construction of the Interstates in the 1950s, ‘60s and early ‘70s, but the shift to globalization and worldwide trade, and to a more laissez-faire and less state-oriented approach, began as early as the 1970s and was strongly evident in the 1980s and ‘90s. A host of other factors, some positive and some negative, also played a role: the larger sense of the public interest faded, corporate power expanded as government action fell, certain technological limits were reached, environmental awareness grew, and construction costs rose. The general public had become vastly more dubious about building new infrastructure, thanks to the NIMBY (“not in my backyard”) mentality and a pervasive skepticism. Traffic engineers meanwhile found that building new roads tended to just make people drive more, rather than reducing traffic. The one important new transportation technology during this period was high-speed rail, but the U.S. showed little interest in it (building only a very limited high-speed corridor in the Northeast) and effectively ceded leadership in its use to other parts of the world. With so little new infrastructure being developed, clearly there would be a need to utilize what existed as efficiently as possible. As an article written in the late 1990s argued, “the political discourse about transportation will, of necessity, shift in focus from the development of new links to more efficient use of existing links. This is in recognition of the fact that the basic modal infrastructure of the United States is now in place and will not expand significantly in the foreseeable future.”[10]

A key point in the growth of American intermodalism was reached with passage of the landmark federal Intermodal Surface Transportation Efficiency Act, better known by its acronym ISTEA, in 1991. (Strangely enough, the terms “intermodal” and “intermodalism” were not actually defined in this legislation.[11]) Interest in intermodalism was enlarged greatly by the act, which was a watershed moment for intermodal transportation as it gained official government support both practical and symbolic in nature. The administration of President George H. W. Bush actually had little desire to boost public transit, bicylists or pedestrians, but rather wanted to improve links between highways, ports and airports. It was left-wing advocates who pushed, with surprising effectiveness, for supporting multiple modes of personal transportation. The final result was legislation that managed to make all the factions reasonably content.[12]

ISTEA changed the transportation landscape in several ways. For our purposes the most relevant was a new emphasis on intermodalism. But ISTEA also embodied two seemingly contradictory tendencies. On the one hand it gave more autonomy to local and state governments in what transportation projects they prioritized and how they spent federal money. Yet it also

---

[10] Rainer Ault, Paul W. Forster, and John Leslie King, “The Great Reversal: Information and Transportation Infrastructure in the Intermodal Vision,” in: Transportation Research Board (National Research Council), *National Conference on Developing a Research Framework for Intermodal Transportation* [Conference Proceedings 12], Washington, D.C., 1997, p. 36.
[11] Lillian Liburdi, “Keynote Address: The Promise of ISTEA,” in: Transportation Research Board (National Research Council), *ISTEA and Intermodal Planning: Concept, Practice, Vision* [Special Report 240], Washington, D.C., 1993, pp. 56-57. (Proceedings of the National Conference on ISTEA and Intermodal Planning Issues, December 2-4, 1992, Irvine, CA)
[12] Mark H. Rose and Raymond A. Mohl, *Interstate: Highway Politics and Policy Since 1939* (3rd ed.) (Knoxville, TN: University of Tennessee Press, 2012), pp. 167-173.

emphasized global connections, such as ports, airports, border crossings, etc.—and not just those facilities, but the transport links to them. Seen in this light ISTEA fits to some degree with Graham and Marvin's "splintering urbanism" thesis, for it represents a diminishment of the nation-state's unifying agency as local and regional divisions emerge, and simultaneously is an effort to integrate national, regional or local infrastructures into larger global systems. But it would not really be accurate to describe ISTEA's changes as a splintering or fracturing of domestic infrastructure; global connections and local autonomy have been enhanced, to be sure, but the basic infrastructural coherence at the national scale remains.

The growth of local and state autonomy (and responsibility) in transportation planning actually began quietly in the 1970s. The Interstate planners and builders, typically engineers, were often condemned in the 1960s and '70s for ramming highways through neighborhoods, especially in cities where their routes invariably passed through areas populated by racial minorities. Critics also argued for the provision of federal funding in support of public transit and bicycling, instead of only road-building. Meanwhile some conservatives sought more autonomy as well, as they resented federal sway over local and regional matters; obviously they were hostile to public transit, but they wanted the power to support their own preferred road projects. In the early and mid-1970s the Nixon and Ford administrations, along with Congress, began to make changes that funneled a bit of funding to public transit and granted greater decision-making powers to cities and regions. A small portion of the Highway Trust Fund was taken away from road construction and dedicated to public transit instead. In addition, metropolitan regional agencies known as Metropolitan Planning Organizations (MPOs), which had only just been created in the late 1960s, were given great involvement in transportation planning, including the allocation of federal dollars.[13]

In the 1980s the process continued. To some degree this was a result of deregulation, but primarily it was caused by policy shifts:

> Despite nominal increases in federal support… public support for transportation infrastructure and services increasingly became a state and local government responsibility. Central federal direction in transportation reduced its reliance on the two key control mechanisms used by governments—regulation and finance. This meant that planning for transportation, faced with evident federal disinterest and a dearth of either tools or money to pursue national transportation goals, increasingly became attuned to local and state concerns.[14]

ISTEA, coming in the early 1990s, was a logical continuation—and confirmation—of the trend. The recognition of intermodalism's importance was new, but perhaps came out of several factors that mitigated the previous dominance of the motor vehicle: an enhanced environmental awareness, growing opposition to road-building, the growth (albeit modest) of public transit

[13] Ibid., pp. 162-165.
[14] John W. Fuller, "The Road to Intermodalism," in: Transportation Research Board, *ISTEA and Intermodal Planning*, p. 118.

systems, the revival of the railroad industry, the survival of Amtrak, the growth in air travel, and the boom in containerized and piggyback freight movements. The greater awareness of the value of intermodal thinking was formalized in the creation of the Office of Intermodalism, within the U.S. Department of Transportation, by the ISTEA legislation.

ISTEA's provision for greater local and state control over how transportation dollars would be used was a reversal of the more top-down approach typified by the Interstate highways. (The contrast should not be overdone, however; the Interstates required extensive negotiations with the states, and among them.) In summarizing the most important aspects of ISTEA in a report two years after its passage, Robert Martinez, an official with the Department of Transportation's Office of Intermodalism, devoted the first two of his three points to describing how the act shifted power to the local and state level. He stated that ISTEA "designates states and localities as the primary determinants of how transportation policies are set," and added that it "provides unprecedented flexibility to transfer funds from one category to another to achieve transportation goals determined by state and local officials."[15] (Only in his third point did he acknowledge what many regard as ISTEA's most critical aspect, its focus on intermodalism.) Martinez provided a rationale for this significant alteration in transportation policy: "ISTEA's unparalleled funding flexibility allows states to spend transportation funds on programs, projects, and modes that are significant to them because, simply put, the transportation priorities of California differ from those of Connecticut."[16]

In the early and mid-1990s ISTEA's impact on transportation priorities was relatively minor, since putting greater decision-making power in the hands of local, regional and state officials did not necessarily lead to changes. Often these policy-makers and politicians were as wedded to the automobile infrastructure as national leaders long had been. In suburban areas especially, where the growth machine depended on the continued expansion of automotive access, local officials were happy to use their newfound power over transportation spending to target their favored road-building projects. Others, however, were quick to recognize the opportunities ISTEA created for alternate modes of transportation. Ultimately the priorities and decisions varied from locality to locality, and from state to state. ISTEA gave new power to the MPO that existed for each major metropolitan area, but how that power was wielded obviously depended on whose interests the MPO tended to serve, or where its priorities lay.[17]

ISTEA was not a piece of legislation that remained permanently in place. It was succeeded in 1998 by the Transportation Equity Act for the 21st Century (TEA-21), that in turn being succeeded in 2005 by the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU), which in turn was followed in 2012 by the Moving Ahead for Progress in the 21st Century Act (MAP-21). (The names of these acts seem to grow progressively more convoluted and ridiculous.) These acts were each of great importance in their own way, of

---

[15] Robert Martinez, "Perspective from the Office of Intermodalism," in: Transportation Research Board, *ISTEA and Intermodal Planning: Concept, Practice, Vision*, p. 47.

[16] Ibid., p. 48.

[17] Rose and Mohl, *Interstate: Highway Politics and Policy Since 1939*, pp. 174-176.

course, but none were watershed shifts in transport policy as ISTEA had been. (The SAFETEA-LU legislation of 2005 was a predictably wasteful and automobile-oriented product of the George W. Bush presidency, and contained the funding for the notorious "bridge to nowhere" in Alaska.[18]) However it must be kept in mind that ISTEA's importance is not merely in the legislation itself, but in the changing approach to transportation, the rising use of intermodalism, that was gaining momentum at the same time—and which has continued to the present. This was helped significantly by ISTEA but surely would have transpired regardless, fueled by the larger changes taking place. Even the conservative eight-year presidency of George W. Bush, though marked by an emphasis on road-building as opposed to public transit, and a whole-hearted devotion to the profitability of the oil industry, could not halt the underlying shift in American transportation.

In the larger context of ISTEA and intermodalism, it is worth noting briefly that the impact of intermodal thinking on passenger transportation has also been substantial since the 1990s. This has tended to be to the advantage of public transit systems, along with long-distance rail and bus operations. Particularly notable is the creation of multimodal stations that merge railroad and bus facilities into a single terminal, or least the locating of such stations adjacent to each other. This is a seemingly obvious idea, yet until recently it was not uncommon for a city's train and bus stations to be entirely separate facilities spatially distant from each other, making passenger transfers between one and the other unnecessarily difficult. Boston is a representative case; the city's principal train station is South Station, located downtown, while the main bus station for a long time was a Greyhound station in the Back Bay district about a mile away. This state of affairs persisted until 1995 when a new bus station, the South Station Bus Terminal, was built adjacent to the train station. In smaller municipalities it is possible to combine the train and bus stations into one building, which has the added benefit of merging the waiting area, ticket booths and restrooms. An example is Syracuse, New York, where separate train and bus stations were combined in 1999 into the new William F. Walsh Regional Transportation Center. (Evidently the previous facilities were not at all missed, as a contributor to Wikipedia writes that the new station "replaced the highly unpopular downtown bus station and even more unpopular Amtrak station in East Syracuse."[19]) Another trend has been the development of better airport connections to public transit systems and even Amtrak. A host of major construction projects were carried out in the 1990s and 2000s to improve these links. In some cases this involved the creation of a direct subway connection, as with the extension of BART to reach the San Francisco Airport, while in other instances it was a matter of the airport building a short link to a nearby subway stop, as with the "AirTrain" people-mover at J.F.K. Airport in New York. Arguably the most impressive feat is to establish a direct link between an airport and a nearby Amtrak station, as has been done at the Newark, Milwaukee and Baltimore airports.

---

[18] Michael Grunwald, *The New New Deal: The Hidden Story of Change in the Obama Era* (New York: Simon & Schuster, 2012).
[19] Wikipedia, "William F. Walsh Regional Transportation Center."
(http://en.wikipedia.org/wiki/Syracuse_(Amtrak_station), accessed 9/25/12)

With regard to the shipping container, ISTEA's most important aspect was the boost it gave to the intermodal way of handling freight, along with its emphasis on developing stronger links to global transport systems. Planners and transportation specialists did not neglect freight movement, and sought to apply intermodalism into national practice. This translated into particular emphasis on two areas: connections to ports, and connections to intermodal terminals. (Border connections with Mexico and Canada were also taken into account, but much less emphasized, even though the North American Free Trade Agreement [NAFTA] was on the horizon and eventually began in 1994. Such border crossings do not involve an intermodal component the way ports do.) The quality of linkages to ports was not a novel concern, though the seamlessness of container movement and the growing quantity of global freight heightened its importance. But the issue of links to intermodal terminals was an entirely new problem, one that had not been raised before at the level of national policy. The newfound awareness of its relevance was due to ISTEA's emphasis on intermodalism and global trade, and also in part to the growth of transfers (of both containers and trailers) at these terminals. Rationalization and mechanization in the railroad industry caused a reduction in the number of terminals, concentrating traffic even more heavily at the remaining terminals which became major nodes. (The development of these intermodal terminals is the subject of chapter 9.)

Even as ISTEA gave more autonomy and responsibility to localities and states, it singled out particular links and nodes as being of national significance. Beneath the rhetoric of ISTEA's emphasis on "national" projects, it is not hard to see a globalizing agenda. The focus on intermodalism was convenient, in the context of freight, because it served to assist a push towards globalizing the transport system, to link it more deeply into the burgeoning global container network of movement. The contrast with the previous creation of the Interstate highways, a project that bound the nation-state together internally, is instructive. ISTEA set up a new nationwide highway network, the National Highway System (NHS). For the most part the NHS was simply a new conception for the existing highways, including the Interstates and other highways, but it also covered other routes and arterials regarded as vital for any reason. This allowed for various connections to ports and intermodal terminals to be included in the NHS and made eligible for funding.[20]

Attention to such links, it was argued, would boost national transportation and also make the nation more competitive globally. In the foreword to a report on ISTEA and the NHS, released by the U.S. Department of Transportation in 1993, it was written (under the name of the Secretary of Transportation Federico Pena) that the new transportation system created by ISTEA "will lower the price of American manufactured goods and services by reducing the time and money spent on transportation. Those savings, in turn, will enable American companies to compete better in

[20] U.S. Department of Transportation (Federal Highway Administration), *The National Highway System: The Backbone of America's Intermodal Transportation Network,* Washington, D.C., December 1993, pp. 12, 15-16; David Smallen, "Intermodal Connectors: NHS Catches Up to the 1990s," *Public Roads,* Vol. 61, No. 6 (May/June 1998).

markets at home and around the world—and create more American jobs."[21] The result of course has been precisely the opposite, as ISTEA's emphasis on improving transportation links to the rest of the world has helped make imports cheap and caused great harm to American manufacturing and its employees. It is the price of goods manufactured abroad, not at home, that has been lowered—and the competitiveness of foreign manufacturers that has been enhanced. In fairness, ISTEA deserves only a smidgeon of the blame for something that has been the product of so many larger trends (the container itself being far more significant), especially since the legislation only made slight changes to a domestic network that was already well established. In addition, no one could have predicted all its effects. It also should be stressed that intermodalism is by and large a worthy policy to pursue.

Improving the nation's connections to the worldwide container network had positive impacts too, both for citizens and the economy. American consumers have benefited immensely from the cheaper prices of so many goods they buy. Many retailers have flourished, and American companies that manufacture their products abroad have also reaped the rewards. So the point here is not to condemn the globalization of American infrastructure, but to note its consequences and some of the misleading ways it has been promoted. It has in particular been part of a larger national shift from production to consumption that has all sorts of implications. The Department of Transportation's optimistic words in the early 1990s about American competitiveness and the national interest prefigure the patriotic rhetoric used by the railroad companies more recently to promote their corridors for stacktrains—and to plead for government subsidies to help build them. As noted in chapter 7, a name like the Heartland Corridor carries an evocation of the nation-building tradition that belies its actual purpose, which is to carry goods moving in global trade.

As a result of ISTEA's emphasis on intermodal connections, a bureaucratic process was initiated in the early and mid-1990s to identify road-based links—in both passenger and freight movement—and decide which were of paramount importance. These would be proposed for inclusion in the NHS. The result was an impressive list of connections, comprising a total of about 2,000 miles that included roughly 1,400 links to all types of facilities, including ports, airports, bus stations, Amtrak stations, intermodal terminals, public transit stops, ferry terminals, etc. Obviously the typical connection was quite short; the concept was meant to deal with bottlenecks and choke points that despite their limited length were key links in a longer chain.[22] As the Federal Highway Administrator, Kenneth R. Wykle, pointed out in the late 1990s, in specific reference to road connections for freight movement:

> There are 163,000 miles in the National Highway System [NHS]. There are 2,000 miles of connectors that we believe severely constrain the capacity of this great highway system. Freight flows rapidly across our NHS system but then comes to a virtual stop as vehicles come off exit ramps out to congested, narrow streets

[21] U.S. Department of Transportation, *The National Highway System*, foreword (page not numbered).
[22] Smallen, "Intermodal Connectors."

> with multiple stoplights leading to our seaports, airports, rail terminals and stations, and major manufacturing areas. If we focus on less than two percent of the system, we can significantly increase productivity.[23]

The new attention to intermodal freight transportation and particular links could be laser-like in its focus on specific choke points. An example was the "Kedzie stoplight" on Kedzie Avenue at the entrance to BNSF's Corwith intermodal container terminal in Chicago. With no traffic signal in place, the daily movement of about 2,000 trucks in and out of Corwith was a major problem not only for local traffic but also for the terminal and hence BNSF's intermodal operations. ISTEA's emphasis on intermodal connections helped lead to a solution in the late 1990s. As the street layout at the time was not suitable for the addition of a traffic signal, the project involved a reconfiguration of the intersection, the repaving and broadening of three miles of the street, and the construction of sidewalks and gutters, in addition to the signal, for a total cost of $4 million. These changes not only improved access to the terminal but also enhanced its connection to Interstate 55, Kedzie Avenue being the short but vital link between the highway and Corwith. The project was an exemplary instance of ISTEA's novel focus on intermodal links, and was even referred to as "the ISTEA poster child."[24] It also illuminated how upgrading access to global trade could involve alterations deep inside the domestic territory, not just in the vicinity of ports and borders.

In tandem with such road-building efforts, there have been numerous projects to improve railroad access at particular bottlenecks. Most were not directly tied to ISTEA, but reflected the new wave of intermodal thinking. Many of these projects have been described in chapter 7, and most were public-private partnerships carried out jointly by railroad companies and government agencies (as opposed to roads where government of course is the sole builder). The most extensive case of government involvement—perhaps the one case where the government actually took the lead—was in the largest, most expensive and most complicated of these projects, the Alameda Corridor, which vastly improved rail access to the ports of Los Angeles and Long Beach. Several other projects have also boosted rail links to various ports, but equally significant are those that, like the Kedzie project in the context of trucking, made alterations to the rail infrastructure deep inside the national space. A good example was the Sheffield Flyover, which resolved a nasty bottleneck in Kansas City.

Arguably the greatest advantage of intermodalism is its greater sustainability in comparison to the longstanding American preference for the motor vehicle. This is most evident in passenger transport, where the environmental credentials of buses and trains are widely known to be dramatically better than automobile (or airplane) use. But a similar pattern holds for freight, where the advantage is substantial since the intermodal approach embodies a preference for

---

[23] Ibid.

