



TR News September-October 2006 The Intermodal Container Era: History, Security, and Trends

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TR NEWS

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The golden anniversaries of the Interstate Highway System and container shipping have made 2006 a special year for transportation. At the same time, a new wave of transportation innovation is gaining momentum through several initiatives, including a transformational and collaborative national strategy to solve the shortfall in transportation capacity and to move freight more reliably and efficiently, so that the transportation system continues to drive economic growth.

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COVER: View of the Port of Long Beach, California, from the upper structure of a new gantry crane on Pier J, showing containers on trucks, trains, and ships. The port handled more than 6.7 million containers in 2005. (Photo courtesy of the Port of Long Beach.)

TR NEWS

features articles on innovative and timely research and development activities in all modes of transportation. Brief news items of interest to the transportation community are also included, along with profiles of transportation professionals, meeting announcements, summaries of new publications, and news of Transportation Research Board activities.

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Containerization was an American innovation, proved in domestic trade by an American company, Sea-Land Service, Inc., before becoming a global revolution. To accomplish the complex and far-reaching task of securing world trade from outside threat, American leadership is needed again to drive the infrastructure and technology investments required for continued economic prosperity, this author maintains, presenting a blueprint for a layered, cooperative approach involving government and industry.

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Text and graphics courtesy of the Port of Tacoma

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Applying chip seal to preserve a highway surface.

The future of highway and transit finance—identified as a critical issue by the TRB Executive Committee—is the topic of a feature article reviewing current sources of revenue, the financing system, and the options ahead, in the November–December 2006 *TR News*. Other features examine the outsourcing of project delivery functions by state departments of transportation and present one state's successful model for a pavement preservation program, plus an initiative to improve road safety in developing countries and the latest on commuting in the United States.

THE INTERMODAL CONTAINER ERA

INTRODUCTION

Toward More Golden Anniversaries

Securing Transportation's Place in the National Policy Agenda

JEFFREY N. SHANE

2006 is a special year for transportation—a double golden anniversary. Two pivotal initiatives were launched 50 years ago. The first—the Interstate Highway Program—is the single largest public works project in history; it changed America forever. The second—containerized shipping—revolutionized international trade.

It is difficult to imagine the U.S. economy without the ribbons of concrete and asphalt, the bustling container ports, or the containerized movement of freight that have transformed commerce over the past half-century. The U.S. intermodal freight system—now seamlessly integrated into the global supply chain—underpins the nation's economic growth and prosperity.

The efficiencies engendered by the Interstate Highway System and by intermodal containerization expanded with the deregulation of transportation in the late 1970s and early 1980s. Trade liberalization and greater competition lowered prices, encouraged service innovations, and stimulated unprecedented levels of demand.

New Wave of Innovation

Today, however, the U.S. transportation system is looking more and more like the victim of its own success. Capacity constraints are making transportation less reliable and are imposing increased costs on shippers, consumers, and the environment. Many companies are maintaining inventory solely as a hedge against congestion. The important question, in celebrating the transformational innovations of a half-century ago, is whether the transportation community will have cause to celebrate a similar golden anniversary 50 years from now.

With the unprecedented amount of attention devoted to transportation policy today—and to freight policy in particular—the answer may well be yes. Thanks to a confluence of important initiatives, a new wave of transportation innovation is gaining momentum.

The author is Under Secretary for Policy, U.S. Department of Transportation.

First, informed by discussions at a freight industry roundtable convened by the Transportation Research Board with interested stakeholders, the U.S. Department of Transportation (U.S. DOT) has been crafting a national Freight Policy Framework for more than a year. The framework will provide a template for improved freight-related decision making at all levels of government and in industry.

Second, President Bush last year established a new, cabinet-level Committee on the Marine Transportation System, chaired by the Secretary of Transportation. The new committee gives maritime policy issues—including port infrastructure—more prominence in Washington, D.C., than they have had in many decades.

Third, a new Surface Transportation Policy and Revenue Commission, also chaired by the Secretary of Transportation, was convened recently in response to a mandate in the current surface transportation authorizing legislation, the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users. The commission will formulate important recommendations for the future funding and governance of surface transportation programs.

Fourth, U.S. DOT and the Federal Aviation Administration have been working for the past two years on a fundamental overhaul in the management of air traffic. The Next Generation Air Transportation System Initiative has the objective of accommodating three times the number of operations without any sacrifice of safety or reliability. Air freight will be a major beneficiary of this essential modernization.

Transformational Strategies

Finally, in May, U.S. DOT launched an overarching new National Strategy to Reduce Congestion on America's Transportation Network—the department's most important new undertaking in many years. The initiative identifies transportation congestion as a fundamental impediment to economic growth, declares it unacceptable, and furnishes a comprehensive blueprint for addressing it from all levels of government and from within the private sector.

Freight Transportation Industry Roundtable

Fostering a Dialogue with Federal Policy Makers

MICHAEL D. MEYER

At the request of the U.S. Department of Transportation (U.S. DOT), the Transportation Research Board (TRB) has convened a Freight Transportation Industry Roundtable, which held its first meeting in June 2005. The National Research Council of the National Academies, TRB's parent organization, appointed the roundtable members, including individuals from a variety of backgrounds—transportation providers, shippers, staff of state departments of transportation and port authorities, and other experts on logistics and transportation system planning.

The roundtable is designed to facilitate a dialogue between the freight industry and U.S. DOT on the challenges that the nation faces in supply chain logistics, and to enhance the department's understanding of the policy and the technical implications of logistics for the freight transportation system. The roundtable members discuss the department's approaches and initiatives that affect supply chain logistics in the United States.

The discussions have continued through a series of meetings, a public workshop, and a technical session at the 2006 TRB Annual Meeting, in parallel with U.S. DOT's development of a national freight policy framework, designed to target resources to key components of the nation's freight network. For example, the roundtable has discussed strategies for improving the operations of the freight network,

adding physical capacity at network bottlenecks, using road pricing to lower demand during peak periods, removing regulatory and other institutional barriers, maximizing the safety and security of the freight system, and mitigating and improving the management of the environmental, health, and community impacts of freight transportation.

The freight policy framework also addresses institutional responsibilities for the different types of investments identified. The roundtable has discussed strategies for financing freight-related infrastructure and services, appropriate performance measures for use at different levels of government and by different transportation providers to monitor and promote transportation system performance, and lessons learned from some of the major freight corridor projects in the United States.

Roundtables are one of many mechanisms that TRB employs to promote information exchange among transportation professionals. Because the focus of the roundtable is on exchanging information and fostering a dialogue among members and the sponsoring agency, no formal reports or products are planned.

The author, Professor in the School of Civil and Environmental Engineering, Georgia Institute of Technology, Atlanta, is Chair of the TRB Executive Committee.

(continued from previous page)

The national strategy is intended to be transformational. It is designed to focus the nation on the importance of finding solutions to the shortfall in transportation capacity, but in ways more appropriate to today's requirements than were the outdated, federal-centric models of the past. One of the key elements is a plan to target major freight bottlenecks and to focus greater attention on moving freight more reliably and efficiently. Pricing strategies, technology, and private-sector participation will be important in the solutions that emerge from this work.

The collaboration under the national strategy will inform and energize the work on each of the other initiatives. It also will engender a new national commitment to ensure that America's transportation system continues to drive economic growth. If the momentum is maintained, it may not be too much to hope that 50 years from now, the transportation community will remember that 2006 was the year that transportation took its rightful place in the national policy agenda.

EDITOR'S NOTE: Appreciation is expressed to Christina S. Casgar, Office of Freight and Logistics, U.S. DOT, and chair of the TRB Freight Systems Group, and to Joedy Cambridge, Senior Program Officer, TRB, for their efforts in developing this issue of *TR News*.

Freight Cooperative Research Program Ready for Delivery

In response to the growing freight-movement demands placed on the U.S. transportation system, the U.S. DOT Research and Innovative Technology Administration (RITA) has established the National Cooperative Freight Research Program (NCFRP) to carry out applied research on problems facing the freight industry that have not been adequately addressed by other research programs.

NCFRP's research agenda will be determined by an oversight committee, appointed by the National Research Council of the National Academies. The Transportation Research Board (TRB) will serve as program manager and secretariat for the oversight committee, with RITA as the program sponsor.