[24] Daniel Smith, "Freight Projects of National Significance: Toward a Working Definition," in: Transportation Research Board (National Research Council), *Policy Options for Intermodal Freight Transportation* [special report 252] (Washington, D.C.: National Academy Press, 1998), pp. 206-207; Smallen, "Intermodal Connectors."

using rail for the bulk of a freight journey. The dynamic is slightly different, however. One might consider a truck as analogous to a bus, since both are large motor vehicles, but while a bus is a very sustainable way to move people, a truck is an environmentally harmful method of moving goods relative to a train. A better analogy is to regard each container as a unit, and to realize that a truck typically moves just one unit at a time while a train can carry hundreds. What makes a container-laden train so much more efficient than a truck is its economies of scale, as it can hold as many as 250 containers. (By the same token carrying containers by ocean shipping is in a sense sustainable, despite the highly polluting technology the ships use, since one container ship holds thousands of containers. But the ideal environmental solution would be to produce goods closer to home and avoid the ocean shipment entirely.)

The environmental edge of the train is vast. The U.S. Department of Energy estimates that when the movement of freight is measured in BTUs per ton-mile (i.e., the number of British thermal units consumed in moving a ton of freight one mile), the figure for trucking is 3,500-4,000 BTU/ton-mile, versus only 350-500 BTU/ton-mile for rail. In other words, the railroad is about nine times more efficient. (Air freight is even worse than trucking, and by a wide margin.) Calculations for CO_2 emissions also give a very substantial advantage to rail.[25] While such rough estimates do not apply in every case, as particular circumstances may vary, rail is without a doubt invariably superior by several orders of magnitude. Little wonder the railroad lines are so fond of trumpeting their sustainability. (Moving containers on inland waterways, or by coastal shipping, is even more environmentally friendly than moving them by train, as noted in chapter 10.) For those in transportation policy and planning, such statistics provide a convincing justification for supporting containerized rail operations and piggyback while discouraging long-distance trucking. The environmental advantages of moving freight intermodally have long been evident, as in the early 1970s the OPEC oil crisis and a newfound environmental awareness already had some seeing the benefits of using rail for most of the journey.[26] The issue was of sufficient interest that Argonne National Laboratory carried out a study in 1980 to quantify the amount of fuel and money that would be saved by the use of piggyback under three future scenarios, and found that piggyback did generate a reasonably substantial advantage. Argonne estimated the difference between piggyback and trucking in terms of energy use, incidentally, at 800 BTU/ton-mile.[27] (This figure seems small in light of the statistics given above, but perhaps it is because piggyback still involves local truck use, as well as terminal operations.) It has only been in the past decade or so, however, that these advantages have been more widely publicized, and have led to some modest shifts in public policy—albeit with fierce resistance from truckers, road

---

[25] James J. Winebrake and James J. Corbett, "Improving the Energy Efficiency and Environmental Performance of Goods Movement," in: Daniel Sperling and James S. Cannon (eds.), *Climate and Transportation Solutions: Findings from the 2009 Asilomar Conference on Transportation and Energy Policy,* Institute of Transportation Studies, University of California, Davis, Davis, CA, 2010, pp. 146-148.
[26] Gus Welty, "TOFC/COFC Growth: The End Is Nowhere in Sight," *Railway Age,* Vol. 174, No. 10 (May 28, 1973), p. 32; Robert D. Bartley, "TOFC and COFC: There's Big New Growth Ahead for Both," *Railway Age,* Vol. 174, No. 20 (October 29, 1973), p. 51.
[27] *Railway Age,* "How Much Energy Can Intermodal Save?" Vol. 181, No. 14 (July 28, 1980), p. 28.

builders and the oil lobby. Higher gas prices of course have also been a key contributing factor in these changes.

An irony of the intermodal movement is that it renews the use of older transport infrastructures, and earlier technologies, that were long slighted. In passenger transport intermodalism supports public transit buses and trains, which were in decline from the 1920s to the '80s but have since rebounded. In freight transport the intermodal approach is greatly to the benefit of the railroads, and has the potential to favor inland waterways also. The revival of the railroads (for both freight and passengers) is perhaps a sign that the modernist desire to constantly advance into the future, to apply the newest technology at all costs, has been moderated by a more practical and thoughtful willingness to draw on the available technologies, and to build a system that is efficient rather than wasteful. At the risk of putting forth an overly grandiose and theoretical interpretation, one might posit that the current emphasis on a system that uses all modes of transportation is postmodern in nature, multivalent rather than univalent, in its willingness to utilize multiple technologies from various eras as is convenient. Older modes of transportation, generally more energy-efficient, possess greater value in such a scheme.

This does not mean the intermodal approach is in any way "low-tech." Many of these older transport modes utilize the most up-to-date technologies to maximize their performance. A modern diesel-electric train engine is incomparably better than a coal-powered steam model, for instance. What is equally significant and perhaps less obvious is that the revolution in information technology and digital networks has transformed transportation in many ways, and generally worked to the advantage of intermodalism. As Rainer Alt, Paul W. Forster and John Leslie King argue perceptively in a 1997 article, the rise of intermodal freight transportation has been tied to the use of information technology to better coordinate and track journeys. Such technologies are integral to just-in-time manufacturing, delivery and inventory techniques as well. So the transportation infrastructure increasingly works in tandem with, and is controlled and coordinated by, the information infrastructure.[28]

As this has evolved, it has gotten easier for multiple links in a transport chain to be meshed into a well-organized and efficient whole. Previously there were substantial inefficiencies in using several modes of transportation, and often the logical decision for sheer simplicity's sake was to go with trucking for an entire land-based journey. Today's vastly better information technology, along with improved cooperation between transport providers, makes the use of multiple modes more feasible. That is a particular boost to global freight movement, which by its nature must rely on multiple modes anyway. As a discrete and exact unit the shipping container to some degree lends itself to this newfound attention to information and data. But what is equally important is that the seamless nature of container movement, its ability to be transferred so quickly from one transport mode to another, is well suited to contemporary information technology that is so rapid and flexible in its own right. (Indeed, in the early days of containerization a lack of information, or the inability to transmit information rapidly enough,

---

[28] Alt, Forster, and King, "The Great Reversal," pp. 31-53.

often represented a bottleneck, as the containers moved so swiftly between modes that traditional record-keeping and paperwork could not keep up.)

With the American transportation infrastructure essentially built up and fully in place, the challenge is to better manage and coordinate it. For a variety of reasons the U.S. now has little appetite for building new infrastructure, and so policy-makers, planners, business people and logistics experts are concentrating on using the intermodal approach to more efficiently leverage what exists. The rise of the shipping container has been an important factor boosting the intermodal approach in freight movement, while at the same time this approach has in turn further strengthened containerization. Policy-makers now have reason to view the container's use in a positive light, especially if the bulk of its overland journey is done by rail or barge. That is particularly the case with domestic containerization, which takes the place of a trip that would otherwise occur entirely through trucking. In a nation whose transportation practices have grown more in tune with intermodal thinking, the container's use gains a larger significance.

Chapter 13 ~ Conclusion

The age of modernity is characterized technologically not merely by machines, but by systems and networks. These infrastructures tie together people and societies, but if we regard them spatially it is evident they also bind together sites, places and territories. They have played a key role in the past few centuries, as Rosalind Williams points out:

> As the Age of Enlightenment faded into the Age of Improvement, the spatial basis of Western society began to be reorganized along ever-extending networks of transportation and communication, which were also networks of economic, political, and intellectual power. As the physical networks continued to be laid down in the nineteenth and twentieth centuries, in layer upon expensive layer, they legitimated themselves in a self-reinforcing cycle of hegemony.[1]

The importance of such physical networks was not entirely new, of course; after all the Romans were famous for their roads and aqueducts. But from the eighteenth century onward (first in certain European nations, then gradually elsewhere) the systems started to acquire a new level of complexity and grew more deeply interwoven, in parallel with modernity. In sum, they became infrastructures.

The presence of infrastructure, and its central importance, thus appears to be a fundamental characteristic of the modern condition. Infrastructures of movement, involving flows of people and goods, seem especially characteristic of modernity. While humans obviously have always possessed some capacity to move (on foot, if all else fails), it is fitting that human civilization has become increasingly characterized by dynamic and constant motion over the nineteenth, twentieth and twenty-first centuries. The Industrial Revolution was the original cause of this transformation, as it brought into being the steam engine that powered early railroads and steamships; better trains and ships, along with motor vehicles and airplanes, have followed since. The "space of flows" to which Manuel Castells often refers is not a new phenomenon, though it has certainly advanced markedly in recent decades. The consequences of this modern frenzy of movement are not only technological and economic, of course, but extend to society and culture too.[2]

---

[1] Rosalind Williams, "Cultural Origins and Environmental Implications of Large Technological Systems," *Science in Context*, Vol. 6, No. 2 (Autumn 1993), p. 395.

[2] For more on movement and modernity, see Tim Cresswell, *On the Move: Mobility in the Modern Western World* (New York: Routledge, 2006). Also see Stephen Kern, *The Culture of Time and Space, 1880-1918* (Cambridge, MA: Harvard University Press, 2003 [orig. 1983]), pp. 109-130.

As chapter 4 relates, such infrastructures have been foundational components of the modern nation-state. Yet they have also long extended far beyond national borders, creating transnational connections for trade, movement and ultimately power. The Europeans of course improved their links with each other, but also ventured out over the oceans, utilizing increasingly better technologies for navigation. These explorations led to colonialism and eventually imperialism, a worldwide condition that in some regards can be seen as a precursor of contemporary globalization. During the nineteenth century in particular global networks of movement and communication flourished and grew more advanced.[3] Amidst such practical advances, more idealistic notions also sprung up, most notably Saint-Simonism. This movement, popular in France during the early and mid-1800s, followed upon the ideas of Claude Henri de Rouvroy, comte de Saint-Simon, though it gained greater force only after his death. Saint-Simonism espoused utopian and vaguely socialist notions of harmony between people, and saw technology as a key tool to advance such aspirations. The Saint-Simonians had an immense enthusiasm for infrastructural networks, which they perceived as potentially global in scope, and as many of them went into engineering or business they had opportunities to pursue this agenda. Probably their greatest concrete accomplishment was the Suez Canal, for the Saint-Simonians were instrumental in its conceptualization and construction.[4] Saint-Simonism prefigures certain elements of the enthusiasm some proclaim for globalization today. In particular, its espousal of global infrastructures as tools for harmony and progress parallels the thinking of today's promoters of globalization, though the technologies at hand are different. And even though Saint-Simonism's socialist tendencies run counter to free-market ideology, it is undeniable that there is a certain utopian strand in the pronouncements of some of today's prophets of globalization.

The nineteenth century was also strongly characterized by infrastructural development in the service of nation-states. Indeed, the Saint-Simonians themselves were active at the domestic level, and played a prominent part in the building of railroads in France. The role of American railroads in binding together the young nation, and ensuring its hold over an expanding territory, is a classic example of infrastructure and the nation in this period. Even in colonized territories, the infrastructures the imperialists put in place for their own purposes often eventually morphed into vital systems of unity and nation building—sometimes before independence was actually achieved—as Manu Goswami describes in the case of the Indian railroads.[5] This link between infrastructure and the national scale remained very much in place for most of the twentieth century, with the Interstate highways arguably representing its apotheosis in the American context. But in the 1970s it started to wane as worldwide

---

[3] For accounts of shipping and telegraphy, see Daniel R. Headrick, *The Tentacles of Progress: Technology Transfer in the Age of Imperialism, 1850-1940* (New York: Oxford University Press, 1988), pp. 18-48, 97-144.
[4] Mark Mazower, *Governing the World: The History of an Idea* (New York: Penguin Press, 2012), pp. 96-100; Rosalind Williams, "Cultural Origins and Environmental Implications of Large Technological Systems," pp. 392-393.
[5] Manu Goswami, *Producing India: From Colonial Economy to National Space* (Chicago: University of Chicago Press, 2004), pp. 103-153.

infrastructures began to take the lead, both reflecting and driving larger trends toward a more globalized world.

One way to view this rise of global infrastructures is to celebrate it, in the style of Thomas Friedman's *The World Is Flat* and similar encomiums, as part of the wonders of globalization. Another reaction is to condemn it as integrally tied to inequality, being linked to social and spatial fracturing and the formation of enclaves, as many scholars in the "splintering urbanism" paradigm maintain. This dissertation has sought for the most part to steer a path between these two extremes, each of which possesses some insights but also a few distortions. It is more interesting to consider how the elements of the nation-state, including its infrastructures, become constitutive of the new global condition. If infrastructure is part and parcel of modernity, surely it is equally important in our current situation, whether we call it postmodern, late modern or still just modern. This is especially true since so many global networks actually utilize the previously built infrastructures of the nation-state, as this dissertation has emphasized is the case with containerization.

Saskia Sassen presents an interesting idea along these lines about the nature of globalization. As discussed in chapter 4, this dissertation draws on her view that globalization is largely implemented by actors working within the scale of the nation-state. Sassen puts forth this claim as she seeks to understand how the economic and political conditions of globalization are being put in place—she has little concern with infrastructure specifically. But she makes a further argument that also may be relevant. Essentially she hypothesizes that the organizational structures of the previous era, that of the nation-state, now play a role in carrying out globalization. While Sassen's verbiage can be dense, the idea merits consideration:

> …the new does not invent itself. I interpret foundational change and the ascendance of novel formations [of globalization] as in good part a function of capabilities shaped and developed in the period preceding the one under examination—in this case, that of the formation and ascendance of the nation-state. The conditionality explaining the outcome [globalization]…is that at least some of those earlier capabilities [of the nation-state] become lodged in novel organizing logics [of globalization].[6]

This argument seems to suit the process of containerization plausibly well. Early versions of the shipping container were used at various national (or local or regional) scales before it shifted to the global, and its dimensions and other qualities derive in many ways from national infrastructures. But a deeper and more subtle point is that infrastructure's foundational role in the modern nation-state can continue, perhaps in a more complex form, into globalization. Infrastructure has been part of a technological process of rationalizing and standardizing the contours of human existence, and while previously it carried this out in order to serve, reinforce,

[6] Saskia Sassen, *Territory, Authority, Rights: From Medieval to Global Assemblages* [updated ed.] (Princeton, NJ: Princeton University Press, 2008), p. 402.

constitute and/or reflect the nation-state in multiple ways, now it does likewise for the larger world scale.

But it does not only work at the global scale. As many scholars have pointed out, globalization has transpired simultaneously with increasing local and/or regional autonomy.[7] The splintering theorists generally are in accord with this view, demonstrating how local enclaves are more and more plugged into worldwide networks even as they may be divided from adjacent neighborhoods. In her emphasis on "overlapping" territories Sassen makes a similar point, as she argues that the local has now become a more critical scale than previously. The importance of the local is not entirely novel, obviously, since before the rise of the nation-state it was even more central than today. But the dynamic is now entirely different, as local places are able to link into global networks, and through them to other localities, with ease. Thanks to this "scale bending," as Neil Smith terms it, the nation-state is made slightly less essential.[8]

Yet the national scale surely remains crucial, and in recent years as some of globalization's hype has receded this has become more evident. As Ellen Meiksins Wood points out:

> …capitalism remains dependent on extra-economic conditions, political and legal supports. Until now, no one has found a more effective means of supplying those supports than the political form with which capitalism has been historically, if not causally, connected: the old nation state. As much as 'global' capital might like a corresponding 'global' state, the kind of day-to-day stability, regularity, and predictability required for capital accumulation is inconceivable on anything like a global scale.[9]

In addition to such economic considerations, innumerable political, social and cultural factors also ensure the nation-state's continued importance for the foreseeable future. But Wood's focus on economics seems particularly relevant to the worldwide network of containerization, which as a functional and commercial system is most powerfully tied to economics (though by no means does it lack relevance to political, social and cultural factors). This global economic scale can seem out of sync with the continuing national and local. Indeed, Wood makes the interesting claim that globalization "is characterized less by the decline of the nation state than by a growing contradiction between the global scope of capital and its persistent need for more local and national forms of 'extra-economic' support, a growing disparity between its economic reach and its political grasp."[10]

---

[7] For instance, see Neil Brenner, *New State Spaces: Urban Governance and the Rescaling of Statehood* (Oxford: Oxford University Press, 2004). For a perceptive discussion of how one metropolis (Los Angeles) has exerted itself through infrastructural means to be a global hub, see Steven P. Erie, *Globalizing L.A.: Trade, Infrastructure, and Regional Development* (Stanford, CA: Stanford University Press, 2004).
[8] Neil Smith, "Scale Bending and the Fate of the National," in Eric Sheppard and Robert B. McMaster (eds.), *Scale and Geographic Inquiry: Nature, Society, and Method* (Malden, MA: Blackwell Publishing, 2004), pp. 192-212.
[9] Ellen Meiksins Wood, *The Origin of Capitalism: A Longer View* (London: Verso, 2002 [orig. 1999]), p. 179.
[10] Ibid., p. 177.

Whether these varied scales are truly in "contradiction," though, is subject to debate, as is the assumption that they normally would—or eventually should—replicate each other. This dissertation tends to question such a notion. As Sassen emphasizes, it may be more productive to view national and local scales as actively constructing the global. While noting the importance of global institutions like the U.N., WTO and ISO, she argues that many of the forces driving globalization "take place deep inside territories and institutional domains that have largely been constructed in national terms in much of the world. What makes these processes part of globalization even though they are localized in national, indeed subnational, settings is that they are oriented towards global agendas and systems."[11] Such a viewpoint acknowledges globalization's importance, while also perceiving the ongoing relevance and agency of other scales, none of which take a back seat to the worldwide scale. Some of the more thoughtful works within the splintering paradigm take a similar position, but unfortunately most splintering theorists tend to adopt a more top-down vision in which the global has primacy.

National, regional and local qualities can help or hinder a global infrastructure, but in addition they will affect it and perhaps reshape it in some way. With regard to the shipping container, this dissertation has demonstrated that the spatial regime of national transportation infrastructures, in particular the railroad and trucking systems, along with the spatial regime of the container itself, are key determinants in how this happens. Particular places matter greatly. Such a statement is not a revelation in the context of most discussions—in terms of culture for instance, we all know that the U.S., Thailand and Paraguay are very different. But when it comes to technology, and especially banal infrastructural systems, the nuances of place can be harder to appreciate. It becomes too easy to make sweeping assertions about a placeless and generic globalized reality. Writers like Manuel Castells, with his concept of the "space of flows," and Michael Hardt and Antonio Negri, with their notion of "smooth space" (a term they borrow from Gilles Deleuze and Felix Guattari), promote images of globalization where significance and power are simultaneously everywhere and nowhere.[12] Such mystical assertions of globalization's zeitgeist, whether expressed through technology or capitalism, have fallen somewhat out of fashion in the past few years. But in a less grandiose form the underlying assumptions persist.

In the North American context, the built landscape most emblematic of this "space of flows" or "smooth space" would surely be that of suburban and exurban sprawl—the anonymous territory of generic big-box stores, dull strip malls, anodyne subdivisions, expansive industrial parks, and humble apartment complexes. The system of freight logistics, with its tractor-trailer trucks, railroad lines, intermodal terminals, truck stops, rail yards, and giant warehouses and distribution centers, fits well into this landscape of sprawl. American logistics is banal and

---

[11] Sassen, *Territory, Authority, Rights*, p. 3.
[12] Manuel Castells, *The Rise of the Network Society* [2nd ed.] *[The Information Age: Economy, Society and Culture, Vol. 1]* (Oxford: Blackwell Publishers, 2000), pp. 407-459; Michael Hardt and Antonio Negri, *Empire* (Cambridge, MA: Harvard University Press, 2000), pp. 190, 198, 327, 333; Gilles Deleuze and Felix Guattari, *A Thousand Plateaus: Capitalism and Schizophrenia* (Minneapolis, MN: University of Minnesota Press, 1987 [orig. 1980]), pp. 474-500.

anonymous in appearance (much like the container itself), and greedy in its demands for vast expanses of land. While the logistics system obviously supplies goods to cities and rural areas too, its natural habitat, so to speak, would seem to be sprawl. In their article "The Logistics Landscape," Charles Waldheim and Alan Berger seek to illuminate the potentially interesting interconnections between logistics and the American landscape.[13] But while the article has many interesting facts, details and images, the authors overstate their argument by claiming that logistics has dramatically reshaped the nation's built form and geography.

Waldheim and Berger rightly point out that the contemporary American geography is entwined with massive flows of resources, but their claim that the resulting landscape is unprecedented goes too far. They state: "The recent shift to an internationally distributed economy has produced a new form of landscape, a landscape of logistics. This logistics landscape is among the more significant transformations of the built environment over the past decade."[14] Shortly after, they add that "this [logistics landscape] is arguably among the most significant transformations in the built environment over the past decade, one that has yet to be fully described or theorized."[15] Such pronouncements are uncomfortably similar to the grandiose proclamations of those who identify a new flat world, one dominated by global flows that pass through splintered infrastructures. For all their far-reaching claims, what Waldheim and Berger actually describe is typical American sprawl, the nation's well-established suburban and exurban geography, and they fail to articulate what makes the so-called "logistics landscape" different. The space of logistics is largely embedded in the sprawl that already exists, and while it may alter and add to this sprawl in some novel ways (especially in places like Joliet-Elwood, as described in chapter 9), it generally does not bring about fundamental change. In fact, containerization in the American context has brought a renewed emphasis back to the spaces along and adjacent to American railroad corridors (as also noted in chapter 9), which to some degree actually represents a return to historical patterns.

In his book *Country of Exiles*, about the loss of a sense of place in American culture, William Leach ponders this realm of logistics and what it means for the nation. He places these ruminations squarely within a strand of American thinking that goes back at least to the 1950s, one concerned over the country's loss of place, its excessively easy mobility, and the increasingly generic quality of its built landscape.[16] But while Leach is aware that containerization has made freight movement more seamless, and opened up the national territory to global flows, he offers few insights, instead retreating into a predictable lament about the loss of local character, the clogging of roads by giant tractor-trailers, and the transitory nature of Americans' attachment to

---

[13] Charles Waldheim and Alan Berger, "Logistics Landscape," *Landscape Journal,* Vol. 27, No. 2 (2008).
[14] Ibid., p. 220.
[15] Ibid., p. 222.
[16] For example, see Peter Blake, *God's Own Junkyard: The Planned Deterioration of America's Landscape* (New York: Holt, Rinehart and Winston, 1964).

the places they inhabit.[17] As this dissertation shows, the changes wrought by the shipping container, and more broadly by logistics networks, have transpired in ways that can be identified with some specificity, rather than just contemplated in broad musings. Furthermore the impact has not been entirely negative with regard to sprawl, traffic and road-building, given that containerization and intermodalism have boosted the railroads so greatly, which in turn takes countless trucks off the road and lessens the need to pave over yet more land.

These changes to the American transportation infrastructure have political and social ramifications. The growth of manufacturing outside the U.S., especially in East Asia, has devastated employment in American manufacturing, with the nation's working class suffering the consequences. More or less simultaneously, it has led to a flood of cheap imports, boosting the nation's quality of life in some ways but also bringing about ever more consumption. While consumerism in American life traces back over a century, the decades since the 1970s have seen rampant consumption—and a throwaway culture—at a level not previously imaginable (though the recession of recent years has caused some Americans to reexamine this lifestyle). A host of economic and political shifts—reductions in trade barriers, the corporate desire to drive wages down, automation in manufacturing, the rise of neoliberal ideology, the decline of unions, the lack of a U.S. national economic strategy, the eagerness of East Asian nations to enter into manufacturing, etc.—are of course the primary causes of these transformations. But the development of the physical transport infrastructure of globalization has been an important factor too. In this the role of the shipping container is evident, and many writers have linked the container, and the ports through which it passes, to globalization and imported goods. The alterations to domestic American infrastructure made for the purpose of accommodating containerization, described throughout this dissertation, are less commonly understood in this way. Yet they too are integral to the Faustain bargain the nation has struck in which imported consumer goods are plentiful and cheap while manufacturing jobs disappear.

The extent of this transformation is not limited to the burgeoning movement of containers within American territory, but also the way they move. Whether by intent or not, American transportation providers have been able to significantly reduce the number of people employed in shuttling containers around the nation. This has transpired primarily through the use of stacktrains in the railroad system, for though railroad jobs pay reasonably well, the number of employees necessary to operate a train is small. Such a train, often carrying about 200 containers a very long distance, in effect takes the place of innumerable truck trips, causing trucking companies to employ dramatically fewer drivers than would otherwise be the case. Where the use of trucking for transporting containers remains widespread, in short drayage trips around ports and intermodal terminals, the trucking industry has been very successful in driving wages down—in comparison with other types of trucking, drayage jobs are notorious for their low pay and long hours. While trucking companies initially did not welcome railroad competition for the

---

[17] William Leach, *Country of Exiles: The Destruction of Place in American Life* (New York: Vintage Books [Random House], 1999), pp. 31-57.

movement of containers, they eventually learned to embrace intermodalism: small drayage providers have flourished (albeit without substantial profits), and since the 1990s major long-haul trucking firms have used domestic containers in partnership with rail.

It is widely recognized that the reduction of longshoremen's employment was a key motivation driving containerization, at least in the beginning. Though the motive may be less clear and the impact less direct, the development of the American railroad infrastructure to serve the container should be understood in a similar way. Projects like the Heartland Corridor, Sheffield Flyover and Alameda Corridor ultimately cut into the employment of truck drivers. (Given the environmental advantages of rail, along with the decline in pay and working conditions for truck drivers over recent decades, this is not necessarily a bad thing, but it still merits note.) All this is not to argue that containerization has been solely implemented for such purposes; the efficiency introduced by the container is undeniable, and to struggle against it would seem a Luddite endeavor. But these political and social aspects are integral to containerization, not merely incidental.[18]

Technological and scientific advances have helped humanity construct networks of ever greater scope and breadth. From the local to the regional to the national, and now the global, these infrastructures have transformed human existence, at the levels of governance, society and economics. The dream of the Saint-Simonians has in a sense been achieved—albeit only in its technological dimensions, as it goes without saying that their utopian aspirations remain unfulfilled. Infrastructural systems now span the globe with unprecedented effectiveness, and, at least in some particular ways, undeniably do draw the world closer together. These networks also control human civilization in many ways, and determine, through the provision and quality of their connections, who wields power and who is left out. As Rosalind Williams puts it: "The pathways of modern life are also corridors of power, with power being understood in both its technological and political senses. By channeling the circulation of people, goods, and messages, they have transformed spatial relations by establishing lines of force that are privileged over the places and people left outside those lines."[19] Perhaps this is one of the ultimate end results of our technologies. It is the culmination of generations of infrastructural development, largely carried out through (or at least within) the nation-state in recent centuries. The new global infrastructures are, to draw on Sassen's argument, often founded in or emerging from the capabilities of the nation-state. As such these infrastructures are not neutral, nor do they represent a fresh start; for better or worse they perpetuate many of the dynamics inherent in previous systems. The temptation to view an infrastructural innovation like the shipping container as a revolutionary breakthrough, though understandable and somewhat justified, can obscure these continuities.

[18] In certain cases technological "innovations" actually cause reduced production and/or efficiency, and clearly are only introduced for sociopolitical reasons, such as to eliminate unions. This is sometimes the case with automation. See David F. Noble, *Forces of Production: A Social History of Industrial Automation* (New York: Oxford University Press, 1984).

[19] Williams, "Cultural Origins and Environmental Implications of Large Technological Systems," p. 395.

Most of all, it is vital to remember that the national, regional and local scales play a formative role in the creation of these global networks. These scales, and the actors within them, possess agency not only inasmuch as they react creatively to globalization, but also because they constantly shape and reshape the global reality. Even as worldwide organizations like the ISO play a key role, globalization is still primarily implemented at the local and national scale. The global is made manifest where it meets the national and/or local, through what transpires in actual places. These places in turn possess agency, as they react with or against the global, adjusting it in ways that may be minor or far-reaching. Globalization is contingent in countless ways; it does not stem from a vague universality or inherent *zeitgeist*, but instead comes from particular events, and it is carried out in different places in different ways. It is an intricate and fascinating process.

Bibliography

Abbate, Janet. "From Control to Coordination: New Governance Models for Information Networks and Other Large Technical Systems." In: Coutard, Olivier (ed.). *The Governance of Large Technical Systems.* London: Routledge, 1999, pp. 114-129.

Agar, Michael H. *Independents Declared: The Dilemmas of Independent Trucking* [Smithsonian Series in Ethnographic Inquiry]. Washington, D.C.: Smithsonian Institution Press, 1986.

Aggregate [group]. *Governing by Design: Architecture, Economy, and Politics in the Twentieth Century*. Pittsburgh, PA: University of Pittsburgh Press, 2012.

Agnew, John. "The Territorial Trap: The Geographical Assumptions of International Relations Theory." *Review of International Political Economy,* Vol. 1, No. 1 (Spring 1994), pp. 53-80.

Alameda Corridor East Construction Authority website. "Project Description and Benefits." (http://www.theaceproject.org/project.htm, accessed 7/4/11).

Alt, Rainer, Paul W. Forster, and John Leslie King. "The Great Reversal: Information and Transportation Infrastructure in the Intermodal Vision." In: Transportation Research Board (National Research Council). *National Conference on Developing a Research Framework for Intermodal Transportation* [Conference Proceedings 12]. Washington, D.C., 1997, pp. 31-53.

Ambrose, Stephen E. *Nothing Like It in the World: The Men Who Built the Transcontinental Railroad, 1863-1869*. New York: Simon & Schuster, 2000.

America's Marine Highway Update. North Atlantic Ports Association – Short Sea Shipping Committee ["Prepared by Kristin Decas, Committee Chair"]. September 2010. (http://eastfire.gmu.edu/gmu-consortium/marine-highway/document/AMH%20Update%20092910%20Final.pdf, accessed 6/22/12)

American Bureau of Shipping. *Marine Container Chassis Test Report* (pamphlet). 1987.

American President Lines. "Equipment Specifications – Standard Containers." American President Lines website (http://www.apl.com/equipment/html/equipment_specs_standard.html, accessed 1/16/12)

American Trailer Exchange. "Information About a Semi-Trailer or Truck Trailer." (http://www.amtrex.net/semitrailer_definition.htm, accessed 12/11/11)

Anderson, Benedict. *Imagined Communities: Reflections on the Origin and Spread of Nationalism.* London: Verso, 1983.

Anderson, James. "The Shifting Stage of Politics: New Medieval and Postmodern Territorialities?" *Environment and Planning D: Society and Space*, Vol. 14, Iss. 2 (1996), pp. 133-153.

Angevine, Robert G. *The Railroad and the State: War, Politics, and Technology in Nineteenth-Century America.* Stanford, CA: Stanford University Press, 2004.

Appelbaum, Binyamin. "U.S. and Mexico Sign Trucking Deal." *The New York Times,* July 6, 2011.

Ascher, Kate. *The Works: Anatomy of a City.* New York: The Penguin Press, 2005.

Ayre, Josephine. "History and Regulation of Trailer-on-Flatcar Movement." *Highway Research Record,* No. 153 (1967), pp. 1-30.

Bajaj, Vikas. "India's Clogged Rail Lines Stall Economic Progress." *The New York Times,* June 15, 2010.

Barden, Lane. "The Alameda Corridor [The Trench]." In: Varnelis, Kazys (ed.). *The Infrastructural City: Networked Ecologies in Los Angeles.* Barcelona: Actar, 2009, pp. 236-251.

Bartley, Robert D. "TOFC <u>and</u> COFC: There's Big New Growth Ahead for Both." *Railway Age,* Vol. 174, No. 20 (October 29, 1973), pp. 26-34, 51-52.

Bascombe, Adrian. "Europe's 'Green' Arteries." *Containerisation International,* Vol. 30, No. 6 (June 1997), pp. 77-81.

Bateson, N. E. "Container Development in the Railroad Industry." Society of Automotive Engineers, New York, 1961 (1961 SAE International Congress and Exposition of Automotive Engineering, Detroit, MI, January 9-13, 1961).

Bauer, K. Jack. *A Maritime History of the United States: The Role of America's Seas and Waterways.* Columbia, SC: University of South Carolina, 1988.

BBC News website. "The Box." (http://news.bbc.co.uk/2/hi/in_depth/business/2008/the_box/default.stm, accessed 6/23/11).

Beauregard, Robert A. "Theorizing the Global-Local Connection." In: Knox, Paul L., and Peter J. Taylor (eds.). *World Cities in a World-System.* Cambridge, UK: Cambridge University Press, 1995, pp. 232-248.

Becker, H. G., Jr. "…The First Domestic Container Program." *Handling & Shipping,* Vol. 11, No. 7 (July 1970), pp. 45-47.

Behling, Burton N. "Factors in Future Development of Rail Piggyback." *Highway Research Record,* No. 153 (1967), pp. 39-42.

Bélanger, Pierre. "Synthetic Surfaces." In: Waldheim, Charles (ed.). *The Landscape Urbanism Reader.* New York: Princeton Architectural Press, 2006, pp. 239-265.

Bélanger, Pierre. "Landscape as Infrastructure." *Landscape Journal,* Vol. 28, Iss. 1 (Spring/Summer 2009), pp. 79-95.

Bélanger, Pierre. “Redefining Infrastructure.” In: Mostafavi, Mohsen and Gareth Doherty (eds.). *Ecological Urbanism.* Baden, Switzerland: Lars Müller Publishers, 2010, pp. 332-349.

Belzer, Michael H. *Sweatshops on Wheels: Winners and Losers in Trucking Deregulation.* New York: Oxford University Press, 2000.

Ben-Joseph, Eran. *The Code of the City: Standards and the Hidden Language of Place-Making.* Cambridge, MA: MIT Press, 2005.

Ben-Joseph, Eran, and Terry S. Szold (eds.). *Regulating Place: Standards and the Shaping of Urban America.* New York: Routledge, 2005.

Beniger, James R. *The Control Revolution: Technological and Economic Origins of the Information Society.* Cambridge, MA: Harvard University Press, 1986.

Bensman, David. “Port Trucking Down the Low Road: A Sad Story of Deregulation.” *Demos,* July 21, 2009. (http://www.demos.org/sites/default/files/publications/Port%20Trucking%20Down%20the%20Low%20Road.pdf, accessed 2011)

Berg, Walter Gilman. *Buildings and Structures of American Railroads.* New York: John Wiley & Sons, 1893.

Bijker, Wiebe E., Thomas P. Hughes, and Trevor J. Pinch (eds.). *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology.* Cambridge, MA: MIT Press, 1987.

BizNS [corporate magazine of Norfolk Southern]. “Raising the Roof on Heartland a Major Feat for Railroading.” Vol. 2, Iss. 1 (January/February 2010), pp. 9-11.

BizNS [corporate magazine of Norfolk Southern]. “NS Readies for Double-Stack Business Over Heartland.” Vol. 2, Iss. 1 (January/February 2010), pp. 12-14.

Black Enterprise. “Tomorrow, the World.” Vol. 19, No. 11 (June 1989), pp. 187-196.

Black, Richard W. “Flexibility in Unitized Cargo Handling for Ships in Military Operations.” In: *Ship Design Implications of Recent Marine Cargo Handling Research.* Conference Proceedings, University of California, Berkeley, May 2-4, 1962.

Blake, Peter. *God’s Own Junkyard: The Planned Deterioration of America’s Landscape.* New York: Holt, Rinehart and Winston, 1964.

Bonacich, Edna, and Jake B. Wilson. *Getting the Goods: Ports, Labor, and the Logistics Revolution.* Ithaca: Cornell University Press, 2008.

Bonney, Joseph. “‘Make ‘Em Pay’.” *The Journal of Commerce,* December 22, 2003.

Bonney, Joseph. “Not in the Cards.” *The Journal of Commerce,* May 30, 2005.

Bonney, Joseph. “Columbia Coastal Expands Container-Barge Service.” *The Journal of Commerce,* March 13, 2012.

Bonney, Joseph. “NY-NJ ExpressRail Volume Up 10 Percent.” *The Journal of Commerce,* July 31, 2012.

Bontekoning, Yvonne. *Hub Exchange Operations in Intermodal Hub-and-Spoke Networks.* Delft, The Netherlands: The Netherlands TRAIL Research School, 2006.

Bowker, Geoffrey C., and Susan Leigh Star. *Sorting Things Out: Classification and Its Consequences.* Cambridge, MA: MIT Press, 1999.

Boyd, John D. "DOT Says Freight 'Hierarchy' Favors Water, Rail." *The Journal of Commerce,* March 24, 2010.

Boyd, John D. "Railroads Redraw the Intermodal Map." *The Journal of Commerce,* August 6, 2010.

Boyd, John D. "If You Build it… Stacking Up Hopes in the Heartland." *The Journal of Commerce,* September 6, 2010.

Boylston, John. Interview by Arthur Donovan, December 7, 1998. Containerization Oral History Collection 1995-1998. Archives Center, National Museum of American History, Washington, D.C.

Brand, Theodore. "Toting Trucks by Rails Has Bright Future: But Plan's Growth May Be Gradual." *Chicago Daily Tribune,* December 20, 1953, pp. 7, 9.

Braun, Ingo. "Geflügelte Saurier: Zur Intersystemische Vernetzung Grosser Technische Netze." In: Braun, Ingo, and Bernward Joerges (eds.). *Technik Ohne Grenzen.* Frankfurt: Suhrkamp, 1994, pp. 446-500.