With funding of approximately \$2.7 million per year expected in Fiscal Years 2006 through 2009, NCFRP will work to produce a series of reports and other products, with primary emphasis on disseminating results to freight transportation professionals. The cooperating parties have executed a memorandum of agreement, and in September U.S. DOT authorized TRB to start up the program.

THE
**INTERMODAL
 CONTAINER ERA**

THE CONTAINERSHIP REVOLUTION

Malcom McLean's 1956 Innovation Goes Global

BRIAN J. CUDAHY



Photo: Maersk Line Ltd.

*The author is a transportation and maritime historian whose books include the recent *Box Boats*, as well as *Around Manhattan Island: And Other Maritime Tales of New York* and *A Century of Subways: Celebrating 100 Years of New York's Underground Railways*. He is a director of the *Steamship Historical Society of America* and lives in Bluffton, South Carolina.*

Photo above: Originator, pioneer, and leader of the multimodal container revolution Malcom McLean surveys containers on a containership pier.

Browsing through a general-purpose bookshop section on “Transport by Sea” would lead to titles on the stately passenger liners of yesteryear, old-fashioned paddle-wheel steamboats, luxury cruise ships, and warships of every shape and size. Few, if any, volumes would cover the seagoing merchant vessels that exercise enormous influence on the national economy—cargo ships.

Overseas trade has assumed unimaginable proportions in the past half century. Although some commodities are transported most readily by air, and some high-value cargo such as software can travel from continent to continent electronically, the great bulk of world trade is carried across the seven seas by cargo ships.

Many commodities are transported in bulk, and specialized vessels have been developed to accommodate this trade. Fleets of giant tankers move petroleum products from producers to consumers, and similar vessels carry such diverse cargo as cement, coal, and grain. The automobile industry has developed the car carrier, a unique vessel that allows vehicles to be driven on and off the ship, and other kinds of large and high-value commodities typically travel on flatbed trailers aboard similar roll on–roll off vessels.

Just about everything else—from boxes of crayons to crates of cereal, television sets to garden tools, model railroad trains to baseball gloves, men’s shirts to women’s shoes—travels across the sea from factory to market aboard fleets of huge containerships. These vessels have played a critical role in allowing the world’s economy to assume global dimensions.

A Vision Takes Shape

To understand how and why the modern containership evolved, turn back the calendar to Thanksgiving week in the prewar year of 1937. The owner of a small trucking firm in North Carolina had ventured north to New York harbor with bales of export cotton to be loaded aboard a ship bound for Istanbul.¹ The man grew irritated when he had to wait for days while longshoremen slowly loaded cargo aboard the vessel.

In those days, a cargo ship typically would spend as much time in port being loaded and unloaded as it did sailing the seven seas. Cargo included a bewil-

¹ McLean often identified the site as Hoboken, New Jersey, but freight bound for Istanbul was more likely to leave from the foot of Exchange Place in Jersey City. American Export Line’s *Examelia* was loaded there in November 1937 for a transatlantic voyage to Istanbul and other Mediterranean ports.



dering variety of merchandise that had to be hoisted aboard ship in small lots and then painstakingly stowed in the hold in a manner that would forestall damage during the ocean journey. The operation was time-consuming and labor-intensive.

Furthermore, because of the uncertainties of steamship schedules, outbound cargo often was delivered to a pier days and even weeks ahead of the presumed sailing date, increasing the chance of damage, loss, and pilferage. One steamship executive suggested that it cost his company more to move cargo 1,000 feet from the street in front of a pier into the hold of a moored ship than it did to transport the cargo thousands of miles across a hostile ocean.

The North Carolina truck driver often said to anyone who would listen, “There has to be a better way than loading cargo aboard ship piece by piece. Why couldn’t an entire truck be hoisted aboard ship, for instance, and then used for delivery purposes at the other end of the line?” The frustrated trucker had begun to think about the implications of intermodalism, a word that in 1937 was decades away from being coined.

That man was Malcom McLean, and his North Carolina-based trucking company would grow into one of the nation’s premier over-the-road cargo operations, McLean Trucking. McLean, however, kept thinking about his experience in 1937 and the inherent limitations of loading cargo aboard ship. On a rainy April Thursday in 1956, he did something about it.

The First Containerships

A vessel bearing the unusual name *Ideal X* was a run-of-the-mill T-2 tanker, similar to countless others that moved petroleum from the Texas oil fields to northern refineries. But when *Ideal X* cast off from Berth 24 at the foot of Marsh Street in Port Newark, New Jersey, on April 26, 1956, and set a course for Houston, Texas, it was more than another tanker heading south in ballast to pick up additional product.

Installed above the vessel’s main deck was a special spar deck—a raised platform or porch—with longitudinal slots to which were attached the bodies of 58 trailer trucks. These were not trucks in any conventional sense—the 58 units had been detached from their running gear on the pier and had become *containers*.

Arriving in Houston six days later, the 58 trailers were hoisted off *Ideal X*, attached to fresh running gear, and delivered to their intended destinations with no intermediate handling by longshoremen. McLean had orchestrated a pioneering voyage.

In preparation, he had acquired a small steamship

company in early 1955 to convert into an adjunct of his trucking enterprise. Based in Mobile, Alabama, the Pan Atlantic Steamship Company was founded in 1933 and was a subsidiary of the Waterman Steamship Company. McLean soon acquired the parent company also, although Waterman eventually would move out of McLean’s control and resume an independent identity. Pan Atlantic, however, would evolve into what many knowledgeable maritime observers would call the most important and most successful deepwater steamship company to operate as part of the U.S. Merchant Marine.

Sea-Land Service

In 1960, McLean hauled down the blue-and-white Pan Atlantic house flag and renamed his maritime venture Sea-Land Service. Although *Ideal X* and three other converted T-2 tankers that entered Pan Atlantic service in 1956 are often called the world’s first successful containerships, the basic design features that characterize the modern containership were not introduced until 1957.

Design Innovations

On October 4, 1957, the Soviet Union launched Sputnik I, the world’s first earth-orbiting satellite. On that same day, the Pan Atlantic ship *Gateway City* steamed away from Port Newark and headed south to Miami, then on to Houston. *Ideal X* had transported containers that were individually attached to a flat spar deck, but *Gateway City*, a World War II cargo ship identified as a C-2 Class vessel, had been thoroughly rebuilt to stack containers one atop another in below-deck racks and to haul additional



Typical containership with container-carrying holds between the deckhouse and bow, and space for additional containers to be stacked aft of the deckhouse.

units stacked atop each other as deck cargo. The 524-foot *Ideal X* could handle 58 trailers, but the 450-foot *Gateway City* could accommodate 226.

In many respects, the voyage of *Gateway City* signaled the onset of the contemporary containership era. Five sister ships soon joined the 1957 pioneer in McLean's fleet, and the spar deck tankers of 1956 were retired.

All manner of older cargo ships were converted into exclusive container carriers, and Sea-Land quickly developed a basic design feature of contemporary containerships—a deck house located well to the stern of the ship, a large open area with container-carrying holds between the deck house and bow, and room for additional containers aft of the deck house.

Expansion and Competition

McLean expanded his waterborne operations to Puerto Rico in 1958, to the West Coast via the Panama Canal in 1962, and north to Alaska that same year. In the meantime, other U.S.-flag steamship companies began to explore the opportunities of containerization. Matson Navigation Company inaugurated container service between California and the Hawaiian Islands in 1958, and Grace Line put its first containerships into service between New York and Venezuela in 1960.

Nevertheless, many of the more traditional ocean-going steamship operators—in particular, important European companies such as Holland America and Cunard—regarded containerization as appropriate only for select domestic niche markets. To them, the innovation had no place along such classic international trade routes as the North Atlantic.

After April 1966, however, the companies held that view at their own corporate peril. Sea-Land's *Fairland*, a converted C-2 cargo vessel and a sister ship of *Gateway City*, left Port Newark for the Channel ports of Europe. More than the pioneering container voyages of 1956 and 1957, *Fairland's* North Atlantic crossing signaled the demise of the conventional cargo ship and of the lengthy stays in port to load and unload cargo.