Braun, Ingo, and Bernward Joerges. "How to Recombine Large Technical Systems: The Case of European Organ Transplantation." In: Summerton, Jane (ed.). *Changing Large Technical Systems.* Boulder, CO: Westview Press, 1994, pp. 25-51.

Braun, Ingo, and Bernward Joerges (eds.). *Technik Ohne Grenzen.* Frankfurt: Suhrkamp, 1994.

Brenner, Neil. "Global, Fragmented, Hierarchical: Henri Lefebvre's Geographies of Globalization." *Public Culture,* Vol. 10, No. 1 (Fall 1997), pp. 135-167.

Brenner, Neil. "Between Fixity and Motion: Accumulation, Territorial Organization, and the Historical Geography of Spatial Scales." *Environment and Planning D: Society and Space*, Vol. 16, Iss. 4 (1998), pp. 459-481.

Brenner, Neil. "Beyond State-Centrism? Space, Territoriality, and Geographical Scale in Globalization Studies." *Theory and Society,* Vol. 28, Iss. 1 (February 1999), pp. 39-78.

Brenner, Neil. "The Urban Question as a Scale Question: Reflections on Henri Lefebvre, Urban Theory and the Politics of Scale." *International Journal of Urban and Regional Research,* Vol. 24, No. 2 (June 2000), pp. 361-378.

Brenner, Neil. *New State Spaces: Urban Governance and the Rescaling of Statehood.* Oxford: Oxford University Press, 2004.

Brenner, Neil, Bob Jessop, Martin Jones, and Gordon MacLeod (eds.). *State/Space: A Reader.* Malden, MA: Blackwell Publishing, 2003.

Brey, Philip. "Theorizing Modernity and Technology." In: Misa, Thomas J., Philip Brey, and Andrew Feenberg (eds.). *Modernity and Technology.* Cambridge, MA: MIT Press, 2003, pp. 33-71.

Broeze, Frank. *The Globalisation of the Oceans: Containerisation from the 1950s to the Present* [Research in Maritime History No. 23]. St. John's, Newfoundland: International Maritime Economic History Association, 2002.

Buckingham, Earle. "Company and National Standards in Interchangeable Parts Manufacture." In: Reck, Dickson (ed.). *National Standards in a Modern Economy.* New York: Harper & Brothers, 1956, pp. 90-99.

Busch, Lawrence. *Standards: Recipes for Reality.* Cambridge, MA: MIT Press, 2011.

The Business History Review. "Uniform Containerization of Freight: Early Steps in the Evolution of an Idea." Vol. 43, No. 1 (Spring 1969), pp. 84-87.

Bykofsky, Joseph. "Conex: A Milestone in Unitization." *National Defense Transportation Journal.* May-June 1958, pp. 49-73.

Cain, Louis P. "Historical Perspective on Infrastructure and US Economic Development." *Regional Science and Urban Economics,* Vol. 27, Iss. 2 (April 1997), pp. 117-138.

Calabrese, Dan. "Steep Worldwide Ocean Shipping Slowdown Forces Truckers to Alter Handling of Boxes." *Transport Topics,* Iss. 3874 (December 14, 2009), pp. 1, 8.

Cambridge Systematics [Sponsored by Trucking Research Institute]. *Freight Matters: Trucking Industry Guide to Freight and Intermodal Planning Under ISTEA.* Trucking Research Institute, Alexandria, VA, November 1993.

Canadian Transportation. "The Year in 1954 for White Pass and Yukon." Vol. 58, Iss. 8 (August 1955), pp. 425-427.

Canadian Transportation. "The Ms. Clifford J. Rogers." Vol. 59, Iss. 1 (January 1956), pp. 48-49, 51.

Carmony, Brad. "Container-on-Barge Service Continues to Gain Momentum on Inland Waterway System." Fullen Dock website, Press Releases & News. (http://www.fullendock.com/news-09-01-06.html, accessed 2/25/11)

Caro, Robert A. *The Power Broker: Robert Moses and the Fall of New York*. New York: Vintage Books, 1974.

Carter, James N., Jr. [Chief Engineer Bridges and Structures, Norfolk Southern Railway] "Heartland Corridor Clearance Improvement Project." (http://www.arema.org/files/library/2010_Conference_Proceedings/Heartland_Corridor_Clearance_Improvement_Project.pdf, accessed 2/8/12)

Cassidy, William B. "More Roads Than One." *The Journal of Commerce,* October 22, 2010.

Castells, Manuel. *The Rise of the Network Society* [2nd ed.] *[The Information Age: Economy, Society and Culture, Vol. 1]*. Oxford: Blackwell Publishers, 2000.

Castells, Manuel (Ida Susser, ed.). *The Castells Reader on Cities and Social Theory.* Malden, MA: Blackwell Publishers, 2002.

Cauchon, Dennis. "Rail Project Goes Through the Roof." *USA Today,* October 9, 2006.

Cavazos, Paul A. "Containerization: A New Tool in Motor Carrier Commercial Transportation." Paper submitted for membership in the American Society of Traffic and Transportation, Morton Grove, IL, 1972.

CenterPoint Properties. "CenterPoint Intermodal Center – Joliet, Illinois: The Largest Master-Planned Inland Port in North America." Publicity brochure, undated (maybe 2009). (http://www.centerpoint-intermodal.com/pdfs/CICJ_brochure.pdf, accessed 4/1/12)

Chandler, Jr., Alfred D. *The Visible Hand: The Managerial Revolution in American Business.* Cambridge, MA: Belknap Press of Harvard University Press, 1977.

Chicago Metropolis 2020. *The Metropolis Freight Plan: Delivering the Goods.* December 2004. (http://www.chicagometropolis2020.org/PDFs/MetropolisFreightPlan.pdf, accessed 12/9/09).

Chicago Metropolis 2020. *The Metropolis Freight Plan Technical Report: Delivering the Goods.* December 2004. (http://www.chicagometropolis2020.org/documents/freighttechreport.pdf, accessed 12/9/09).

Childs, William R. *Trucking and the Public Interest: The Emergence of Federal Regulation 1914-1940.* Knoxville, TN: University of Tennessee Press, 1985.

Cidell, Julie. "The Decentralization of Freight Transportation: Chicago in Context." Presented at the 2008 Transport Chicago Conference. (http://www.transportchicago.org/2008papers.html, accessed 4/15/10)

Cidell, Julie. "Distribution Centers Among the Rooftops: The Global Logistics Network Meets the Suburban Spatial Imaginary." *International Journal of Urban and Regional Research,* Vol. 35, Iss. 4 (July 2011), pp. 832-851.

Cidell, Julie. "Flow and Pauses in the Urban Logistics Landscape: The Municipal Regulation of Shipping Container Mobilities." *Mobilities*, Vol. 7, No. 2 (May 2012), pp. 233-245.

Cidell, Julie. "From Hinterland to Distribution Center: The Chicago Region's Shifting Gateway Function." In: Hall, Peter V., and Markus Hesse (eds.). *Cities, Regions and Flows.* Abingdon, U.K.: Routledge, 2012, pp. 114-128.

Close, Alex. See: Klose, Alexander.

Coachbuilt website, Coachbuilt.com. "Trailmobile." (http://www.coachbuilt.com/bui/t/trailmobile/trailmobile.htm, accessed 10/30/11)

COLD: Container Liner Service Danube. Via Donau in cooperation with Constanta Port Authority and Mierka Donauhafen Krems, Vienna, August 2006. (available online at http://www.via-donau.org/fileadmin/group_upload/5/projektseiten/cold/COLD_Final-Report-___Annex.pdf, as of 6/15/12)

Colten, Craig E. "Adapting the Road to New Transport Technology." In: Raitz, Karl (ed.). *The National Road.* Baltimore: The Johns Hopkins University Press, 1996, pp. 193-223.

Commission of the European Communities. *Integrated Concept on Commercial Vehicle Dimensions.* Brussels, May 11, 1990.

Constant, Edward W., II, "The Social Locus of Technological Practice: Community, System, or Organization?" In: Bijker, Wiebe E., Thomas P. Hughes, and Trevor J. Pinch (eds.). *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology.* Cambridge, MA: MIT Press, 1987, pp. 223-242.

Container Transport by Inland Waterways. Ports and Waterways Institute, Louisiana State University, February 1987. [Prepared for U.S. Department of Transportation, Maritime Administration, University Research Program, Final report under contract DTMA91-85-C-50116]

Containerization Oral History Collection 1995-1998. Archives Center, National Museum of American History.

Continental Rail Gateway (www.crgateway.com). "It's Time to Build the High-Clearance Replacement Rail Tunnel at the Detroit/Windsor Crossing." Publicity document. (http://crgateway.com/LinkClick.aspx?fileticket=w75XuM2hbig%3d&tabid=74, accessed 7/2/11).

Cook, Richard and Marcus Oleniuk. *Around the World in 40 Feet: Two Hundred Days in the Life of a 40FT NYK Shipping Container.* Hong Kong: WordAsia (NYK Group), 2007.

Cooper Alarcon, Daniel. *The Aztec Palimpsest: Mexico in the Modern Imagination.* Tucson, AZ: University of Arizona Press, 1997.

Coutard, Olivier (ed.). *The Governance of Large Technical Systems.* London: Routledge, 1999.

Coutard, Olivier. "Placing Splintering Urbanism: Introduction." *Geoforum,* Vol. 39, Iss. 6 (November 2008), pp. 1815-1820.

Coutard, Olivier, Richard E. Hanley, and Rae Zimmerman (eds.). *Sustaining Urban Networks: The Social Diffusion of Large Technical Systems.* Abingdon, UK: Routledge, 2005.

Cox, Kevin R. (ed.). *Spaces of Globalization: Reasserting the Power of the Local*. New York: Guilford Press, 1997.

Creno, Glen. "Historical Phoenix Freight Depot Gets New Life." *The Arizona Republic,* November 27, 2010. (http://www.azcentral.com/community/phoenix/articles/2010/11/27/20101127phoenix-freight-depot.html, accessed 2/29/12)

Cresswell, Tim. *On the Move: Mobility in the Modern Western World.* New York: Routledge, 2006.

Crew, James, Anatoly Hochstein, and Kevin Horn. "Prospects for Container-on-Barge Service on the Mississippi River." *Transportation Research Record*, No. 1156 (1988), pp. 56-65.

Cronon, William. *Nature's Metropolis: Chicago and the Great West.* New York: W. W. Norton & Company, 1991.

CSX Corporation. "Clean Air." (http://www.csx.com/index.cfm/about-csx/projects-and-partnerships/clean-air/, accessed 2/25/11)

Cudahy, Brian J. *Box Boats: How Container Ships Changed the World.* New York: Fordham University Press, 2006.

Cullen, David. "Intermodal Outlook: How It All Stacks Up." *Fleet Owner.* Vol. 90, No. 9 (September 1995), pp. 70-77.

Curphey, Ted ("Funnelfan"). "BNSF and KCS Auto-Max Cars." Trainweb website, February 14, 2000. (http://www.trainweb.org/funnelfan/automax.htm, accessed 7/4/11).

Cushing, Charles. Interview by Arthur Donovan and Andrew Gibson, May 8, 1995. Containerization Oral History Collection 1995-1998. Archives Center, National Museum of American History, Washington, D.C.

David, Paul A., and Julie Ann Bunn. "The Economics of Gateway Technologies and Network Evolution: Lessons from Electricity Supply History." *Information Economics and Policy,* Vol. 3, Iss. 2 (1988), pp. 165-202.

DeBoer, David J. *Piggyback and Containers: A History of Rail Intermodal on America's Steel Highway.* San Marino, CA: Golden West Books, 1992.

Deleuze, Gilles, and Felix Guattari. *A Thousand Plateaus: Capitalism and Schizophrenia.* Minneapolis, MN: University of Minnesota Press, 1987 [orig. 1980].

Dellinger, Matt. *Interstate 69: The Unfinished History of the Last Great American Highway.* New York: Scribner, 2010.

Department of the Army, Office of the Chief of Transportation. "CONEX: A Milestone in Unitization" ("TC in the Current National Emergency: The Post-Korean Experience"). March 27, 1957.

Distribution Age. Advertisement for the Port of Los Angeles. Vol. 65, No. 1 (January 1966), p. 37.

Distribution Age. "Highway Carriers Eye Foreign Markets." Vol. 65, No. 10 (October 1966), pp. 33-35.

Doig, Jameson W. *Empire on the Hudson: Entrepreneurial Vision and Political Power at the Port of New York Authority.* New York: Columbia University Press, 2001.

Donovan, Arthur, and Joseph Bonney. *The Box That Changed the World: Fifty Years of Container Shipping—An Illustrated History.* East Windsor, NJ: Commonwealth Business Media (The Journal of Commerce), 2006.

Double, Zoe. "The Pacemakers." *Containerisation International*, Vol. 37, No. 9 (September 2004), pp. 66-67.

Double, Zoe. "Shortsea Shortchanged?" *Containerisation International*, Vol. 37, No. 10 (October 2004), pp. 44-47.

Douglas, Peter S. "Year of Decision Ahead for the 20-Foot Container." *Traffic World,* Vol. 128, No. 11 (December 10, 1966), pp. 64-67.

Down, James W., and Dean H. Wise. "Domestic Containerization: Overview of Terminal Design and Operating Issues." In: Transportation Research Board (National Research Council). *Facing the Challenge: The Intermodal Freight Terminal of the Future.* State of the Art Report 4, Washington, D.C., 1986, pp. 116-122. (Papers from the Conference on Intermodal Freight Terminal Design, March 1986)

Downey, Greg. "Virtual Webs, Physical Technologies, and Hidden Workers: The Spaces of Labor in Information Internetworks." *Technology and Culture,* Vol. 42, No. 2 (April 2001), pp. 209-235.

Downs, James W. "Domestic Containerization: A Preliminary Feasibility Study." National Conference of State Railway Officials [American Association of State Highway and Transportation Officials, 72nd Annual Meeting Proceedings], 1986.

Dupin, Chris. "Back to the Future: APL Logistics Rebuilds Domestic Intermodal Business a Decade After Selling Double-Stack Business to Pacer." *American Shipper*, Vol. 53, No. 9 (September 2011), pp. 16-19.

Easterling, Keller. "Interchange and Container: The New Orgman." *Perspecta,* Vol. 30 (1999), pp. 112-121.

Easterling, Keller. *Organization Space: Landscapes, Highways, and Houses in America.* Cambridge, MA: MIT Press, 1999.

Easterling, Keller. *Enduring Innocence: Global Architecture and Its Political Masquerades.* Cambridge, MA: MIT Press, 2005.

Easterling, Keller. "Zone: The Spatial Softwares of Extrastatecraft." *Places*, June 11, 2012. (http://places.designobserver.com/feature/zone-the-spatial-softwares-of-extrastatecraft/34528/, accessed 6/27/13)

Eisenhower, Dwight D. *At Ease: Stories I Tell to Friends.* Garden City, NY: Doubleday, 1967.

The Economist. "A Survey of Logistics." June 17, 2006, pp. 3-20.

Edmonson, R.G. "Columbia Coastal Halts NJ-Boston Service." *The Journal of Commerce,* August 25, 2010.

Edmonson, R.G. "Stockton-Oakland Barge Service to Ship Containers." *The Journal of Commerce,* December 5, 2011.

Edwards, Brian. *Sustainability and the Design of Transport Interchanges.* Abingdon, UK: Routledge, 2011.

Edwards, Paul N. "Y2K: Millennial Reflections on Computers as Infrastructure." *History and Technology,* Vol. 15, Iss. 1-2 (1998), pp. 7-29. (Also available online as pdf, with different pagination, at http://pne.people.si.umich.edu/articles.html)

Edwards, Paul N. "Infrastructure and Modernity: Force, Time, and Social Organization in the History of Sociotechnical Systems." In: Misa, Thomas J., Philip Brey, and Andrew Feenberg (eds.). *Modernity and Technology.* Cambridge, MA: MIT Press, 2003, pp. 185-225.

Edwards, Paul N. "Meteorology as Infrastructural Globalism." In: Krige, John, and Kai-Henrik Barth (eds.). *Global Power Knowledge: Science and Technology in International Affairs* [*Osiris*, Vol. 21 (2006)]. Chicago: University of Chicago Press, 2006, pp. 229-250.

Edwards, Paul N., Steven J. Jackson, Geoffrey C. Bowker, and Cory P. Knobel. *Understanding Infrastructure: Dynamics, Tensions, and Design.* Report of a Workshop on "History & Theory of Infrastructure: Lessons for New Scientific Cyberinfrastructures," January 2007, available at Deep Blue website, University of Michigan Library. (http://deepblue.lib.umich.edu/handle/2027.42/49353, accessed 6/3/2010)

Edwards, Paul N. *A Vast Machine: Computer Models, Climate Data, and the Politics of Global Warming.* Cambridge, MA: MIT Press, 2010.

Egyedi, Tineke M. "Infrastructure Flexibility Created by Standardized Gateways: The Cases of XML and the ISO Container." *Knowledge, Technology, and Policy,* Vol. 14, No. 3 (October 2001), pp. 41-54.

Egyedi, Tineke M. "The Standardized Container: Gateway Technologies in the System of Cargo Transportation." Paper for the Helsinki Workshop on Standardisation and Transportation, Helsinki, August 23-24, 1996. (Also in *Homo Oeconomicus [EURAS Yearbook of Standardization]*, Vol. 17, No. 3 [2000], pp. 231-262) (http://www.silvertipdesign.com/BR%28Imperial%29/%5B29%5D%20container_Euras%20%28THE%20STANDARDIZED%20CONTAINER%20Gateway%20Technologies%20in%20Cargo%20Transportation%29%20-%20the%20development%20of%20competitive%20gateways%20and%20systems.pdf, accessed 7/10/11)

Erie, Steven P. *Globalizing L.A.: Trade, Infrastructure, and Regional Development.* Stanford, CA: Stanford University Press, 2004.

Fair, Marvin L. (director), and E. Grosvenor Plowman (editor) [The American University, Transportation and Logistics Research Center]. *Coordinated Transportation: Problems and Requirements.* Cambridge, MD: Cornell Maritime Press, 1969. (papers from five Workshop Conferences on Coordinated Transportation from 1964 to 1966)

Fairplay International Shipping Weekly. "West Coast ICTFs Swell." Vol. 300, No. 5391 (January 29, 1987), pp. 30-33.

Faith, Nicholas. *The World the Railways Made.* New York: Carroll & Graf Publishers, 1990.

Federal Highway Administration (U.S. Department of Transportation). "Right of Passage: The Controversy Over Vertical Clearance on the Interstate System [Highway History]." Undated, but with note: "This page last modified on 04/07/11." (http://www.fhwa.dot.gov/infrastructure/50vertical.cfm, accessed 10/17/11)

Fein, Michael R. *Paving the Way: New York Road Building and the American State, 1880-1956.* Lawrence, KS: University Press of Kansas, 2008.

Feng, Patrick. "Studying Standardization: A Review of the Literature." Institute of Electrical and Electronics Engineers, IEEE 3rd Conference on Standardization and Innovation in Information Technology, Delft, The Netherlands, October 22-24, 2003, pp. 99-112.

Fishman, Robert. "1808 - 1908 - 2008: National Planning for America." Rockefeller Urban Summit, July 2007. (Paper commissioned by the Regional Plan Association) (http://www.rpa.org/pdf/temp/America%202050%20Website/Fishman%20National%20Planning%20Final.pdf, accessed 6/8/12)

Fitch, Edwin M. *The Alaska Railroad.* New York: Frederick A. Praeger, Publishers (Praeger Library of U.S. Government Departments and Agencies), 1967.

Fitzgerald, Joan. *Emerald Cities: Urban Sustainability and Economic Development.* Oxford: Oxford University Press, 2010.

Fleet Owner. "Container Pools Open Wide [Containerization—Potentials and Pitfalls, Special Report]." Vol. 56, No. 1 (January 1961), pp. 77-80.

Fleet Owner. "Containerization's Changing Pattern [Containerization—Potentials and Pitfalls, Special Report]." Vol. 56, No. 1 (January 1961), pp. 66-71.

Fleet Owner. "Standards and Equipment [Containerization—Potentials and Pitfalls, Special Report]." Vol. 56, No. 1 (January 1961), pp. 77-80.

Fleet Owner. "Telescoping Container Trailer." Vol. 79, No. 3 (March 1984), p. 56.

Ford, Nancy. "Piggy-Back Spreads Out." *Modern Railroads*, Vol. 10, No. 12 (December 1955), pp. 61-72.

Foucault, Michel (ed. Paul Rabinow). *The Foucault Reader.* New York: Pantheon Books, 1984.

Foucault, Michel (ed. Michel Senellart, trans. Graham Burchell). *Security, Territory, Population: Lectures at the College de France, 1977-1978.* New York: Picador (Palgrave Macmillan), 2007 (orig. 2004).

Freight [also known as *Freight: The Shipper's Forum*]. "The Motor Truck a Strong Link in the Transportation Chain." Vol. 12, No. 1 (January 1911), p. 14.

Friedman, Thomas L. *The World Is Flat: A Brief History of the Twenty-First Century.* New York: Farrar, Straus and Giroux, 2005.

Friends of the Ypsilanti Freighthouse [website]. "History." (http://www.foyf.org/foyf/history/, accessed 3/1/12)

Frittelli, John. *Can Marine Highways Deliver?* Congressional Research Service [CRS Report for Congress], January 14, 2011. (Also available online at http://www.fas.org/sgp/crs/misc/R41590.pdf, as of 6/19/12)

"Fruehauf History – Semitrailer History." At http://home.uninet.ee/~trailer/tech_info/history.pdf, accessed 9/29/11. (Not clear who put this up, who wrote it, what the website/web page is for, etc.)

Fuller, John W. "The Road to Intermodalism." In: Transportation Research Board (National Research Council). *ISTEA and Intermodal Planning: Concept, Practice, Vision* [special report 240]. Washington, D.C., 1993. (Proceedings of the National Conference on ISTEA and Intermodal Planning Issues, December 2-4, 1992, Irvine, CA)

Gage, Robert W., and Bruce D. McDowell. "ISTEA and the Role of MPOs in the New Transportation Environment: A Midterm Assessment." *Publius,* Vol. 25, No. 3 (Summer 1995), pp. 133-154.

Galbincea, Pat. "Cleveland Port Close to Becoming U.S. Home Base and Lone Great Lakes City for International Container Service." *The Plain Dealer*, October 22, 2010.

George, Rose. *Ninety Percent of Everything: Inside Shipping, the Invisible Industry That Puts Clothes on Your Back, Gas in Your Car, and Food on Your Plate*. New York: Metropolitan Books, 2013.

Gibson, Andrew. Interview by Arthur Donovan, April 28, 1998. Containerization Oral History Collection 1995-1998. Archives Center, National Museum of American History, Washington, D.C.

Giddens, Anthony. *The Consequences of Modernity.* Stanford, CA: Stanford University Press, 1990.

Gillis, Chris. "Breaking Into the Jones Act." *American Shipper*, Vol. 50, No. 9 (September 2008), pp. 71-73.

Glass, Nick. "Historic Canal Reborn as Low-Carbon Cargo Route." CNN website, August 17, 2011. (http://articles.cnn.com/2011-08-17/world/canals.carbon.transport_1_historic-canal-canal-network-british-waterways?_s=PM:WORLD, accessed 8/18/2011)

Goddard, Stephen B. *Getting There: The Epic Struggle Between Road and Rail in the American Century.* New York: BasicBooks (HarperCollins Publishers), 1994.

Goldenberg, Suzanne. "Mississippi River Faces Shipping Freeze as Water Levels Drop." *The Guardian*, December 14, 2012.

Goldin, Greg. "Open Doors: SCI-Arc Rediscovers Itself—and the City—Downtown." *LA Weekly,* September 12, 2001. (http://www.laweekly.com/2001-09-20/art-books/open-doors/, accessed 2/28/12)

Goodwin, Arthur B. "Design Considerations for Intermodal Container Transfer Facilities." In: Transportation Research Board (National Research Council). *Facing the Challenge: The Intermodal Freight Terminal of the Future.* State of the Art Report 4, Washington, D.C., 1986, pp. 48-51. (Papers from the Conference on Intermodal Freight Terminal Design, March 1986)

Gordon, Sarah H. *Passage to Union: How the Railroads Transformed American Life, 1829-1929.* Chicago: Ivan R. Dee, 1997.

Goswami, Manu. *Producing India: From Colonial Economy to National Space.* Chicago: University of Chicago Press, 2004.

Grabell, Michael. "The 4 A.M. Army." *Time*, June 27, 2013. (http://nation.time.com/2013/06/27/the-4-am-army/, accessed 6/27/13)

Graham, Stephen, and Simon Marvin. *Splintering Urbanism: Networked Infrastructures, Technological Mobilities and the Urban Condition.* London: Routledge, 2001.

Graham, Wade. "Dark Side of the New Economy." *On Earth,* Spring 2007, pp. 14-21.

Gray, Christopher. "A Bus Terminal, Overshadowed and Unmourned." *The New York Times,* November 3, 2011.

Grissom, John K. "Containerization – From the Motor Carrier Viewpoint." Paper submitted for membership in the American Society of Traffic and Transportation, Redondo Beach, CA, 1971.

Grubler, Arnulf. *The Rise and Fall of Infrastructures: Dynamics of Evolution and Technological Change in Transport.* Heidelberg, Germany: Physica-Verlag, 1990.

Grundy-Warr, Carl. "Cross-Border Regionalism Through a 'South-East Asian' Looking-Glass." *Space and Polity,* Vol. 6, No. 2 (August 2002), pp. 215-225.

Grunwald, Michael. *The New New Deal: The Hidden Story of Change in the Obama Era.* New York: Simon & Schuster, 2012.

Guldi, Jo. *Roads to Power: Britain Invents the Infrastructure State.* Cambridge, MA: Harvard University Press, 2012.

Gupta, Akhil. "The Song of the Nonaligned World: Transnational Identities and the Reinscription of Space in Late Capitalism." *Cultural Anthropology [Space, Identity, and the Politics of Difference],* Vol. 7, No. 1 (February 1992), pp. 63-79.

Gutridge, J. E. "Technical Advances in the Railroad Industry Leading to Integrated Transportation." In: *Ship Design Implications of Recent Marine Cargo Handling Research.* Conference Proceedings, University of California, Berkeley, May 2-4, 1962.

Guzzardi, Walter, Jr. "Freight Goes Forward with Forgash." *Fortune,* July 1962, pp. 131-135, 219-226.

Hamilton, Shane. *Trucking Country: The Road to America's Wal-Mart Economy.* Princeton, NJ: Princeton University Press, 2008.

Hannes, Matt. *The Intermodal Container Web Page.* (http://www.matts-place.com/intermodal/part1/sea_containers1.htm). (Note: There is no connection between this person and the dissertation author [Matthew Heins], despite the similar names.)

Hapag-Lloyd. *Container Specification* [pamphlet]. Hapag-Lloyd AG, Hamburg, January 2012. (http://www.hapag-lloyd.com/downloads/press_and_media/publications/Brochure_Container_Specification_en.pdf, accessed 11/24/12)

Hardt, Michael, and Antonio Negri. *Empire.* Cambridge, MA: Harvard University Press, 2000.

Harlander, Les [Leslie]. Interview by Arthur Donovan and Andrew Gibson, June 19, 1997. Containerization Oral History Collection 1995-1998. Archives Center, National Museum of American History, Washington, D.C.

Harris, Paul. "Walmart Supply Chain: Warehouse Staff Agencies Accused of Wage Theft." *The Guardian*, October 18, 2012.

Harrison, Robert, Nathan Hutson, Jolanda Prozzi, Jason West, John McCray, and Juan Gonzalez. *Drayage Activity in Texas.* Center for Transportation Research, The University of Texas at Austin, October 2007.

Hartgen, David T., and Michael A. McAdams. *I-40 Economic Impact Study: Impact of Interstate 40 on the Port of Wilmington.* Charlotte, NC: University of North Carolina at Charlotte, October 1991. [Transportation Publications Report No. 49]

Harvey, David. *Consciousness and the Urban Experience: Studies in the History and Theory of Capitalist Urbanization.* Baltimore, MD: John Hopkins University Press, 1985.

Harvey, David. *Spaces of Capital: Towards a Critical Geography.* New York: Routledge (Taylor & Francis Group), 2001.

Hayes, Brian. *Infrastructure: A Field Guide to the Industrial Landscape.* New York: W.W. Norton & Company, 2005.

Hayes, Derek. *Historical Atlas of the North American Railroad.* Berkeley, CA: University of California Press, 2010, pp. 112-115, 128.

Hayuth, Yehuda. "The Overweight Container Problem and International Intermodal Transportation." *Transportation Journal,* Vol. 34, No. 2 (Winter 1994), pp. 18-28.

HBS Case Services. *American President Lines, Ltd.: The CMS-I Decision.* Boston, MA: Havard Business School, 1982.

Headrick, Daniel R. *The Tentacles of Progress: Technology Transfer in the Age of Imperialism, 1850-1940.* New York: Oxford University Press, 1988.

Hess, Martin. "'Spatial' Relationships? Towards a Reconceptualization of Embeddedness." *Progress in Human Geography,* Vol. 28, No. 2 (April 2004), pp. 165-186.

Hinden, Eugene. "Factors Affecting Container Design." In: *Ship Design Implications of Recent Marine Cargo Handling Research.* Conference Proceedings, University of California, Berkeley, May 2-4, 1962.

Hoffman, Kurt. "Phenomenon or Flash in the Pan?" *Chilton's Distribution,* Vol. 85, No. 10 (October 1986), p. 112.

Hoops, William T. "The L. C. L. Merchandise Container." *Railway Age,* Vol. 84, No. 8 (February 25, 1928), pp. 499-502.

Horvitz, Wayne. Interview by Arthur Donovan and Andrew Gibson, April 11, 1997. Containerization Oral History Collection 1995-1998. Archives Center, National Museum of American History, Washington, D.C.

Hounshell, David A. *From the American System to Mass Production, 1800-1932: The Development of Manufacturing Technology in the United States.* Baltimore: Johns Hopkins University Press, 1984.

Howell, Robert E. "What Is a Container? A Container Is…" *CCJ (Commercial Car Journal),* Vol. 117, No. 3 (May 1969), pp. 96-101.

Howell, Robert E. "Containers…Facts You Need to Get a Piece of the Action." *CCJ (Commercial Car Journal),* Vol. 117, No. 4 (June 1969), pp. 144-150.

Howell, Robert E. "ABCs of…Containers." *CCJ (Commercial Car Journal),* Vol. 117, No. 5 (July 1969), pp. 101-105.

Hub Group [website]. "History." (http://www.hubgroup.com/history/, accessed 9/13/12)

Huffington Post, "Port Of Miami Tunnel Reaches Halfway Point." August 1, 2012. (http://www.huffingtonpost.com/2012/08/01/port-of-miami-drilling_n_1728059.html, accessed 12/15/12)

Hughes, Thomas P. *Networks of Power: Electrification in Western Society, 1880-1930.* Baltimore: The Johns Hopkins University Press, 1983.

Hughes, Thomas P. "The Evolution of Large Technological Systems." In: Bijker, Wiebe E., Thomas P. Hughes, and Trevor J. Pinch (eds.). *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology.* Cambridge, MA: MIT Press, 1987, pp. 51-82.

Hughes, Thomas P. "Technological Momentum." In: Smith, Merritt Roe, and Leo Marx (eds.). *Does Technology Drive History? The Dilemma of Technological Determinism.* Cambridge, MA: MIT Press, 1994, pp. 101-114.

Hughes, Thomas P. *Rescuing Prometheus.* New York: Pantheon Books, 1998.

Hugill, Peter J. *World Trade Since 1431: Geography, Technology, and Capitalism.* Baltimore: The Johns Hopkins University Press, 1993.

Hyland, Erin, and Joe Bryan. "Sustainability in Ports, Freight, and Logistics." In: Pollalis, Spiro, Andreas Georgoulias, Stephen Ramos, and Daniel Schodek (eds.). *Infrastructure Sustainability and Design.* New York: Routledge, 2012, pp. 148-154.

Interrante, Joseph. "The Road to Autopia: The Automobile and the Spatial Transformation of American Culture." In: Lewis, David L., and Laurence Goldstein (eds.). *The Automobile and American Culture.* Ann Arbor, MI: The University of Michigan Press, 1983 (orig. 1980), pp. 89-104.

Jackson, Steven J., Paul N. Edwards, Geoffrey C. Bowker, and Cory P. Knobel. "Understanding Infrastructure: History, Heuristics, and Cyberinfrastructure Policy." *First Monday*, Vol. 12, No. 6 (June 2007) (http://firstmonday.org/ojs/index.php/fm/article/view/1904/1786, accessed 8/4/13)

Jaeger, Steve [Heart of Illinois Regional Port District]. "Putting the Ship Back in Shipping." *Midwest Commercial Journal,* October 2009. (http://www.peoriamagazines.com/ibi/2010/jan/putting-ship-back-shipping, accessed 2/25/11)

Jindel, Satish. "Growing Imports Put More Containers Into the Transport Network." *World Trade*, Vol. 19, Iss. 12 (December 2006), pp. 66-68.

Joerges, Bernward. "Large Technical Systems: Concepts and Issues." In: Mayntz, Renate, and Thomas P. Hughes. *The Development of Large Technical Systems.* Boulder, CO: Westview Press, 1988, pp. 9-36.

John, Richard R. *Network Nation: Inventing American Telecommunications.* Cambridge, MA: Belknap Press of Harvard University Press, 2010.

Jones, Andrew. *Globalization: Key Thinkers*. Cambridge, U.K.: Polity Press, 2010.

Katims, Ron. Interview by Arthur Donovan and Andrew Gibson, April 9, 1997. Containerization Oral History Collection 1995-1998. Archives Center, National Museum of American History, Washington, D.C.

Kay, Jane Holtz. *Asphalt Nation: How the Automobile Took Over America, and How We Can Take It Back.* New York: Crown Publishers, 1997.

Keen, Judy. "Buying Time on Mississippi River Shipping Crisis." *USA Today*, December 9, 2012.

Kern, Stephen. *The Culture of Time and Space, 1880-1918.* Cambridge, MA: Harvard University Press, 2003 (orig. 1983).

Klinksiek, Brian, and Kristina Shih. "The Tortoise and the Hare: Comparing the Chicago and San Francisco Economies." *Urbanist*, Issue 452 (August 2006), pages unknown. (published by the San Francisco Planning and Urban Research Association) (http://www.spur.org/publications/library/date/2006, accessed 4/15/10)

Klose, Alexander. "Cells, Modules, Series – The Rationale of Space Processing in the Age of Containers." Presentation at Northwestern University, Dept. of German, 2/13/06. (http://www.containerwelt.info/pdf/AK_chicago_present_long.pdf, accessed 1/3/08)

Klose, Alexander [using pen name of Alex Close]. "The Container Manifesto, or: Why Boxes Must Be Closed." *Homo Oeconomicus,* Vol. 25, No. 2 (2008), pp. 1-5. (http://www.containerwelt.info/pdf/HOEC_25_AlexClose_ContainerManifesto.pdf, accessed 2/8/12)

Klose, Alexander. *Das Container: Wie Eine Box Unser Denken Verandert.* Hamburg: Mare, 2009.

Kornhauser, Alain L., and Michael Bodden. "Network Analysis of Highway and Intermodal Rail-Highway Freight Traffic." *Transportation Research Record,* Iss. 920 (1983), pp. 61-68.

Kramer, Larry. "Use of Landbridge Cuts Containerized Cargo Travel Time." *The Washington Post,* August 20, 1978, p. H2.

Kronberg, George H. [Vice-President—Traffic, The Milwaukee Road]. "Stacy Street, the Milwaukee Road Link Between the Orient and the Midwest." *Traffic World,* Vol. 146, No. 13 (June 28, 1971), pp. 30-32.

Kulisch, Eric. "RoadLink Snaps Up Drayage Firms." *American Shipper,* Vol. 50, Iss. 8 (August 2008), pp. 63-66.

LaHood, Ray. "America's Waterways, Poised to Deliver the Goods." *Welcome to the FastLane: The Official Blog of the U.S. Secretary of Transportation,* April 8, 2010. (http://fastlane.dot.gov/2010/04/americas-waterways-poised-to-deliver-the-goods.html, accessed 4/29/10)

LaHood, Ray. "America's Marine Highway System: Delivering Goods More Efficiently, Reducing Dependence on Foreign Oil." *Welcome to the FastLane: The Official Blog of the U.S. Secretary of Transportation,* April 8, 2011. (http://fastlane.dot.gov/2011/04/americas-marine-highway-system-delivering-goods-more-efficiently-reducing-dependence-on-foreign-oil-.html, accessed 6/23/12)

Lappin, Todd. "Truckin'." *Wired,* Vol. 3. No. 1 (January 1995), pagination unknown (http://www.wired.com/wired/archive/3.01/truckin_pr.html, accessed 6/8/08)

Leach, Peter T. "Toledo Port Gets New Cranes." *The Journal of Commerce*, June 18, 2010.

Leach, Peter T. "Virginia Container Volume Jumps 12.6 Percent." *The Journal of Commerce*, June 12, 2012.