Advantages and Adaptations

The containership offered important advantages to both shipper and steamship operator. Freight was securely loaded aboard a trailer at the shipper's factory, its doors sealed, and the consignment dispatched to a nearby port city. There the cargo remained secure while awaiting the ship that would transport it across the sea. Furthermore, because the containers were hoisted on and off ship by swift gantry cranes, stays in port that once were mea-



PHOTO: MAERSK LINE, LTD.

Gantry cranes have made the loading and unloading of containerized cargo speedy and efficient.

sured in days and weeks were reduced to hours. The shipper benefited from decreases in pilferage and damage, and the operator gained more efficient and effective use of ships and maritime personnel.

Many critical challenges arose along the way. How the trucking and maritime industries developed a set of standards for the design of containers and associated hardware such as gantry cranes is a story in itself. Organized labor had to be convinced that waterfront workers would face a better and more secure future by thinning the ranks to take advantage of the efficiencies of containerization.

Another part of the containership saga is the reconfiguring of port facilities around the world to handle inbound and outbound containers efficiently. The covered piers and storage sheds that protected cargo from the weather before hoisting aboard ship were replaced by large open tracts of land, where teamsters could position trailers to move on and off the ship via huge gantry cranes. In the wake of *Fairland's* transatlantic voyage of 1966, replacing conventional cargo ships with new container-carrying tonnage became the goal.

Reaching Southeast Asia

McLean's Sea-Land Service remained the pacesetter of the containership industry, and the company continued to expand its fleet of U.S.-flag vessels and to open up new services. In the late 1960s McLean was able to tap an interesting market—moving supplies to and from South Viet Nam for the U.S. military.

McLean convinced the military that containerization could solve many troublesome problems associated with maintaining an effective chain of supply. McLean and his representatives made the case that waterfront theft from conventional cargo ships in Viet Nam was so serious that a hefty percentage of inbound material was winding up in enemy hands. Just as containerization was able to reduce dockside pilferage in U.S. ports, so too it could thwart efforts by Viet Cong sympathizers to steal war material intended for U.S. soldiers.



PHOTO: U.S. DEPARTMENT OF DEFENSE

Supplying the U.S. military forces in Viet Nam demonstrated not only the versatility and efficiency but also the security of containerized cargo.

McLean also was aware that a considerable portion of traditional manufacturing was shifting from North America to Asia. Because vessels bound for Viet Nam were returning to North America largely empty, McLean established a triangular trade from the West Coast to Viet Nam with war supplies, from Viet Nam to Japan and Hong Kong empty, and then back across the Pacific with commercial cargo from Asia to North America. When transpacific trade assumed an important role in Sea-Land operations, McLean teamed up with Southern Pacific Railroad to develop the first double-stack freight car for carrying containers inland from West Coast ports.

The implications and impacts of the Viet Nam War continue to be debated. Nevertheless, the transpacific logistical supply line that was established in support of the war provided another dramatic example of the efficiencies of containerships.

The Magnificent SL-7s

In 1972, Sea-Land took delivery of eight new containerships with extraordinary specifications—ships that would be fast enough to cut full days from the transatlantic and transpacific crossing times. Two different European yards turned out the SL-7 Class.²

The eight SL-7s that joined the Sea-Land fleet could maintain 33 knots—10 to 15 knots faster than any other cargo ship then in service. The superliner SS *United States* may have wrested the transatlantic speed record from the *Queen Mary* in 1952, but the *Sea-Land Exchange*, one of the SL-7s, crossed the North Atlantic in August 1973 at 34.92 knots, only 0.97 knots slower than the *United States*. Another SL-7, *Sea-Land Commerce*, is the all-time speed champion in the transpacific merchant trade.

In addition to being fast, the SL-7s also were the world's largest containerships at the time. *Gateway City* and the other converted C-2 cargo ships of 1957 could accommodate 226 trailers each. Each SL-7 was able to carry more than 1,000 containers.

² Foreign-built cargo ships may sail under the U.S. flag but are prohibited by the 1920 Jones Act from engaging in trade between U.S. ports.



McLean worked with Southern Pacific Railroad to develop the double-stack freight car.



PHOTO: McLEAN FOUNDATION

SL-7 Class containership *Sea-Land Galloway* under construction in a West German shipyard. One of the fastest cargo ships ever built, it was purchased by the U.S. Navy in 1981 and converted to a Fast Sealift Ship, USNS *Antares*, for carrying vehicles.

Containerships typically are compared in terms of carrying capacity. Because a 20-foot container is the smallest in common use, vessels are measured in TEUs, trailer-equivalent units or 20-foot-equivalent units. A 1,000-TEU containership therefore can accommodate 1,000 20-foot containers or 500 40-foot containers. Sea-Land was something of a renegade, employing a large fleet of 35-foot units, which made precise comparisons difficult, although the company soon shifted to more conventional trailers. As built, an SL-7 could accommodate 896 35-foot containers plus an additional 400 TEUs.

The new fleet proved to have a liability. To maintain the design speed of 33 knots, the boilers that generated steam to drive the dual turbine engines burned an extraordinary quantity of fuel. At pre-1972 price levels, this would not have been a problem, but 1973 brought the first of several worldwide petroleum crises that caused the price of petroleum to increase at an unprecedented rate.

The company throttled back its fleet to conserve fuel, and the eight vessels became a luxury that a commercial operator could not afford. The company sold off its prize vessels to the U.S. Navy in 1981 and 1982, and they remain in service for the Department of Defense as T-AKR Class fast supply ships.

Parting Company

Following the advent of the SL-7 in 1972, Sea-Land Service began an interesting corporate evolution. McLean had sold controlling interest in the line to R.J. Reynolds in 1969 to gain the investment capital to move the SL-7 into production. Several years later he severed his ties with the company.

McLean later acquired United States Lines and returned to the containership industry. But new and different currents were affecting the maritime indus-

try, and much of the U.S. Merchant Marine faced the same kind of outsourcing and shifting to offshore operations that were prevalent in many other commercial sectors. In 1999, after a short period of ownership by the CSX Corporation, Sea-Land Service, *nee* the Pan Atlantic Steamship Company, was sold to a Danish conglomerate, the A.P. Moeller Group, and the world's pioneer containership operation was absorbed into the Maersk Line, the largest containership fleet in the world.

Extraordinary Evolution

The economies of scale that motivated Sea-Land and McLean to build ever-larger containerships continue to prevail in the now-global industry. On April 26, 2006, the 50th anniversary of the departure of *Ideal X* from Port Newark with a capacity load of 56 trailers, containerships in service under operators such as Hapag-Lloyd and the Mediterranean Shipping Company had passed 9,000 TEUs, with 10,000-TEU vessels certain to follow.

The first 50 years of the containership era can be viewed through different prisms. Naval architects and merchant seamen may concentrate on the extraordinary evolution of containership design that has progressed from the converted T-2 tanker *Ideal X* and the C-2 cargo ship *Gateway City* to vessels with capacities approaching 10,000 TEUs. Shippers may marvel at the wonders of “just in time” chains of international delivery that bring products to market with extraordinary efficiency. Transportation planners may grow exasperated as they seek to develop more seamless links between seaports, highways, and railways, and port officials may wonder how they will find the resources to adapt their harbors for the ever-larger containerships. Economists and political scientists may continue to measure and assess the implications of a global economy in which the clothes and backpacks worn by youngsters heading to school in Middle America were manufactured in factories in the Far East and transported across the Pacific aboard containerships that fly flags of many countries, but rarely that of the United States.



The Hapag-Lloyd containership *Essen Express* bringing a load of containers into Savannah Harbor, Georgia.

Photo: Brian Cudahy

McLean Container Center Established

A group of shipping industry leaders associated with intermodal container pioneer Malcom McLean and the early development of containerization have established the McLean Container Center to collect and preserve records, photographs, and other items documenting the history of containerization. The American Maritime Museum and Bland Library at the U.S. Merchant Marine Academy, Kings Point, New York, will house and maintain the collection, which will be available to historians, researchers, students, and the public.

The center also is intended to serve as a resource and catalyst for the advancement of containerization technology, notes Paul F. Richardson, who chairs the board of directors.