Leach, William. *Country of Exiles: The Destruction of Place in American Life.* New York: Vintage Books (Random House), 1999.

Leamer, Edward E. "A Flat World, a Level Playing Field, a Small World After All, or None of the Above? A Review of Thomas L. Friedman's *The World is Flat*." *Journal of Economic Literature,* Vol. 45 (March 2007), pp. 83-126.

LeCavalier, Jesse. "All Those Numbers: Logistics, Territory and Walmart." *Places*, May 24, 2010. (http://places.designobserver.com/feature/walmart-logistics/13598/, accessed 7/11/13)

Lefebvre, Henri [trans. Donald Nicholson-Smith). *The Production of Space.* Malden, MA: Blackwell Publishing, 1991 (orig. 1974).

Lefebvre, Henri [Neil Brenner and Stuart Elden, eds.]. *State, Space, World: Selected Essays.* Minneapolis: University of Minnesota Press, 2009.

Leone, Dan. "C.R. England Intermodal Continues to Add Technology." *Transport Topics,* Iss. 3929 (January 17, 2011), p. 8.

Levinson, Marc. *The Box: How the Shipping Container Made the World Smaller and the World Economy Bigger.* Princeton, NJ: Princeton University Press, 2006.

Levinson, Marc. *The Great A&P and the Struggle for Small Business in America.* New York: Hill and Wang, 2011.

Lewis, David L., and Laurence Goldstein (eds.). *The Automobile and American Culture.* Ann Arbor, MI: The University of Michigan Press, 1983 (orig. 1980).

Lewis, Peirce. "The Landscapes of Mobility." In: Raitz, Karl (ed.). *The National Road.* Baltimore: The Johns Hopkins University Press, 1996, pp. 3-44.

Lewis, Tom. *Divided Highways: Building the Interstate Highways, Transforming American Life.* New York: Penguin, 1997.

Linklater, Andro. *Measuring America: How an Untamed Wilderness Shaped the United States and Fulfilled the Promise of Democracy.* New York: Walker & Company, 2002.

Lockridge, Deborah. "The Changing Face of Trucking: Part 1." *Truckinginfo ("the web site of* Heavy Duty Trucking *magazine"),* March 12, 2010. (http://www.truckinginfo.com/news/news-detail.asp?news_id=69692, accessed 12/13/11)

Lockridge, Deborah. "The Changing Face of Trucking Part 2: Riding the Rails." *Truckinginfo ("the web site of* Heavy Duty Trucking *magazine"),* June 16, 2010. (http://www.truckinginfo.com/operations/news-detail.asp?news_id=70724&news_category_id=73, accessed 12/14/11)

Lockridge, Deborah. "The Changing Face of Trucking, Part 3: The Rise of Third-Party Logistics." *Truckinginfo ("the web site of* Heavy Duty Trucking *magazine"),* September 20, 2010. (http://www.truckinginfo.com/operations/news-detail.asp?news_id=71892&news_category_id=73, accessed 12/14/11)

Lockridge, Deborah. "The Changing Supply Chain: It Takes More Than Trucks." *Heavy Duty Trucking*, Vol. 90, Iss. 8 (August 2011), pp. 57-62.

LoDico, John A. "ICC Allows CSX and ACL to Create Nation's First Rail-Barge Company." *Traffic World,* Vol. 199, No. 5 (July 30, 1984), pp. 31-33.

Lohr, Steve. “Seeing Promise and Peril in Digital Records.” *The New York Times,* July 16, 2011.

Long, Mindy. “Carriers Say Port Drayage Operations Vex Drivers.” *Transport Topics,* Iss. 3603 (August 30, 2004), p. 30.

Lyster, Clare. “Landscapes of Exchange: Re-articulating Site.” In: Waldheim, Charles (ed.). *The Landscape Urbanism Reader.* New York: Princeton Architectural Press, 2006, pp. 219-237.

Machalaba, Daniel. “New Era Dawns for Rail Building.” *The Wall Street Journal,* February 13, 2008.

Mahoney, John H. *Intermodal Freight Transportation.* Westport, CT: Eno Foundation for Transportation, 1985.

Malone, Frank. “New Peaks for Piggyback.” *Railway Age,* Vol. 179, No. 20 (October 30, 1978), pp. 22-25.

Malone, Frank. “CP Rail Moves Toward Domestic Containers.” *Railway Age,* Vol. 182, No. 22 (November 30, 1981), pp. 26-28.

Malone, Frank. “CP Rail Moves Toward Domestic Containers.” *Railway Age,* Vol. 182, No. 22 (November 30, 1981), pp. 26-28.

Malone, Frank. “Trailers/Containers: Sizing Up Tomorrow’s Fleet.” *Railway Age,* Vol. 186, No. 3 (March 1985), pp. 42-43, 88.

Malone, Frank. “APL Linertrains Stack Up Profits.” *Railway Age,* Vol. 186, No. 4 (April 1985), pp. 62-64.

Manalytics. *The Impact of Maritime Containerization on the United States Transportation System.* San Francisco, CA: Manalytics, Inc., February 1972. (Report to Maritime Administration, U.S. Department of Commerce)

Mann, Michael. “The Autonomous Power of the State: Its Origins, Mechanisms and Results.” In: Brenner, Neil, Bob Jessop, Martin Jones, and Gordon MacLeod (eds.). *State/Space: A Reader.* Malden, MA: Blackwell Publishing, 2003, pp. 53-64.

Mansfield, Becky. “Beyond Rescaling: Reintegrating the `National' as a Dimension of Scalar Relations.” *Progress in Human Geography*, Vol. 29, No. 4 (August 2005), pp. 458–473.

Marcus, Henry S. *Intermodal Movement of Marine Containers.* MIT Sea Grant College Program, Report #MITSG92-21, 1993.

Marine Engineering/Log. “Grace Initiates Seatainer Service.” Vol. 65, No. 2 (February 1960), pp. 55-61.

Massey, Doreen. *Space, Place and Gender.* Minneapolis, MN: University of Minnesota Press, 1994. [see in particular the essay “A Global Sense of Place,” pp. 146-156, that originally appeared in *Marxism Today*, Vol. 38, 1991]

Massey, Doreen. *For Space.* London: Sage Publications, 2005.

Matson Research Corporation. *The Impact of Containerization on the U.S. Economy.* San Francisco, CA: Matson Research Corporation, September 1970. (2 vols.) [A Report to Maritime Administration, U.S. Department of Commerce]

Maurer, Herrymon. "New Signals for the Pennsy." *Fortune*, November 1955, pp. 111-117, 159-160, 164-166, 171.

Mayntz, Renate, and Thomas P. Hughes (eds.). *The Development of Large Technical Systems.* Boulder, CO: Westview Press, 1988.

Mazower, Mark. *Governing the World: The History of an Idea.* New York: Penguin Press, 2012.

McCalla, Robert J. "Global Change, Local Pain: Intermodal Seaport Terminals and Their Service Areas." *Journal of Transport Geography,* Vol. 7 (1999), pp. 247-254.

McCalla, Robert J., Brian Slack, and Claude Comtois. "Dealing with Globalisation at the Regional and Local Level: The Case of Contemporary Containerization." *The Canadian Geographer*, Vol. 48, No. 4 (December 2004), pp. 473-487.

McCool, Daniel. *River Republic: The Fall and Rise of America's Rivers.* New York: Columbia University Press, 2012.

McCullough, John T. "Following a Through Container: From New Jersey Shipper to West German Consignee." *Distribution Age,* Vol. 65, No. 6 (June 1966), pp. 27-34.

McDowell, B. D. "Reinventing Planning Under ISTEA: MPOs and State DOTs—ISTEA's Impact." *TR News,* Vol. 175 (November/December 1994), pp. 6-9, 29.

McKenzie, David R., Mark C. North, and Daniel S. Smith. *Intermodal Transportation—The Whole Story.* Omaha, NE: Simmons-Boardman Books, 1989.

McNally, Sean. "U.S. Proposes Chassis Rule." *Transport Topics,* Iss. 3723 (January 8, 2007), pp. 1, 27.

McNichol, Dan. *The Roads That Built America: The Incredible Story of the U.S. Interstate System.* New York: Sterling Publishing, 2006.

McPhee, John. *Uncommon Carriers.* New York: Farrar, Straus and Giroux, 2006.

McShane, Clay. *Down the Asphalt Path: The Automobile and the American City.* New York: Columbia University Press, 1994.

Medina, Jennifer. "A Busy California Port Seeks to Grow, But a Neighbor Objects." *New York Times,* April 11, 2013.

Misa, Thomas J., Philip Brey, and Andrew Feenberg (eds.). *Modernity and Technology.* Cambridge, MA: MIT Press, 2003.

Mitchell, Timothy. *Colonising Egypt.* Berkeley, CA: University of California Press, 1988.

Modern Railroads. "Flexi-Van—NYC's New Piggyback." Vol. 12, No. 5 (May 1957), p. 137.

Modern Railroads. "NYC Introduces New Flexi-Van." Vol. 12, No. 9 (September 1957), p. 160.

Mongelluzzo, Bill. "The Port Moves Inland." *The Journal of Commerce,* September 13, 2010.

Morgan, David P. "What Price Piggyback?" *Trains*, Vol. 20, No. 7 (May 1960), pp. 30-42.

Morgan, David P. "The Paraphernalia of Piggyback." *Trains*, Vol. 20, No. 8 (June 1960), pp. 37-45.

Morrison, Scott. Interview by Arthur Donovan and Andrew Gibson, March 27, 1997. Containerization Oral History Collection 1995-1998. Archives Center, National Museum of American History, Washington, D.C.

Morrow, Edward A. "3-Way Piggyback Introduced Here." *The New York Times,* August 10, 1960, p. 62.

Murphy, Craig N., and JoAnne Yates. *The International Organization for Standardization (ISO): Global Governance Through Voluntary Consensus.* London: Routledge, 2009.

Muhlethaler, Nate. "Mexican Railroads: Photographic Profiles of Mexican Rail Lines and Operations." (http://mexicanrailroads.blogspot.com/2008/08/kcs-de-mexico-south-from-laredo.html, accessed 7/2/11).

National Cooperative Freight Research Program. *North American Marine Highways* [NCFRP Report 5]. Washington, D.C.: Transportation Research Board (The National Academies), 2010. (Also available online at http://onlinepubs.trb.org/onlinepubs/ncfrp/ncfrp_rpt_005.pdf, as of 6/9/12)

National Cooperative Freight Research Program. *Truck Drayage Productivity Guide* [NCFRP Report 11]. Washington, D.C.: Transportation Research Board (The National Academies), 2011. (Also available online at http://onlinepubs.trb.org/onlinepubs/ncfrp/ncfrp_rpt_011.pdf, as of 10/29/11)

National Cooperative Highway Research Program (Transportation Research Board). *Rail Freight Solutions to Roadway Congestion—Final Report and Guidebook* [NCHRP Report 586]. Washington, D.C.: Transportation Research Board, 2007.

National Waterways Study – A Framework for Decision Making – Final Report. U.S. Army Engineer Water Resources Support Center, Institute for Water Resources, January 1983.

New York Port Handbook. Port Resources Information Committee, New York, 1964.

Newswanger, Philip. "Container Barge Service from Norfolk to Richmond Is Still in Business." *The Virginian-Pilot* (*PilotOnline.com*) [In partnership with *Inside Business*], December 21, 2009. (http://hamptonroads.com/2009/12/container-barge-service-norfolk-richmond-still-business, accessed 10/1/10)

Niven, John. *The American President Lines and Its Forebears, 1848-1984.* Newark, DE: University of Delaware Press, 1987.

Noble, David F. *Forces of Production: A Social History of Industrial Automation*. New York: Oxford University Press, 1984.

Norfolk Southern Corporation. "'New Thinking, New Resolve, and New Optimism' Characterize Official Opening of Norfolk Southern's Heartland Corridor." Press release, September 9, 2010. (http://www.nscorp.com/nscportal/nscorp/Media/News%20Releases/2010/heartland_opening.html, accessed 10/28/10).

Norris, Frank B. "Cargoes North: Containerization and Alaska's Postwar Shipping Crisis." *Alaska History,* Vol. 7, No. 1 (Spring 1992), pp. 17-30.

Norris, Frank B. *Spatial Diffusion of Intermodal Rail Technologies.* PhD Dissertation, University of Washington (Geography), 1994.

Notteboom, Theo, and Jean-Paul Rodrigue. "The Future of Containerization: Perspectives from Maritime and Inland Freight Distribution." *GeoJournal*, Vol. 74, Iss. 1 (February 2009), pp. 7-22.

Novacek, Arthur C. *One Step Ahead.* Charlotte, NC: Pure Heart Press (Main Street Rag Publishing Company), 2006.

Ogden, E. B. "What the Operator Wants in Containers." Society of Automotive Engineers, New York, 1961 (1961 SAE International Congress and Exposition of Automotive Engineering, Detroit, MI, January 9-13, 1961).

Owen, Mary. "Joliet Seeks to Become the O'Hare of the Train-Truck World." *Chicago Tribune,* August 4, 2010. (http://articles.chicagotribune.com/2010-08-04/news/ct-x-s-center-point-0804-20100804_1_centerpoint-train-truck-union-pacific, accessed 12/31/10)

Pacer International [website]. "History." (http://www.pacer.com/OurCompany/History.aspx, accessed 9/13/12)

Pacer International [website]. "Intermodal Container Dimensions." (http://www.pacer.com/Intermodal/IntermodalContainers.aspx, accessed 9/16/12)

Pacific Northwest Waterways Association. "Columbia Snake River System" [slide presentation]. Portland, OR, undated [circa 2005-2012]. (http://aapa.files.cms-plus.com/SeminarPresentations/05_Shallow_Draft_Meira_Kristin.pdf, accessed 6/20/12)

Parker, Martin. "Containerisation: Moving Things and Boxing Ideas." *Mobilities*, Vol. 8, Iss. 3 (2013), pp. 368-387.

Patch, David. "Wood County Intermodal Site Offers Sneak Peek of Future." *The Blade,* November 13, 2010, pages unknown. (http://www.toledoblade.com/local/2010/11/13/Wood-County-intermodal-site-offers-sneak-peek-of-future.html, accessed 4/14/11)

Patch, David, and Alex Parker. "Metro Area Ripe for Shift Into Global Trade Portal." *The Blade*, May 18, 2008. (http://www.toledoblade.com/frontpage/2008/05/18/Metro-area-ripe-for-shift-into-global-trade-portal.html, accessed 7/13/09)

Patton, Oliver B. "Who Owns the Chassis?" *Heavy Duty Trucking*, Vol. 90, No. 8 (August 2011), pp. 64-67.

Patton, Phil. *Open Road: A Celebration of the American Highway.* New York: Simon and Schuster, 1986.

Perakis, Anastassios N., and Athanasios Denisis. "A Survey of Short Sea Shipping and Its Prospects in the USA." *Maritime Policy Management,* Vol. 35, No. 6 (December 2008), pp. 591-614.

Perrier, Dianne. *Onramps and Overpasses: A Cultural History of Interstate Travel*. Gainesville, FL: University Press of Florida, 2009.

Perry, Jean. "Riding the Crest of Innovation in Trucking [Black Business in Profile: Leamon McCoy]." *Black Enterprise*, Vol. 4, No. 10 (May 1974), pp. 36-38, 53.

Peterson, Larry. "Deal Likes Part of Proposal for New Interstate; Barnes Wants More Study." *Savannah Morning News,* August 26, 2010.

Peyton, Billy Joe. "Surveying and Building the Road." In: Raitz, Karl (ed.). *The National Road.* Baltimore: The Johns Hopkins University Press, 1996, pp. 123-158.

Pfeiffer, Robert J., and Stanley Powell, Jr. Interview by Arthur Donovan and Andrew Gibson, June 18, 1997. Containerization Oral History Collection 1995-1998. Archives Center, National Museum of American History, Washington, D.C.

Pinch, Trevor J., and Wiebe E. Bijker. "The Social Construction of Facts and Artifacts: Or How the Sociology of Science and the Sociology of Technology Might Benefit Each Other." In: Bijker, Wiebe E., Thomas P. Hughes, and Trevor J. Pinch (eds.). *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology.* Cambridge, MA: MIT Press, 1987, pp. 17-50.

Pisani, John M. *Container Transport by Inland Waterways in the United States*. March 1989. [Prepared by: John M. Pisani, Director, Office of Port and Intermodal Development, Maritime Administration, U.S. Department of Transportation, Washington, D.C.]

Pollak, Richard. *The Colombo Bay.* New York: Simon & Schuster, 2004.

Port Inland Distribution Network [Fact Sheet]. The Port Authority of New York and New Jersey, New York, March 2006. (http://www.panynj.gov/doingbusinesswith/seaport/html/port_inland.html, accessed date unknown, circa 2010, link no longer active)

Port of Oakland. "Green Trade Corridor Marine Highway (Oakland-Stockton-West Sacramento)." Port of Oakland Website – Projects. (http://www.portofoakland.com/maritime/grcmh.asp, accessed 6/22/12)

Prelorenzo, Claude. "L'Immobilité des Infrastructures." In: Prelorenzo, Claude, and Dominique Rouillard (eds.). *Le Temps des Infrastructures*. Paris: L'Harmattan, 2007, pp. 85-91.

Prince, Adam. "To The Shore! - North Carolina's Struggle to Build Interstate 40 to the Atlantic Coast." *Welcome to All Things NC!!,* 2006. (http://www.gribblenation.com/ncpics/history/i40.html, accessed 10/29/11)

Puffert, Douglas J. "The Standardization of Track Gauge on North American Railways, 1830-1890." *The Journal of Economic History,* Vol. 60, No. 4 (December 2000), pp. 933-960.

Rabens, Tye. "Steaming Ahead." *Phoenix Magazine,* October 2010, p. 52. (http://www.phoenixmag.com/lifestyle/history/201010/steaming-ahead/, accessed 2/29/12)

Radkau, Joachim. "Zum Ewiger Wachstum Verdammt? Jugend und Alter Grosstechnischer Systeme." In: Braun, Ingo, and Bernward Joerges (eds.). *Technik Ohne Grenzen.* Frankfurt: Suhrkamp, 1994, pp. 50-106.

Rae, John B. *The Road and the Car in American Life.* Cambridge, MA: MIT Press, 1971.

Railway Age. "P. R. R. Container Transfer Station at Harrisburg, Pa. [News]." Vol. 91, No. 25 (December 19, 1931), p. 954.

Railway Age. "Containers—Next Step in Freight?" Vol. 145, No. 21 (November 24, 1958), pp. 30-31, 35.

Railway Age. "Barrel Arches Top Big Terminal." Vol. 148, No. 20 (May 16, 1960), pp. 56-58.

Railway Age. "Containers: The Right Track?" Vol. 148, No. 22 (May 30, 1960), pp. 9, 49.

Railway Age. "Containerization: Always a Bridesmaid?" Vol. 161, No. 23 (December 12, 1966), pp. 19-23, 34-35.

Railway Age. "'BIG LANDBRIDGE' Versus 'LITTLE LANDBRIDGE." Vol. 166, No. 19 (May 26, 1969), p. 23.

Railway Age. "How Much Energy Can Intermodal Save?" Vol. 181, No. 14 (July 28, 1980), p. 28.

Railway Age. "Terminal Efficiency and Flexibility: The Key to TOFC/COFC's Future?" Vol. 181, No. 14 (July 28, 1980), p. 26.

Railway Age. "West Coast Ports Vie for Lead in Intermodal Race." Vol. 186, No. 2 (February 1985), p. 21.

Railway Age. "BN's 'Seattle International Gateway' Yard Opens for Business." Vol. 186, No. 9 (September 1985), p. 23.

Railway Age. "CP Adopts Longer Domestic Containers." Vol. 190, No. 9 (September 1989), p. 29.

Railway Age. "Doublestacks on Donner Pass." November 24, 2009. (http://www.railwayage.com/breaking-news-archive/doublestacks-on-donner-pass.html, accessed 12/7/09).

Raitz, Karl (ed.). *The National Road.* Baltimore: The Johns Hopkins University Press, 1996.

Ramos, Stephen J. *Dubai Amplified: The Engineering of a Port Geography.* Farnham, UK: Ashgate, 2010.

Ramsey, Duane. "Container Shipping Terminal Remains Possibility for Port." *Toledo Free Press,* August 22, 2008.

Ramsey, Duane. "CSX Terminal in North Baltimore Part of $842 Million Project." *Toledo Free Press*, November 19, 2010.

Rath, Eric. *Container Systems.* New York: John Wiley & Sons, 1973.

Razemon, Olivier. "Gennevilliers, Le Rungis Fluvial." *Direct Matin/Ile-de-France* ["*Le Monde* pour *Direct Matin*"], No. 840, March 8, 2011, p. 6.

Reck, Dickson (ed.). *National Standards in a Modern Economy.* New York: Harper & Brothers, 1956.

Reebie, Robert S. "The Public Interest and Course of Action in Optimizing Rail-Highway Transportation." *Highway Research Record,* No. 153 (1967), pp. 31-38.

Regular Common Carrier Conference (of the American Trucking Associations, Inc.). *Report on Containerization in International and Domestic Commerce.* Washington, D.C., 1967.

Renjel, Louis [Vice-President, Strategic Infrastructure Initiatives, CSX Transportation]. "US Intermodal: Creating a National Gateway." CargoSystems.net, October 5, 2010. (http://www.cargosystems.net/freightpubs/cs/features/us-intermodal-creating-a-national-gateway, accessed 10/10/2010)

Revill, George. *Railway*. London: Reaktion Books, 2012.

Revis, Joseph S., and Curtis Tarnoff. *The Nation's Public Works: Report on Intermodal Transportation* (also titled *Intermodal Transportation and Public Works Programs*) [Categories of Public Works Series]. National Council on Public Works Improvement, Washington, D.C., May 1987.

Richardson, Paul. Interview by Arthur Donovan and Andrew Gibson, July 1, 1997. Containerization Oral History Collection 1995-1998. Archives Center, National Museum of American History, Washington, D.C.

Richmond, Deborah. "Consumers Gone Wild [Distribution]." In: Varnelis, Kazys (ed.). *The Infrastructural City: Networked Ecologies in Los Angeles.* Barcelona: Actar, 2009, pp. 206-217.

Richter, Daniel K. *Before the Revolution: America's Ancient Pasts.* Cambridge, MA: Belknap Press of Harvard University Press, 2011.

Rivoli, Pietra. *The Travels of a T-Shirt in the Global Economy: An Economist Examines the Markets, Power, and Politics of World Trade.* Hoboken, NJ: John Wiley & Sons, 2005.

Roberts, Robert. "Defining the Intermodal Terminal." *Modern Railroads,* Vol. 39, No. 7 (July 1984), pp. 21-29.

Rodrigue, Jean-Paul. "Globalization and the Synchronization of Transport Terminals." *Journal of Transport Geography,* Vol. 7 (1999), pp. 255-261.

Rodrigue, Jean-Paul. "Transportation and the Geographical and Functional Integration of Global Production Networks." *Growth and Change,* Vol. 37, No. 4 (December 2006), pp. 510-525.

Rodrigue, Jean-Paul. "Carrying Capacity of Containers (in Cubic Feet)." *The Geography of Transport Systems* website, http://people.hofstra.edu/geotrans/, undated. (http://people.hofstra.edu/geotrans/eng/ch3en/conc3en/containerscubic.html, accessed 9/29/11)

Rodrigue, Jean-Paul, and Theo Notteboom. "The Geography of Containerization: Half a Century of Revolution, Adaptation and Diffusion." *GeoJournal*, Vol. 74, No. 1 (February 2009), pp. 1-5.

Rodrigue, Jean-Paul, and Theo Notteboom. "Dry Ports in European and North American Intermodal Rail Systems: Two of a Kind?" *Research in Transportation Business & Management,* Vol. 5 (December 2012), pp. 4-15.

Rohou, Anne. "Voie d'Eau, Voie d'Avenir." *Direct Matin/Ile-de-France* ["*Le Monde* pour *Direct Matin*"], No. 731, September 15, 2010, p. 8.

Rose, Gregory S. "Extending the Road West." In: Raitz, Karl (ed.). *The National Road.* Baltimore: The Johns Hopkins University Press, 1996, pp. 159-192.

Rose, Mark H., and Raymond A. Mohl. *Interstate: Highway Politics and Policy Since 1939* (3rd ed.). Knoxville, TN: University of Tennessee Press, 2012. (First edition published as *Interstate: Express Highway Politics, 1941-1956*, by Mark H. Rose; second edition published as *Interstate: Express Highway Politics, 1939-1989*, by Mark H. Rose.)

Rose, Mark H., Bruce E. Seely, and Paul F. Barrett. *The Best Transportation System in the World: Railroads, Trucks, Airlines, and American Public Policy in the Twentieth Century.* Columbus, OH: Ohio State University Press, 2006.

Roso, Violeta, Johan Woxenius, and Kenth Lumsden. "The Dry Port Concept: Connecting Container Seaports with the Hinterland." *Journal of Transport Geography,* Vol. 17, Iss. 5 (September 2009), pp. 338-345.

Salpukas, Agis. "When Trucks and Trains Unite." *New York Times*, June 21, 1992. (http://www.nytimes.com/1992/06/21/business/when-trucks-and-trains-unite.html?pagewanted=all&src=pm, accessed 6/18/2012)

Salsbury, Stephen. "The Emergence of an Early Large-Scale Technical System: The American Railroad Network." In: Mayntz, Renate, and Thomas P. Hughes (eds.). *The Development of Large Technical Systems.* Boulder, CO: Westview Press, 1988, pp. 37-68.

Sassen, Saskia. *A Sociology of Globalization.* New York: W. W. Norton & Company, 2007.

Sassen, Saskia. "Introduction: Deciphering the Global." In: Sassen, Saskia (ed.). *Deciphering the Global: Its Scales, Spaces and Subjects.* New York: Routledge (Taylor & Francis Group), 2007, pp. 1-18.

Sassen, Saskia. *Territory, Authority, Rights: From Medieval to Global Assemblages* [updated ed.]. Princeton, NJ: Princeton University Press, 2008.

Saunders, Richard, Jr. *Main Lines: Rebirth of the North American Railroads, 1970-2002.* DeKalb, IL: Northern Illinois University Press, 2003.

Sayre, Alan, and Holbrook Mohr. "Flooding Hinders Shipping on the Mississippi River." *Yahoo! News [Associated Press],* May 18, 2011. (http://news.yahoo.com/flooding-hinders-shipping-mississippi-river-145142826.html, accessed 5/18/11)

Scharmen, Fred. "Logistics: the Backend of the Big Box." SevenSixFive.net, April 2006. (http://www.sevensixfive.net/logistics/logistics.html, accessed 5/23/07)

Schivelbusch, Wolfgang. *The Railway Journey: The Industrialization of Time and Space in the 19th Century.* Berkeley: The University of California Press, 1977.

Schwartz, John. "Freight Train Late? Blame Chicago." *New York Times,* May 7, 2012.

Schwartz, Marvin. *J.B. Hunt: The Long Haul to Success*. Fayetteville, AR: University of Arkansas Press, 1992.

Scott, James C. *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed.* New Haven, CT: Yale University Press, 1998.

Seaton, Bruce. Interviews by Arthur Donovan and Andrew Gibson, June 19, 1997 and July 25, 1997. Containerization Oral History Collection 1995-1998. Archives Center, National Museum of American History, Washington, D.C.

Seely, Bruce E. *Building the American Highway System: Engineers as Policy Makers.* Philadelphia: Temple University Press, 1987.

Seiberlich, Carl. Interview by Arthur Donovan, June 21, 1997. Containerization Oral History Collection 1995-1998. Archives Center, National Museum of American History, Washington, D.C.

Serenbetz, Warren L. "The Real Potential of Containerization." Automotive Engineering Congress and Exposition, Detroit, MI, February 23-27, 1976. (Society of Automotive Engineers, Warrendale, PA.)

Shannon, Homer H. "Between the Package and the Box Car." *Traffic World,* Vol. 45, No. 23 (June 7, 1930), pp. 1513-1516.

Shannon, Kelly, and Marcel Smets. *The Landscape of Contemporary Infrastructure.* Rotterdam: NAi Publishers, 2010.

Sharp, Eric. "Army Corps Blocks St. Lawrence Seaway's Economic Potential." *Detroit Free Press,* July 3, 2011.

Sharpsteen, Bill. *The Docks.* Berkeley, CA: University of California Press, 2011.

Shaw, Ronald E. *Canals for a Nation: The Canal Era in the United States, 1790-1860.* Lexington, KY: University Press of Kentucky, 1990.

Shea, Bill. "Canada and Michigan Make It Official: New Bridge Ends 10-Year Effort." *Crain's Detroit Business,* June 15, 2012 (modified June 18, 2012) (http://www.crainsdetroit.com/article/20120615/FREE/120619934/canada-and-michigan-make-it-official-new-bridge-ends-10-year-effort#, accessed 10/14/12)

Sheppard, Eric. "The Spaces and Times of Globalization: Place, Scale, Networks, and Positionality." *Economic Geography,* Vol. 78, No. 3 (July 2002), pp. 307-330.

Shott, John G. *Progress in Piggyback and Containerization* (pamphlet). Washington, D.C.: Public Affairs Institute, 1961.

Siddall, William R. "Railroad Gauges and Spatial Interaction." *Geographical Review,* Vol. 59, No. 1 (January 1969), pp. 29-57.

Simpson, John Warfield. *Visions of Paradise: Glimpses of Our Landscape's Legacy.* Berkeley, CA: University of California Press, 1999.

Slack, Brian. "Intermodal Transportation in North America and the Development of Inland Load Centers." *The Professional Geographer,* Vol. 42, No. 1 (February 1990), pp. 72-83.

Slack, Brian. "Satellite Terminals: A Local Solution to Hub Congestion?" *Journal of Transport Geography,* Vol. 7 (1999), pp. 241-246.

Smallen, David. "Intermodal Connectors: NHS Catches Up to the 1990s." *Public Roads,* Vol. 61, No. 6 (May/June 1998). (http://www.fhwa.dot.gov/publications/publicroads/98may/nhs.cfm, accessed 9/24/12)

Smil, Vaclav. "The Two Prime Movers of Globalization: History and Impact of Diesel Engines and Gas Turbines." *Journal of Global History*, Vol. 2, Iss. 3 (November 2007), pp. 373-394.

Smil, Vaclav. *Prime Movers of Globalization: The History and Impact of Diesel Engines and Gas Turbines.* Cambridge, MA: MIT Press, 2010.

Smith, A. M. "Sea-Land Terminals: Incompatibility Isolates the Innovator." *Containerisation International*, Vol. 16, No. 10 (October 1982), pp. 75-79.

Smith, Cecil O., Jr. "The Longest Run: Public Engineers and Planning in France." *The American Historical Review,* Vol. 95, No. 3 (June 1990), pp. 657-692.

Smith, Daniel. "Freight Projects of National Significance: Toward a Working Definition." In: Transportation Research Board (National Research Council). *Policy Options for Intermodal Freight Transportation* [special report 252]. Washington, D.C.: National Academy Press, 1998, pp. 199-233.

Smith, Michael Peter. *Transnational Urbanism: Locating Globalization.* Malden, MA: Blackwell, 2001.

Smith, Michael Peter. "Power in Place: Retheorizing the Local and the Global." In: Lin, Jan, and Christopher Mele (eds.). *The Urban Sociology Reader.* London: Routledge, 2005, pp. 241-250.

Smith, Neil. "Remaking Scale: Competition and Cooperation in Pre-National and Post-National Europe." In: Brenner, Neil, Bob Jessop, Martin Jones, and Gordon MacLeod (eds.). *State/Space: A Reader.* Malden, MA: Blackwell Publishing, 2003, pp. 227-238.

Smith, Neil. "Scale Bending and the Fate of the National." In: Sheppard, Eric, and Robert B. McMaster (eds.). *Scale and Geographic Inquiry: Nature, Society, and Method.* Malden, MA: Blackwell Publishing, 2004, pp. 192-212.

Snyder, Susan Nigra, and Alex Wall. "Emerging Landscapes of Movement and Logistics." *Architectural Design Profile*, No. 134 (1998), pp. 16-21.

Solomon, Brian. *Amtrak.* St. Paul, MN: Voyageur Press (MBI Publishing), 2004.

Solomon, Brian. *Intermodal Railroading.* St. Paul, MN: Voyageur Press (MBI Publishing), 2007.

Solomon, Mark B. "Rails Try New Route to Intermodal Growth." *DC Velocity*, July 4, 2011. (http://www.dcvelocity.com/articles/20110704rails_new_route_for_intermodal_growth/, accessed 9/12/12)

Sorrell, Lewis C. "The Container Car." *Traffic World,* Vol. 44, No. 15 (October 12, 1929), pp. 895-901.

Soppelsa, Peter S. *The Fragility of Modernity: Infrastructure and Everyday Life in Paris, 1870-1914.* PhD Dissertation, University of Michigan (History), 2009.

Southeastern Colorado Heritage Center [website]. "Denver & Rio Grande Western Freight Depot." (http://www.theheritagecenter.us/freight_depot.html, accessed 2/29/12)

Southeastern Ohio Port Authority. "Container-on-Barge Port Concept Paper." June 2008. (http://www.pioneerspirit.us/pub/Container_on_Barge_Concept_Paper2.pdf, accessed 2/25/11)

Southwest Region University Transportation Center. *Towards the Future: The Promise of Intermodal and Multimodal Transportation Systems.* Report #SWUTC/95/60017/71249-3, Center for Transportation Research, University of Texas, Austin, TX, February 1995.

Spivak, Jeffrey. "Freight Finds Its Niche." *Planning*, Vol. 76, No. 5 (May/June 2010), pp. 28-32.

Spychalski, John C., and Evelyn Thomchick, "Drivers of Intermodal Rail Freight Growth in North America." *European Journal of Transport and Infrastructure Research [EJTIR],* Vol. 9, Iss. 1 (March 2009), pp. 63-82.

Stackhouse, R. K. "The Pennsylvania's Container Plan." *Railway Age,* Vol. 100, No. 3 (January 18, 1936), pp. 143-145.

Stagl, Jeff. "CSX Wagers on a Public-Private Partnership to Place the Double-Stack National Gateway in the Intermodal Win Column." *Progressive Railroading*, January 2009, cover story. (http://www.progressiverailroading.com/pr/article/CSX-wagers-on-a-publicprivate-partnership-to-place-the-doublestack-National-Gateway-in-the-intermodal-win-column--19322, accessed 10/28/10).

Star, Susan Leigh, and Karen Ruhleder. "Steps Toward an Ecology of Infrastructure: Design and Access for Large Information Spaces." *Information Systems Research*, Vol. 7, No. 1 (March 1996), pp. 111-134.

Stilgoe, John R. *Metropolitan Corridor: Railroads and the American Scene.* New Haven, CT: Yale University Press, 1983.

Stilgoe, John R. *Train Time: Railroads and the Imminent Reshaping of the United States Landscape.* Charlottesville, VA: University of Virginia Press, 2007.

Stindt, Fred A. *Matson's Century of Ships.* Modesto, CA: Fred A. Stindt, 1982. ("Privately published at Modesto, California, United States of America, by Fred A. Stindt, on the 100th Anniversary of Matson Navigation Co.")

Stover, John F. *The Life and Decline of the American Railroad.* New York: Oxford University Press, 1970.

Stover, John F. *American Railroads* (2nd ed.). Chicago: University of Chicago Press, 1997.

Summerton, Jane (ed.). *Changing Large Technical Systems.* Boulder, CO: Westview Press, 1994.

Summerton, Jane. "Power Plays: The Politics of Interlinking Systems." In: Coutard, Olivier (ed.). *The Governance of Large Technical Systems.* London: Routledge, 1999, pp. 93-113.

Swift, Earl. *The Big Roads: The Untold Story of the Engineers, Visionaries, and Trailblazers Who Created the American Superhighways.* Boston: Houghton Mifflin Harcourt, 2011.

Swyngedouw, Erik. *Social Power and the Urbanization of Water: Flows of Power*. Oxford, UK: Oxford University Press, 2004.

Szatan, Jerry W. "On Track: Two New Developments Are Helping Bolster the Chicago Region's Historic Role as a Freight Transportation and Distribution Center." *Urban Land,* Vol. 62, No. 6 (June 2003), pp. 65-69. (http://www.szatanassociates.com/images/On_Track_Szatan.pdf, accessed 7/12/11).

Szkotak, Steve. "Reviving Marine Highways." The Associated Press [64 Express website], February 23, 2009. (May have been originally published in *Daily Press*, newspaper for Hampton Roads) (http://www.64express.com/news--events/reviving-marine-highways.aspx, accessed 6/13/12)

Tabak, Herman D. *Cargo Containers: Their Stowage, Handling and Movement.* Cambridge, MD: Cornell Maritime Press, 1970.

Tabb, William K. *Economic Governance in the Age of Globalization*. NewYork: Columbia University Press, 2004.

Taff, Charles A. *Commercial Motor Transportation* (7th ed.). Centreville, MD: Cornell Maritime Press, 1986.

Taggart, Stewart. "The 20-Ton Packet." *Wired*, Vol. 7, No. 10 (October 1999), pp. 246-255.