“Malcom McLean was a leading transportation innovator of the 20th century, and all of our board members had the honor of knowing him,” Richardson adds. “It is important to compile as complete and accurate a historical account of containerization and its far-reaching effects as possible. The U.S. Merchant Marine Academy at Kings Point is the ideal location for the center.”

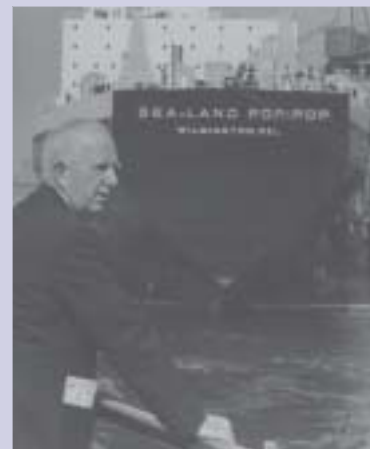


Photo: McLean Foundation

McLean at a West German shipyard in 1972 for the launching of the SL-7 containership *Sea-Land* McLean—temporarily identified by his grandchildren's nickname for him, “Pop-Pop.”

One can only wonder how things might have turned out if longshoremen in Jersey City had managed to unload a truckload of cotton with greater dispatch during Thanksgiving week of 1937 and sent a trucker home to North Carolina with nary a frustration.

Additional Resources

Brooks, Mary R. *Sea Change in Liner Shipping: Regulation and Managerial Decision-Making in a Global Industry*. Pergamon Press, Oxford, 2000. [Discussion of the economics of the unusual cooperative activities that prevail in the maritime sector.]

Containerization Oral History Collection: 1999–2000. National Museum of American History, Washington, D.C. [Written transcripts of conversations conducted by Arthur Donovan with important individuals in the industry.]

Cudahy, Brian J. *Box Boats: How Container Ships Changed the World*. Fordham University Press, Bronx, New York, 2006. [A concise history of world shipping—from freighter types to steamship lines—focusing on the growth of global trade carried by box boats.]

Pollak, Richard. *Colombo Bay*. Simon & Schuster, New York, 2004. [First-person account of a trip between Hong Kong and New York aboard a contemporary containership.]

THE
**INTERMODAL
 CONTAINER ERA**

CONTAINER SHIPPING AND THE ECONOMY

Stimulating Trade and Transformations Worldwide

MARC LEVINSON

The author, an economist, has been finance and economics editor of the Economist. He is the author of the recently released book, The Box: How the Shipping Container Made the World Smaller and the World Economy Bigger, published by Princeton University Press (see page 33).

This article was excerpted from The Box with material added for TR News by Anne Marie Kappel, Vice President, World Shipping Council, Washington, D.C. (www.worldshipping.org). The book excerpts are copyrighted by Princeton University Press and are used with permission.

Aerial view of Pier 400, in the Port of Los Angeles. The largest proprietary container terminal in the world, the 484-acre Maersk Pacific Ltd. project took more than 8 years to complete at a total construction value of more than \$400 million.

What is it about the container that is so important? Surely not the thing itself. A soulless aluminum or steel box held together with welds and rivets, with a wooden floor and two enormous doors at one end, the standard container has all the romance of a tin can.

The value of this utilitarian object lies not in what it is, but in how it is used. The container is at the core of a highly automated system for moving goods from anywhere to anywhere, with a minimum of cost and complication. The container made shipping cheap and changed the shape of the world economy.

Economic Effects

Sleepy harbors such as Busan in South Korea and Seattle moved into the front ranks of the world's ports, and massive new ports were built in places where none had been before, like Felixstowe in England and Tanjung Pelepas in Malaysia. Poor countries, desperate to climb the rungs of the ladder of economic development, could dream realistically of

becoming suppliers to wealthy countries far away. Huge industrial complexes mushroomed in places like Los Angeles and Hong Kong, because the cost of bringing raw materials in and sending finished goods out had dropped drastically (1).

Shipping costs no longer sheltered producers whose advantage was proximity to the customers—even with customs duties and time delays, factories in Malaysia could deliver blouses to Macy's in Herald Square more cheaply than could blouse manufacturers in the lofts of New York's garment district. Multinational manufacturers—companies with plants in different countries—transformed into international manufacturers, integrating once-isolated factories into networks so that they could choose the cheapest location for making a particular item yet still shift production from one place to another as costs or exchange rates might dictate.

In 1956, the year the container was introduced, the world was full of small manufacturers selling locally. By the end of the 20th century, purely local markets for goods of any sort were few and far between.



PHOTO: PORT OF LOS ANGELES

As Secretary of Transportation Norman Y. Mineta pointed out in his farewell remarks to the U.S. Chamber of Commerce on July 6, “The modern economy—and by extension, our transportation system—is global in nature.... Today, international trade is propelling the American economy—and the world economy—in ways previously unimaginable.”

Consumers enjoy infinitely more choices thanks to the global trade the container has stimulated. By one careful study, the United States imported four times as many varieties of goods in 2002 as in 1972, generating a consumer benefit—not counted in official statistics—equal to nearly 3 percent of the entire economy. The competition that came with increased trade has diffused new products with remarkable speed and has held down prices so that average households can partake.

The ready availability of inexpensive imported consumer goods has boosted living standards around the world (2). For workers, this has been a mixed blessing. Low shipping costs helped make capital even more mobile, making the wages for less mobile factory workers in the United States and Europe depend on the pay and productivity of their counterparts in Asia. Yet the emergence of the logistics industry in the quest for more effective supply chain management has led to the creation of new and often better-paying jobs in warehousing and transportation.

Containerport Efficiencies

A modern containerport is a factory whose scale strains the limits of the imagination. Every day at every major port, thousands of containers arrive and depart by truck and train. Loaded trucks stream through the gates, where scanners read the unique number on each container and computers compare it against ships’ manifests before the trucker is told where to deliver the load. Tractor units arrive to hook up chassis and haul away containers that have just come off the ship.

Trains carrying double-stacked containers roll into an intermodal terminal near the dock, where giant cranes straddle the train to remove one container after another. Outbound container trains, destined for a rail yard 2,000 miles away with only the briefest of stops en route, are assembled on the same tracks and loaded by the same cranes.

The result of all this activity is a nearly seamless system for shipping freight around the world. A 15-ton container of coffee makers can leave a factory in Malaysia, be loaded aboard a ship, and cover the 9,000 miles to Los Angeles in 16 days. A day later, the container is on a unit train to Chicago, where it is transferred immediately to a truck headed for

Cincinnati. The 11,000-mile trip from the factory gate to the Ohio warehouse can take as little as 22 days, a rate of 500 miles per day, at a cost lower than that of a single first-class air ticket.

Historic Costs

How much the container matters to the world economy—and therefore to the U.S. economy—is impossible to quantify. How much did it cost to send 1,000 men’s shirts from Bangkok to Chicago in 1955, and how did that cost change as containerization came into use? The data do not exist, but clearly the container reduced the cost of moving freight.

In 1961, before the container was in international use, ocean freight costs accounted for 12 percent of the value of U.S. exports and 10 percent of the value of U.S. imports. According to the staff of the Joint Economic Committee of Congress, “these costs are more significant in many cases than governmental trade barriers,” noting that the average U.S. import tariff was 7 percent (3).

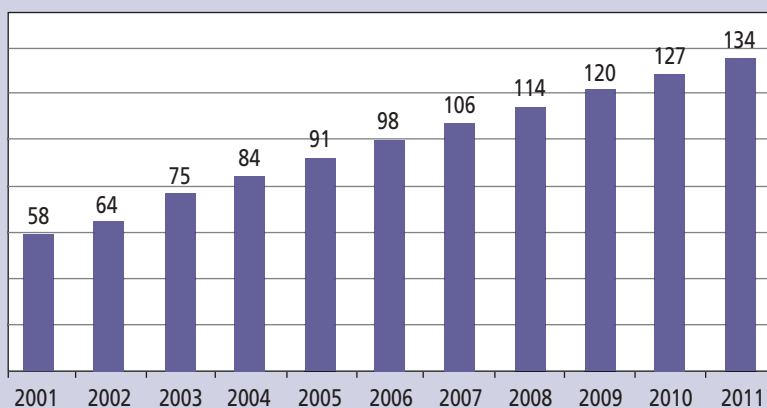
This process was so expensive that in many cases selling international was not worthwhile. “For some commodities, the freight may be as much as 25 percent of the cost of the product,” two engineers concluded after a careful study of data from 1959 (4). Shipping steel pipe from New York to Brazil cost an average of \$57 per ton in 1962 or 13 percent of the average cost of the pipe—not includ-



The Port of Seattle, Washington, has revived and thrived with containerized trade.