Tantlinger, K. W. [Keith W.]. "Van Container Standardization – Goals, Problems and Progress." Society of Automotive Engineers, New York, 1961 (1961 SAE International Congress and Exposition of Automotive Engineering, Detroit, MI, January 9-13, 1961).

Tantlinger, Keith W. "Motor Freight Equipment Outlook: Containers and the Transportation Industry." *Traffic World,* Vol. 128, No. 11 (December 10, 1966), pp. 46-48.

Taylor, George Rogers, and Irene D. Neu. *The American Railroad Network, 1861-1890.* Urbana, IL: University of Illinois Press, 2003 (orig. 1956).

Taylor, John C., and George C. Jackson. "Conflict, Power, and Evolution in the Intermodal Transportation Industry's Channel of Distribution." *Transportation Journal,* Vol. 39, No. 3 (Spring 2000), pp. 5-17.

Taylor, Peter J. "The State as Container: Territoriality in the Modern World-System." In: Brenner, Neil, Bob Jessop, Martin Jones, and Gordon MacLeod (eds.). *State/Space: A Reader.* Malden, MA: Blackwell Publishing, 2003, pp. 101-113.

Temple, Barker & Sloane, Inc. *Domestic Containerization: A Preliminary Feasibility Study.* Prepared for the Association of American Railroads [AAR Report R-622], Washington, D.C., March 1986.

Tennessee-Tombigbee Waterway Website. "Construction [History of the Tenn-Tom]." http://tenntom.org. (http://history.tenntom.org/construction-process/, accessed 6/22/12)

Tennessee-Tombigbee Waterway Website. "History of the Tenn-Tom." http://tenntom.org. (http://history.tenntom.org/, accessed 6/22/12)

Thuong, Le T. "From Piggyback to Double-Stack Intermodalism." *Maritime Policy and Management,* Vol. 16, No. 1 (January-March 1989), pp. 69-81.

Timmermans, Stefan, and Marc Berg. "Standardization in Action: Achieving Local Universality Through Medical Protocols." *Social Studies of Science,* Vol. 27, No. 2 (April 1997), pp. 273-305.

Tonne, Herbert A. "How the Fork-Lift Helps Materials Handling." *The Journal of Business Education,* Vol. 24, Iss. 4 (1948), pp. 19, 31.

Traffic World. "New Container Chassis System Offers Greater Flexibility." Vol. 128, No. 11 (December 10, 1966), p. 69.

Traffic World. "Uniform Cargo Container Specifications Published by USA Standards Institute." Vol. 128, No. 11 (December 10, 1966), pp. 81-82.

Traffic World. "CN Car 'Double-Decks' Containers [Services and Products]." Vol. 146, No. 11 (June 14, 1971), p. 77.

Traffic World. "Container Handling Systems at Rail Terminals Probed in Consulting Firm Study." Vol. 146, No. 13 (June 28, 1971), pp. 64-66.

Transportation Research Board (National Research Council). *Facing the Challenge: The Intermodal Freight Terminal of the Future.* State of the Art Report 4, Washington, D.C., 1986. (Papers from the Conference on Intermodal Freight Terminal Design, March 1986)

Transportation Research Board (National Research Council). *Intermodal Marine Container Transportation, Impediments and Opportunities* [special report 236]. Washington, D.C., 1992.

Transportation Research Board (The National Academies). *Landside Access to U.S. Ports* [special report 238]. Washington, D.C., 1993.

Transportation Research Board (National Research Council). *ISTEA and Intermodal Planning: Concept, Practice, Vision* [special report 240]. Washington, D.C., 1993. (Proceedings of the National Conference on ISTEA and Intermodal Planning Issues, December 2-4, 1992, Irvine, CA)

Transportation Research Board (National Research Council). *Intermodal Freight Terminal of the Future.* Transportation Research Circular, Washington, D.C., Number 459, June 1996. (Papers from the National Conference on the Intermodal Freight Terminal of the Future, December 1994)

Transportation Research Board (National Research Council). *Policy Options for Intermodal Freight Transportation* [special report 252]. Washington, D.C.: National Academy Press, 1998.

Truck Trailer Manufacturers Association. *Containerization: Problems of Today and Potential for Tomorrow*. Panel Discussion, 26th Annual Convention, Grand Bahama Island, April 17, 1967.

Trummer, Peter. "Spatial Regimes: Material Organization and Its Architectural Effects." *Hunch: the Berlage Institute Report,* No. 9 (Summer 2005), pp. 102-113.

Tsing, Anna Lowenhaupt. *Friction: An Ethnography of Global Connection*. Princeton, NJ: Princeton University Press, 2005.

TT Club. *The Box: An Anthology Celebrating 50 Years of Containerisation.* London: TT Club, 2006 (orig. 1996).

Tuchman, Barbara W. *The Proud Tower: A Portrait of the World Before the War, 1890-1914.* New York: The Macmillan Company, 1966.

Twain, Mark, and Charles Dudley Warner. *The Gilded Age: A Tale of Today.* New York: Modern Library (Random House), 2006 (orig. 1873).

Union Pacific Railroad. "Union Pacific's Historic Sunset Route Importance Underscored as Traffic Booms" [news release]. (http://www.uprr.com/newsinfo/releases/capital_investment/2005/0630_sunset.shtml, accessed 2/5/11)

United Nations (Department of Economic and Social Affairs). *Physical Requirements of Transport Systems for Large Freight Containers.* New York: United Nations, 1973.

Urban Land Institute. *Just-in-Time Real Estate: How Trends in Logistics Are Driving Industrial Development.* Washington, D.C.: Urban Land Institute, 2004.

U.S. Army Transportation Museum. "History & Development of the Container" [website]. (http://www.transchool.eustis.army.mil/MUSEUM/CONEX.htm, accessed 6/8/08)

U.S. Department of Transportation (Federal Highway Administration). *The National Highway System: The Backbone of America's Intermodal Transportation Network.* Washington, D.C., October 1993. (Publication No. FHWA-PD-94-002)

U.S. Department of Transportation (Federal Highway Administration). *The National Highway System: The Backbone of America's Intermodal Transportation Network.* Washington, D.C., December 1993. ("Report to Congress on the Proposed National Highway System Required by Section 1006(a) of the Intermodal Surface Transportation Efficiency Act of 1991 Public Law 102-240")

U.S. Department of Transportation. *Comprehensive Truck Size and Weight Study, Final Report.* August 2000. (http://www.fhwa.dot.gov/reports/tswstudy/TSWfinal.htm, accessed 11/18/11)

U.S. Department of Transportation (Research and Innovative Technology Administration, Bureau of Transportation Statistics). *Freight in America: A New National Picture.* Washington, D.C., January 2006.

U.S. General Accounting Office. *Intermodal Freight Transportation: Combined Rail-Truck Service Offers Public Benefits, But Challenges Remain.* Washington, D.C., Report #GAO/RCED-93-16, 1992.

Van Den Burg, G. *Containerisation and Other Unit Transport* (rev. ed.). London: Hutchinson Benham, 1975.

Van Der Vleuten, Erik. "Infrastructures and Societal Change: A View from the Large Technical Systems Field." *Technology Analysis & Strategic Management,* Vol. 16, No. 3 (September 2004), pp. 395-414.

Van Der Vleuten, Erik. "Understanding Network Societies: Two Decades of Large Technical System Studies." In: Van Der Vleuten, Erik, and Arne Kaijser (eds.). *Networking Europe: Transnational Infrastructures and the Shaping of Europe, 1850-2000.* Sagamore Beach, MA: Science History Publications/USA (Watson Publishing International), 2006, pp. 279-314.

Van Der Vleuten, Erik, and Arne Kaijser (eds.). *Networking Europe: Transnational Infrastructures and the Shaping of Europe, 1850-2000.* Sagamore Beach, MA: Science History Publications/USA (Watson Publishing International), 2006.

van Ham, Hans, and Joan Rijsenbrij. *Development of Containerization: Success Through Vision, Drive and Technology.* Amsterdam: IOS Press, 2012.

Vandeveer, David. “Intermodal Rail Facility Design for the Next Century.” In: Transportation Research Board (National Research Council). *Intermodal Freight Terminal of the Future.* Transportation Research Circular, Washington, D.C., Number 459 (June 1996), pp. 88-98. (Papers from the National Conference on the Intermodal Freight Terminal of the Future, December 1994)

Vanterpool, Alan. *Silk Trains of North America* (pdf on the web). Edmonton, Canada: Alberta Pioneer Railway Association, 2010. (http://railwaymuseum.ab.ca/?q=node/49, accessed 2010, currently at http://www.albertarailwaymuseum.com/silk-trains-of-north-america.html).

Varnelis, Kazys (ed.). *The Infrastructural City: Networked Ecologies in Los Angeles.* Barcelona: Actar, 2009.

Voigtleander, Christian H. *Intermodal Freight Transportation – An Integrated Analysis of Strategy and Operations.* Thesis (M.S. Operations Research), Massachusetts Institute of Technology, 1994.

Waldheim, Charles, and Alan Berger. “Logistics Landscape.” *Landscape Journal,* Vol. 27, No. 2 (2008), pp. 219-246.

Wallin, Theodore Oscar. *The Development, Economics and Impact of Technological Change in Transportation: The Case of Containerization.* Dissertation, Cornell University, 1974.

Walton, Jon. “Tunneling Under Miami: Florida’s Port of Miami Tunnel Project.” *Construction Digital,* April 23, 2012. (http://www.constructiondigital.com/under_construction/tunneling-under-miami, accessed 5/7/12)

Ward, James A. *Railroads and the Character of America, 1820-1887.* Knoxville, TN: University of Tennessee Press, 1986.

Warren, David. “Breaking Free of Intermodal Gridlock.” *Area Development,* August/September 2006. (http://www.areadevelopment.com/logisticsInfrastructure/aug06/intermodalGridlock.shtml, accessed 9/1/07)

Warzecha, Monika. “Off the Rails.” Top 100: Canada’s Biggest Infrastructure Projects (www.top100projects.ca) [*ReNew Canada*], June 23, 2010. (http://top100projects.ca/tags/detroit-river-tunnel-project/, accessed 4/2/11)

Watson, Jonathan P., Arun Chatterjee, and David B. Clarke. “Safety Issues Involving Marine Containers on Chassis.” National Transportation Research Center, University Transportation Center, 2009. (http://ntl.bts.gov/lib/31000/31700/31704/U04-Safety_Issues_Involving_Marine_Containers_on_Chassis.pdf, accessed 12/27/11)

Watson, Julie. “1st Mexican Truck to Enter U.S. Interior Within Days.” *Yahoo! News [Associated Press],* October 19, 2011. (http://news.yahoo.com/1st-mexican-truck-enter-us-interior-within-days-184747565.html, accessed 10/19/11)

Watson, Rip. "Intermodal Projects Advance for Norfolk Southern Corp." *Transport Topics,* Iss. 3911 (September 6, 2010), pp. 8, 12.

Watson, Rip. "Fleets Find More Options to Use Intermodal Chassis." *Transport Topics,* Iss. 3928 (January 10, 2011), pp. 5, 27.

Watson, Rip. "Intermodal Carriers Feel Strain As Chassis Shortages Surface." *Transport Topics,* Iss. 3929 (January 17, 2011), pp. 1, 24.

Weber, Eugen. *Peasants into Frenchmen: The Modernization of Rural France, 1870-1914.* Stanford, CA: Stanford University Press, 1976.

Weikel, Dan. "Pollution Drop From Building Rail Yard Near L.A. Harbor Disputed." *Los Angeles Times,* October 21, 2012.

Weikel, Dan. "Council OKs Port Rail Yard But Lawsuit Is Threatened." *Los Angeles Times,* May 8, 2013.

Weldon, Foster L. "Cargo Containerization in the West Coast-Hawaiian Trade." *Operations Research,* Vol. 6, No. 5 (September-October 1958), pp. 649-670.

Wells, Christopher W. *Car Country: An Environmental History.* Seattle: University of Washington Press, 2012.

Welty, Gus. "TOFC/COFC Terminals: Key to Service and Growth [Piggyback Gets Set for Bigger Things]." *Railway Age,* Vol. 166, No. 19 (May 26, 1969), pp. 21-24, 40.

Welty, Gus. "TOFC/COFC Growth: The End Is Nowhere in Sight." *Railway Age,* Vol. 174, No. 10 (May 28, 1973), pp. 22-28, 32.

Welty, Gus. "SP's Entry for High Intermodal Stakes." *Railway Age,* Vol. 178, No. 21 (November 14, 1977), pp. 16-18.

Welty, Gus. "Intermodal: Evolution—and Revolution [Railroad Technology, Part VI]." *Railway Age,* Vol. 181, No. 14 (July 28, 1980), pp. 24-30.

Welty, Gus. "TOFC/COFC: It's a Growth Market Again." *Railway Age,* Vol. 182, No. 22 (November 30, 1981), pp. 22-25.

Welty, Gus. "Intermodal Terminals: The Tempo Quickens [High-Tech Railroading]." *Railway Age,* Vol. 186, No. 11 (November 1985), pp. 42-47.

Welty, Gus. "Truckers Are Some of Our Best Customers." *Railway Age,* Vol. 195, No. 4 (April 1994), pp. 33-38.

White, Adam J. "Infrastructure Policy: Lessons from American History." *The New Atlantis,* No. 35 (Spring 2012), pp. 3-31.

White, John H., Jr. "The Magic Box: Genesis of the Container." *Railroad History,* No. 158 (Spring 1988), pp. 72-93.

Whittaker, J. R. *Containerization* (2nd ed.). Washington, D.C.: Hemisphere Publishing (John Wiley & Sons), 1975.

Wikipedia. "Autorack." (http://en.wikipedia.org/wiki/Autorack, accessed 7/4/11).

Wikipedia. “Container Ship.” (http://en.wikipedia.org/wiki/Container_ship, accessed 4/18/12)

Wikipedia. “Containerization.” (http://en.wikipedia.org/wiki/Containerization, accessed 4/18/12)

Wikipedia. “Donner Pass.” (http://en.wikipedia.org/wiki/Donner_Pass, accessed 7/4/11)

Wikipedia. “Freight House (Kansas City, Missouri).” (http://en.wikipedia.org/wiki/Freight_House_(Kansas_City,_Missouri), accessed 9/26/12)

Wikipedia. “Freycinet gauge.” (http:// http://en.wikipedia.org/wiki/Freycinet_gauge, accessed 6/18/12)

Wikipedia. “Interstate 110 and State Route 110 (California).” (http://en.wikipedia.org/wiki/Interstate_110_and_State_Route_110_(California), accessed 10/29/11)

Wikipedia. “Interstate 710.” (http://en.wikipedia.org/wiki/Interstate_710, accessed 10/29/11)

Wikipedia. “Joliet, Illinois.” (http://en.wikipedia.org/wiki/Joliet,_Illinois, accessed 2/25/10)

Wikipedia. “Kansas City Southern Railway.” (http://en.wikipedia.org/wiki/Kansas_City_Southern, accessed 7/2/11).

Wikipedia. “Loading gauge.” (http://en.wikipedia.org/wiki/Loading_gauge, accessed 6/28/11).

Wikipedia. “Port of Miami Tunnel.” (http://en.wikipedia.org/wiki/Port_of_Miami_Tunnel, accessed 11/2/11)

Wikipedia. “Rochelle, Illinois.” (http://en.wikipedia.org/wiki/Rochelle,_Illinois, accessed 2/5/10)

Wikipedia. “Santa Fe Freight Depot.”

(http://en.wikipedia.org/wiki/Santa_Fe_Freight_Depot, accessed 2/28/12)

Wikipedia. “Superliner (railcar).” (http://en.wikipedia.org/wiki/Superliner_(railcar), accessed 7/4/11).

Wikipedia. “Track gauge.” (http://en.wikipedia.org/wiki/Track_gauge, accessed 6/28/11).

Wikipedia. “William F. Walsh Regional Transportation Center.” (http://en.wikipedia.org/wiki/Syracuse_(Amtrak_station), accessed 9/25/12)

Williams, John D. “Versatile Vans: Big Boxes Which Shed Wheels to Ride Trains Capture More Cargo.” *The Wall Street Journal,* August 14, 1963, pp. 1, 14.

Williams, Mason B. *City of Ambition: FDR, La Guardia, and the Making of Modern New York.* New York: W. W. Norton, 2013.

Williams, Rosalind. “Cultural Origins and Environmental Implications of Large Technological Systems.” *Science in Context*, Vol. 6, No. 2 (Autumn 1993), pp. 377-403.

Willis, Carol. *Form Follows Finance: Skyscrapers and Skylines in New York and Chicago.* New York: Princeton Architectural Press, 1995.

Winebrake, James J., and James J. Corbett. “Improving the Energy Efficiency and Environmental Performance of Goods Movement.” In: Sperling, Daniel, and James S. Cannon (eds.).

Climate and Transportation Solutions: Findings from the 2009 Asilomar Conference on Transportation and Energy Policy. Institute of Transportation Studies, University of California, Davis, Davis, CA, 2010, pp. 145-154.

Winner, Langdon. “Do Artifacts Have Politics?” *Daedalus*, Vol. 109, No. 1 (Winter 1980), pp. 121-136.

Wolmar, Christian. *Blood, Iron, and Gold: How the Railroads Transformed the World.* New York: PublicAffairs (Perseus Books Group), 2010.

Wolmar, Christian. *The Great Railway Revolution: The Epic Story of the American Railroad.* London: Atlantic Books, 2012.

Wood, Ellen Meiksins. *The Origin of Capitalism: A Longer View.* London: Verso, 2002 [orig. 1999].

Wood, Joseph S. “The Idea of a National Road.” In: Raitz, Karl (ed.). *The National Road.* Baltimore: The Johns Hopkins University Press, 1996, pp. 93-122.

Worden, William L. *Cargoes: Matson's First Century in the Pacific.* Honolulu, HI: University Press of Hawaii, 1981.

World Trade Ref website (World Trade Press). “Guide to Railcars.” (http://worldtraderef.com/wtr_site/rail_cars/guide_to_rail_cars.asp, accessed 7/4/11).

Young, David M. *The Iron Horse and the Windy City: How Railroads Shaped Chicago.* DeKalb, IL: Northern Illinois University Press, 2005.

YRC Freight [website]. “Semi-Trailer Dimensions.” (http://www.yrc.com/shippers/semi-trailer-dimensions.html, accessed 9/16/12)

Zimmer, Ronald N. “Designing Intermodal Terminals for Efficiency.” In: Transportation Research Board (National Research Council). *Intermodal Freight Terminal of the Future.* Transportation Research Circular, Washington, D.C., Number 459 (June 1996), pp. 99-109. (Papers from the National Conference on the Intermodal Freight Terminal of the Future, December 1994)