Global Containerized Trade, 2001 to 2011 (Forecast), in Million TEU

According to data from Global Insight, Inc., global containerized trade has grown at a compound annual rate of 12 percent from 2001 to 2005. The forecast growth rate for the period 2005 to 2011 is 6.5 percent. In 2011, global containerized trade is forecast to reach 134 million TEU, 2.3 times as much as the 58 million TEU recorded in 2001. The data represent maritime trade in fully loaded containers, not port throughput or the movement of full and empty containers.



Source: Global Insight, Inc. World Trade Service



A container is transloaded in the Port of Amsterdam, Netherlands.

ing the cost of moving the pipe from the steel mill to the dock (3). No wonder that, relative to the size of the economy, U.S. international trade was smaller in 1960 than it had been in 1950, or even in the Depression year of 1930 (5). The cost of conducting trade had risen so high that in many cases trade made no sense.

By far the biggest expense in the process was shifting the cargo from land transport to ship at the port of departure and then moving it back to truck or train at the other end of the ocean voyage (see table, below). As one expert explained, “A 4,000-mile voyage for a shipment might consume 50 percent of its costs in covering just the two 10-mile movements through two ports.”

The container first affected these costs. The elimination of piece-by-piece freight handling brought lower expenses for longshore labor, insurance, pier rental, and the like. Containers were quickly adopted for land transportation, and the reduction in loading time and transshipment cost lowered rates for goods that moved entirely by land. As ship lines built huge vessels designed to handle containers, ocean freight rates plummeted. As container shipping became intermodal, with a seamless shifting of containers among ships, trucks, and trains, goods could move in a never-ending stream from Asian factories directly to the stockrooms of retail stores in North America or Europe, making the overall cost of transporting goods little more than a footnote in a company’s cost analysis (6).

Time Dimensions

Transport efficiencies, however, hardly begin to capture the economic impact of containerization. The container not only lowered freight bills but saved time. Quicker handling and less time in storage translated to faster transit from manufacturer to customer, reducing the costs of financing inventories that could sit unproductively on railway sidings or in pierside warehouses awaiting a ship.

Combined with the computer, the container

made it practical for companies like Toyota and Honda to develop just-in-time manufacturing, in which a supplier makes the goods its customer wants only as the customer needs them and then ships them, in containers, to arrive at a specified time. Such precision, unimaginable before the container, has led to massive reductions in manufacturers’ inventories and correspondingly huge cost savings. Retailers have applied these same lessons, using careful logistics management to squeeze out billions of dollars in costs.

Global Effects

In 1966, in the decade after the container first came into international use, the volume of international trade in manufactured goods grew more than twice as fast as the volume of global manufacturing production, and two-and-a-half times as fast as global economic output. Something was accelerating the growth of trade even though economic expansion was weak. Something was driving a vast increase in international commerce in manufactured goods even though oil shocks were making the world economy sluggish.

Attributing the vast changes in the world economy to a single cause would be foolhardy, but the possibility should not be dismissed that the sharp drop in freight costs from the introduction of container shipping played a major role in increasing the integration of the global economy (7, 8).

References

1. Erie, S. P. *Globalizing L.A.: Trade, Infrastructure, and Regional Development*. Stanford University Press, Palo Alto, California, 2004.
2. Broda, C., and D. E. Weinstein. *Globalization and the Gains from Variety*. Working Paper 10314, National Bureau of Economic Research, Cambridge, Massachusetts, February 2004.
3. Joint Economic Committee, U.S. Congress. *Discriminatory Ocean Freight Rates and the Balance of Payments*. Washington, D.C., 1964.
4. MacMillan, D. C., and T. B. Westfall. Competitive General Cargo Ships. *Transactions of the Society of Naval Architects and Marine Engineers*, 68, 1970, p. 843. 5.
5. *Historical Statistics of the United States*. Bureau of the Census, Washington, D.C., 1975, p. 887.
6. Eyre, J. L. Shipping Containers in the Americas. In *Recent Developments in the Use and Handling of Unitized Cargoes*. Pan American Union, Washington, D.C., 1964.
7. Krugman, P. *Growing World Trade: Causes and Consequences*. Brookings Papers on Economic Activity 1995, No. 1, 1995, p. 341.
8. *World Trade Report 2004*. World Trade Organization, Geneva, 2005, pp. 114–129

Cost of Shipping One Truckload of Medicine from Chicago to Nancy, France (Estimates, 1960)

	Cash Outlay	Percent of Cost
Freight to U.S. port city	\$ 341	14.3
Local freight in port vicinity	\$ 95	4.0
Total port cost	\$1,163	48.7
Ocean shipping	\$ 581	24.4
European inland freight	\$ 206	8.6
Total	\$2,386	

Source: American Association of Port Authorities (6).

THE
**INTERMODAL
 CONTAINER ERA**

The 40-Foot CONTAINER

Industry Standard Faces Challenges and Change

RON KATIMS



PHOTO: NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Containers await transfer in the marshalling yard at Port Elizabeth, New Jersey.

The author, a consultant who works on port projects in the United States, South America, Asia, and Europe, has more than 40 years of experience in the maritime industry. He was president of the shipping firm Navieras—NPR and Vice President of Engineering for Sea-Land Service, overseeing the development of facilities, containers, and handling equipment, as well as related research. He recently was appointed to the new Crowley Chair in Logistics and Transportation at the U.S. Merchant Marine Academy, Kings Point, New York.

Are the days of the 40-foot container as the standard unit in international trade coming to an end? In the early 1960s, when containerization was still new, American and international standards committees held many meetings to develop and formalize the basic criteria to enable containers and cargo to move safely and efficiently between transportation modes and users. Standards were to be developed for specifications—including container sizes, geometry, and strength—as well as corner castings, testing, and markings. The meetings were intense, because substantial investments would be made based on the resulting voluntary industry standards.

A range of committees studied in detail the technical needs across all modes of surface transportation, examined international problems such as customs and security, and considered the future of shipping. The selection of a standard length for containers therefore should have developed from the data that were presented and from knowledge of cargo-density relationships, compatibility with pallet and packaging standards, and current and projected regulatory criteria.

Instead, the length selection was based on a simplistic building-block concept proposed by engineers from influential steel and aluminum industry suppliers. At meeting after meeting, many times as chairs, the materials industry representatives repeated the principle: “Two 10s make a 20, two 20s make a 40.”

The International Organization for Standardization (ISO) accepted this premise and adopted as standards the 10-, 20-, 30-, and 40-foot length selections—although few 10- or 30-foot units were constructed. The industry then started to invest in containers with dimensions that had been selected arbitrarily, without consideration of transportation economics or projections of the industry’s future.

Costly Choices

The choice has cost the transportation industry billions of dollars in increased operating costs and loss of cargo-carrying capacity. In the past 50 years, shippers seeking compatibility and interchangeability have made huge investments to comply with the ISO standards. Any change to the basic length of containers would send to the scrap heap mil-



PHOTO COURTESY OF PACER STACKTRAIN

Highly productive 53-foot container units, common in U.S. domestic freight, are double-stacked on specially designed rail cars, enabling twice as much freight to be carried with marginal increases in cost.

lions on millions of containership tonnage and would make billions of dollars of equipment and infrastructure throughout the world useless or inefficient.

At the same time, ISO set the standard for the outside dimensions of containers at 8 feet or 8 feet 6 inches high by 8 feet wide. This decision also negatively affected the carrying capacity of containers. Only a few 8-foot-high containers were built—for the U.S. military—because even before the dimension was adopted, companies had realized that a higher unit would be a better fit for the developing systems. Today most newly constructed containers are 9 feet 6 inches high, and some units are 8 feet 6 inches wide.

The domestic container currently in widespread use in the United States is 53 feet long, 9 feet 6 inches high, and 8 feet 6 inches wide, with an internal capacity of 3,850 cubic feet. The ISO standard 40-foot unit is 8 feet 6 inches high and has an internal capacity of 2,390 cubic feet. Additional cubic capacity translates into sizable cost-efficiencies.

Sample Cost Breakdown

To quantify the operational savings that a larger unit offers, consider a typical move of a full container of freight from a plant in Chicago to a warehouse in Ponce, Puerto Rico. Industry experience would project the total cost of this intermodal move as approximately \$3,000, including \$250 in sales and administrative expenses.

First a trucker picks up the full shipment at the end of the manufacturing line in Chicago and moves the container across town to a railhead. This costs \$150.

There it is loaded on a train for shipment to a port—in this example, to Elizabeth, New Jersey. The rail cost, including lifting onto the rail car, is \$700.

On arrival in Elizabeth, the container is offloaded in the port, trucked to a terminal, and stored in a marshalling yard until the vessel is ready for loading. The total cost for offloading from the train, for processing and yard-holding, and for stevedoring onto the vessel is \$500.

Already \$1,350 has been spent on land before the container is ready to sail. If 60 percent more cargo is stowed in each container, the savings are approximately \$800 per move. With 12 million containers projected to move through the ports of the United States annually, the savings can total \$10 billion a year.

The vessel costs are \$600 per container for the move from Elizabeth to the port of San Juan. The cubic capacity of vessels does not materially change according to the size of containers stowed on board, although some cubic space may be gained on a 40-foot configured vessel if oversize units are stowed on deck. Once the vessel arrives, the stevedoring and truck delivery from San Juan to the Ponce warehouse cost \$800; a larger container would have saved \$480.

Shippers prefer to move cargos in the larger units, because one lift or one road or rail move can handle more freight. On the typical move described from Chicago to Ponce, using a larger container translates into a savings of at least \$1,280 per shipment. With 350,000 units yearly, the potential savings only in the domestic United States–Puerto Rico trade could exceed half a billion dollars. Worldwide, the savings would be staggering.

Back-Haul Considerations

The handling of back-haul cargos presents another opportunity for savings. After the container in the example is unloaded in Ponce, the shipping line looks to carry the container back to the United States loaded with cargo. Because of the imbalance of United States–Puerto Rico trade, most of the containers return empty. Back-haul cargos from Puerto Rico consist mostly of manufactured goods or agricultural products, which are moved more efficiently in a larger container because of their weight-to-cubic-space ratio.

When the empty containers arrive at ports in the United States, the operators solicit cargos mov-

ing inland. This repositioning puts the units in competition with truckers' high-cubic-space trailers, which almost exclusively are 53 feet in length. As a result, most 20- and 40-foot containers are repositioned empty at considerable cost.

In addition, shipping more cargo in one unit is environmentally responsible, cutting back on traffic volume and fuel emissions. Decreasing the number of units to be examined also enhances security.

The savings that back-haul and other factors generate are difficult to quantify but can be significant, with millions of units in use each day across the United States and in service around the world. One caveat is that some containers ship cargos at less than the total cubic capacity. Studies have shown that this occurs in less than 50 percent of cargos; moreover, lighter cargos generally have the greater value and command a greater freight rate. As Malcom McLean, the father of containerization, liked to say, "Any cargo that fits into a 20-foot container will fit into a 40-foot container." The same rationale applies to 53-footers.

Testing Larger Sizes

Sea-Land and other companies have designed and developed containers larger than the standard ISO unit and have tackled difficult technical problems to enable the units to be used with available ships, hardware, handling equipment, and infrastructure.¹ One of the most visible innovations is the double corner casting, a patent assigned to Sea-Land. This innovation allowed the stacking of oversized containers on the decks of vessels or on top of other containers in a marshalling yard and enabled cranes and other handling equipment to lift the containers. Other innovations include a special chassis design, vessel deck modifications, alternative layouts for container marshalling yards, and unique rail car designs.

A wide range of container and trailer lengths is in service in Puerto Rico, largely for domestic trade served by several innovative intermodal carriers under the Jones Act.² Puerto Rico long has been a place for establishing trends in freight transportation—it played a key role in the genesis of overseas containerization.

The port of San Juan receives 12,000 TEUs of domestic cargo every week. Service levels are high. Domestic vessels arrive with on-time rates exceed-

¹ The author was involved in many of these research and development projects as an employee of Sea-Land Service and as a consultant.

² The Jones Act requires that vessels carrying cargo between U.S. ports be built in the United States, owned by U.S. citizens, and documented under U.S. laws.



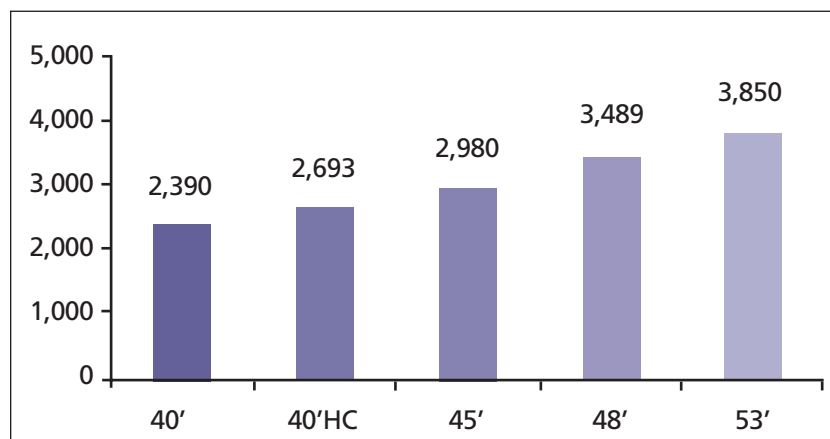
Containership in the Port of San Juan, Puerto Rico.

ing 95 percent. More than 50 percent of freight is delivered to users within 12 hours of a vessel's arrival, and the commodities include anything that can be containerized. It is a true intermodal market with the carriers offering complete pickup and delivery service to and from the United States.

In addition, foreign container vessels arrive regularly, bringing all types of goods to a population of more than 4 million with the highest per capita income in Latin America. Although not a major hub, Puerto Rico hosts a brisk transshipment trade to the other islands and nations in the Caribbean.

The competitive and intermodal nature of the United States–Puerto Rico trade has forced carriers to offer shippers equipment longer than the 40-foot ISO standard. This is what the customers demand, to control the costs of the internal handling of cargo and the rates paid to carriers.

A walk through the marshalling yards of the various operators in Puerto Rico highlights the trend



Containers in the Puerto Rico lane: total cubic feet inside.

Source: Trailer Bridge, Inc.



PHOTO: MAERSK LINE, LTD.

Changes in container sizes will require adjustments in port infrastructure.

toward larger equipment. Outnumbering the 20- and 40-foot units are 45-, 48-, and 53-foot units, with all of the sizes designed for roll on–roll off or lift on–lift off equipment, or both. To be competitive, all five domestic carriers offer big-box capabilities. One carrier, however, operates only 53-foot units in both a roll on–roll off and lift on–lift off configuration, stating in reports to investors that the system is “a vastly superior business model” and that the “assets provide tangible competitive advantage.” Simply translated, bigger is better.

Delays and Pressures

If this trend to bigger boxes in the United States–Puerto Rico trade extends to other trade routes, international carriers with huge investments in vessels and infrastructure will attempt to oppose or delay the change. The start-up of containerization encountered a similar opposing strategy. Only after Sea-Land expanded from Puerto Rico and developed services to Europe and Asia did international carriers make the leap to the new technology. The inability of developing countries to accept containerization was highly touted but proved short-lived—today containers of various sizes are deployed in almost all global trade.

Some carriers in international trade already have taken steps to satisfy customer demands for larger equipment. The decks of many vessels are loaded with 45-foot containers and sometimes with 48- or

53-footers. Some carriers are forced to transfer cargos from 40-foot standard containers to domestic standard containers or trailers at transfer stations near the ports. In this way shippers can benefit from the economics of a larger box for a portion of the move.

These are half-way measures that lack the efficiency of a standardized complement of same-size units. Shippers will continue to exert pressure on the transportation providers to change to the larger units. Operators will make more and more space available but will not easily abandon the ISO 40-foot length.

Preparing for Change

Some time soon, an entrepreneur will invest billions of dollars to construct a fleet of vessels designed to handle only 53-foot equipment to match the U.S. domestic standard. The economics of this intermodal service will be far superior to that of all competitors.

Operators need to consider vessels, equipment, terminals, trucking, and rail for this future system. Installing the new system and providing a transition from current operations will require a major technical effort. Yet the big box is the future and is technically doable—carriers, ports, and terminals should prepare for the inevitable changeover.

The United States currently has large numbers of 53-foot containers, as well as compatible rail cars, chassis, and handling equipment. Transporting 53-foot units across Europe, however, is a problem, because the European Union limits the length to 45 feet, although the size restriction does not apply to movements of units within a port area or on barges. In addition, an effort is under way to change the regulations.

Asia and particularly China also will influence change. China manufactures almost all of the 53-foot container units, and many are dispatched loaded with cargo. If China decides to adopt the 53-foot unit as the standard for its own internal transportation system, to serve the commercial interests of trade between China and the United States, the freight transportation map of the world will change. China will select and promote standards that support its position as the world’s leading exporter of manufactured products. China and other Asian nations will favor lengths that meet shippers’ needs and that move cargo in the most cost-effective way.

Are the days of the 40-foot container as the standard unit in international trade coming to an end? The answer is yes, and the change from the current, arbitrarily selected length will be made based on economics and experience.

Can Intermodal Freight Terminals Handle Supersizing?

ROBERT HARRISON

Containerization is the driving force for global trade in nonbulk commodities, and shippers, transportation companies, and terminal operators are constantly searching for ways to reduce costs and increase output. In recent years, each mode has undergone significant changes that affect intermodal economies of scale.

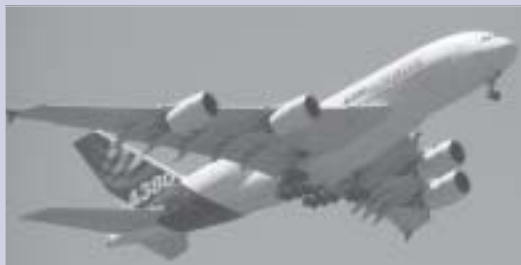
The intermodal services of U.S. Class 1 rail offer efficient schedules for 40-foot international and 53-foot domestic and transloaded traffic via mile-long trains to a variety of terminal types. Some—like the terminal in Alliance, Texas—are located in inland ports and offer other related services such as free trade zones and light manufacturing plants. Air freight, an important sector in terms of international freight value, is served by a variety of large fuel-efficient craft, and even larger planes are coming—such as the Airbus Industries A380 double-deck freighter.

In the maritime sector, the rate of change is fast and furious. From 1970 to 1990, the Panamax vessel—designed to pass through the Panama Canal locks—was dominant, with a container capacity of approximately 4,400 20-foot-equivalent units (TEU). As naval architecture and diesel engine technologies made larger designs possible, steamship companies ordered larger ships with limits around 5,500 TEU. In the 1990s, a new vessel class entered service—the megacontainer-ship or S Class, with capacities starting around 6,600 TEU and reaching up to 8,000 TEU. The S Class of the Orient Overseas Container Line, for example, carries up to 8,063 TEU; 10 of these vessels are now in service.

The latest development in vessel size is the L203 design SX Class commissioned by the A.P. Moller-Maersk Group and built by the Odense Steel Shipyards in Denmark, with a capacity of around 11,000 TEU, expandable to 14,800 TEU. The large containerships that now dominate global shipping lanes store containers in cells that conform to the International Organization for Standardization measures; none is designed to accommodate the domestic 53-foot container.

The TRB Intermodal Freight Terminal Design and Operations Committee works to share information on the ways that terminals worldwide

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The freight carrier version of the new superjumbo Airbus 380 will carry 150 tonnes of cargo in standard containers plus pallets.

serve the variety of modes and sizes in service. Large terminals capable of serving the biggest vessels, aircraft, and trains are few, because economies of scale require only a few key load centers or hubs. A range of technologies, equipment, storage, demurrage policies, and labor productivity is necessary to handle the large container volumes carried by the new modal equipment. In addition, environmental programs are being instituted to reduce the social costs of large terminals—particularly the effects on air quality.

Terminals are facing new and challenging programs to increase the security of operations from terrorism. The implementation of the Transportation Worker Identification Credential system is the issue currently under debate, to be followed by consideration of the ongoing debate over how best to secure containers. The Intermodal Freight Terminal Design and Operations Committee is monitoring these developments to help inform the freight transportation community in supporting endeavors to move the nation's freight efficiently and safely.



Photo: Maersk Line, Ltd.

L203 vessel Emma Maersk, one of the world's largest containerships, with a capacity of 11,000 TEU, awaits final fitting out in the Odense Steel Shipyard, Denmark, August 2006. The ship's hull is covered with environment-friendly silicone paint below the waterline, reducing water resistance and fuel consumption.

POINT OF VIEW

World Trade Security Is Imperative and Attainable

Cooperative Effort, U.S. Leadership Are Necessary

CHARLES G. RAYMOND

The author is CEO, Horizon Lines, Charlotte, North Carolina.

It is amazing how far container shipping has come in the past 50 years. Trade has expanded far beyond what was imaginable in 1956 when Malcom McLean's *Ideal X* sailed from Newark, New Jersey, to Houston, Texas, with 58 containers lashed on board. Today, ships as long as three football fields carry more than 8,000 containers, delivering millions of dollars of goods in a single voyage.

Thirty years ago, it took more than 24 hours for the world to record \$10 billion in international trade. Today that amount of trade is achieved in 1 second. More than \$155 billion is invested in the vessels, containers, marine terminals, and other assets in service around the world to support the global trade explosion.

As the U.S. maritime industry gives way in international trade to overseas competitors, it is easy to forget that containerization was an American innovation, proved in domestic trade by an American company, Sea-Land Service, Inc., before becoming a global revolution. To accomplish the complex and far-reaching task of securing world trade from outside threat, American leadership is needed again to

drive the infrastructure and technology investments required for continued economic prosperity.

Transportation companies, shippers, government agencies, and labor groups must cooperate in addressing the security needs of the intermodal commerce system, which is vital to the world today. Together these groups have the knowledge, experience, and resources to produce tangible and lasting results.

Shrinking World

Participants in the world's largest consumer market can see how dramatically and quickly the world has changed. Any shopping mall has ready access to goods from all over the world. By reducing the cost of international shipping from dollars to cents, containerization has made possible the global sourcing strategies that drive the expansion of every major retailer. Without the container, many of the leading brand names could not have emerged.

The inextricable commercial connection growing stronger every day between Americans and the rest of the world—supported by containerized ocean shipping—has created a new world reality. In



PHOTO: HORIZON LINES

The *Horizon Producer* sails past El Morro off the coast of Puerto Rico. The Horizon System rigorously tracks the movement of each container against an established trip plan and schedule.

tandem with the container, information technology has forged cultural connections between people, making the world smaller.

The change has come quickly, leaving little time to prepare for the effects of a shrinking world. September 11, 2001, was the wake-up call—an unimaginable alarm that the world has changed and cannot change back, and that the effects of the shrinking world must be addressed quickly. What would happen if another event disrupted container shipping for one week and world trade stopped?

Fifty years into its history, the container shipping industry is facing a challenge that may determine the future of commerce. Is the industry prepared to handle the challenge?

Dubai Ports Lessons

The fiasco earlier this year over the Dubai Ports World acquisition of a British company operating several U.S. port facilities underlines the need for the federal government and the news media to develop a better awareness of how the nation's transportation system works. One positive effect of the debate is an increased understanding and appreciation of the shipping industry and its essential role in the U.S. economy and way of life.

The public debate over Dubai Ports was founded on the incorrect assumption that Americans control the assets—the facilities, the vessels, the chassis, the cranes, and the containers—that deliver 98 percent of the trade entering the United States. On the contrary, a major portion of U.S. trade infrastructure is foreign-owned.

The maritime industry is a global community. Indian manufacturers ship containers on European vessels unloaded by Asian terminal operators on American soil. No one company or nation can control the process. No one system oversees all of the transactions and tracks the shipments. Everyone has a stake in world trade. Therefore, everyone has an interest in protecting the equipment, facilities, vessels, and people involved. That must be the starting point for addressing the problem.

The national maritime security process can be divided into three parts:

- ◆ Physical security,
- ◆ Vessel security, and
- ◆ Cargo security.

The U.S. Coast Guard monitors physical security and vessel security. Some politicians and journalists wrongly suggested that Dubai Ports would compromise these security areas, which present the least risk.

Coast Guard inspectors review port facilities regularly to ensure that agreed-to precautions are in place. The Coast Guard has jurisdiction over the safe operation of vessels in U.S. waters and over crew security clearances. The Coast Guard has good data to determine which vessels represent various levels of risk. Dubai Ports posed no likelihood of interfering with these activities.

What Is in the Box?

In the process of confusing the public and alienating the industry, the pundits failed to mention the most serious risk in maritime security—the cargo. A global trade security program must focus on answering the question, “What is in the box, and where has the box been?” Cargo security requires knowing what is going into containers and who is packing them long before the containers reach their destination.

Who will lead the cargo security effort? The industry is concerned with moving goods—where, how, when, and at what price. Industry is in the trenches without a view of the entire field. Shippers can work effectively to secure their own transportation chains but lack the time, resources, and authority to secure all trade. Regulatory and government bodies are needed for oversight.

But can government agencies do what is right without a thorough understanding of the business? This is a major question for the container shipping industry, with ramifications for the entire economy. The industry must work together with government authorities across borders in one concerted effort to secure world trade. Working together, government and industry can apply the experience, the knowledge, and the information to build a system to secure trade and maintain the tremendous efficiency developed in the past 50 years.

SAFE Formula for Trade

U.S. trade with China demonstrates what is at stake. In 2001, the United States imported \$102 billion of goods from China, accounting for 7.5 percent of total imports. Last year, imports from China topped \$243 billion, approximately 15 percent of total U.S. imports. This year through March, imports from China were up more than 17 percent from last year's figures.

The U.S. economy increasingly depends on efficient and reliable ocean transportation. America is the final destination for a majority of world trade. A functioning container transportation network is essential. Protecting that system is a matter of utmost importance to national security and to the security of the world.



PHOTO: U.S. CBP

Using a handheld isotope identification device, a U.S. Customs and Border Protection officer checks a seaport container for radioactive materials.

FROM THERE TO HERE

Supply Chain Security

Every day, thousands of containers arrive at U.S. seaports from countries all around the world. These metal boxes contain everything from auto parts and medical instruments to toys, electronics, clothing, and the shoes we purchase from our local department store. Each shipment represents a specific supply chain, whether it is patio furniture from Thailand bound for a Kansas City retailer or—as illustrated here—shoes shipped from China to a Spokane, Washington, athletic supply store. Every supply chain is subject to multiple layers of security processes, reducing the risk that something bad may arrive in our country. The supply chain shown to the right illustrates just a few of the security processes that scrutinize each container that enters the United States. Other programs, such as the Customs-Trade Partnership Against Terrorism (C-TPAT) and the Container Security Initiative (CSI), contribute to overall supply chain security by establishing security criteria for importers and carriers, as well as protecting the global commerce ... and adding extra layers of security for our local communities.

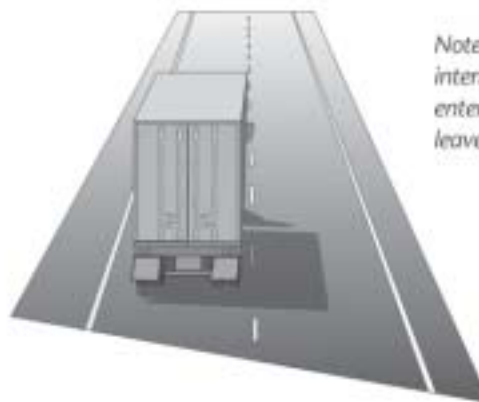
Text and graphics courtesy of the Port of Tacoma. Reprinted with permission from Pacific Gateway, Spring 2006.



A Spokane athletic supply store is running low on the season's hot new shoes, which are manufactured in northern China. The company places an order for 500 pairs. The shoe company works with a Canadian freight forwarder to arrange transport from the Chinese factory for a containerload of shoes.



Once the ship arrives in Tacoma, Port of Tacoma Security, Tacoma Police, and other federal, state, and local agencies ensure perimeter security around the port. Also, terminal security ensures that only authorized people have access to the terminal and vessel. The Coast Guard, meanwhile, is responsible for waterside security.



Note: More than 70 percent of international import containers entering the Port of Tacoma leave the Port by rail.

The truck arrives at an import distribution center in nearby Sumner, Washington, where the container is opened and the orders by individual stores are separated and prepared for shipment. The next day, the Spokane athletic supply store receives 500 pairs of the season's most popular athletic shoes.

To support the global economy, the world needs trade that is SAFE:

- ◆ Secure from disruptive threat,
- ◆ Acknowledged for its critical importance,
- ◆ Forward-looking with sustainable investment programs and government policies, and
- ◆ Efficient to support a global economy with opportunities worldwide.

SAFE trade is attainable, and information technology is the key. The container shipping industry already generates the data required for monitoring supply chains in near real-time. Nonetheless, the government receives only fragmented pieces of the information available, and much of it arrives too late in the shipping cycle to set in motion effective security procedures.

Cooperative Blueprint

No airline security system would inspect passengers and baggage after arrival at the destination, yet this is what some have suggested for container security. Like the airline industry, the container security system must clear shipments before they are loaded on the vessel. U.S. Customs and Border Protection (CBP) therefore implemented the advance manifest rule. Manifest data, however, constitute a document-based snapshot of the shipping process produced 24 hours before a ship's departure.

CBP needs more accurate data earlier in the shipment cycle to make effective security decisions. Ocean carriers and terminals are collecting operational data—usually two to three weeks before a vessel's departure, with live tracking to the destination. This kind of information can allow CBP and foreign agencies to conduct more extensive searches on suspicious containers long before arrival, effectively extending U.S. borders not only to foreign ports but beyond.

A layered approach to supply chain security should be implemented, using information technology as the backbone:

- ◆ A **physical security layer**, including radiation detection devices and electronic seals, would ensure that containers are not tampered with on the way from the factory floor to the port.
- ◆ An **operational tracking data layer**, using the information captured by carriers, terminals, trucks, and railroads, would show the location of any box at any time. If the National Targeting Center received an alert, agents would have ready access to the information necessary for actionable decisions.
- ◆ A **documentation data layer**, using the 24-hour manifest and transactional information, would include buyer and seller profiles, point of origin, cargo descriptions, and data on the ultimate consignee.

These information layers are the key to effective security, because inspecting the contents of every container entering the United States is impossible. Using information intelligently can increase efficiencies and security at U.S. ports. Port authorities must migrate from the traditional reactive security model to a more proactive approach. To manage and secure facilities and shipments moving to inland points, port authorities will need access to detailed shipment data before the shipments reach their locations.

Much of this information is readily available as the core data that support the ocean carrier business. An example is the Horizon System developed by the research and development team at Horizon Services Group and used as a tool to manage all customer booking, event tracking, and documentation for Horizon Lines operations.

System Model

Any international supply chain involves many players—therefore capturing information on the movement of cargo early and continuously from origin to destination is crucial. In the Horizon System, a trip plan assembles in detail the schedule of events for a shipment, tracking all modes and players involved in moving a container from origin to destination—including trucks, railroads, warehouses, ports, container carriers, and barges. As the cargo moves, actual events are captured and compared against the trip plan schedule, so that unplanned deviations can be identified proactively with alerts to appropriate parties for action.

The system gathers key information about shipments as early as possible. The trip plan is developed as soon as a shipment is booked and is used to monitor the shipment. A complex business-rules



PHOTO: U.S. CUSTOMS AND BORDER PROTECTION

A mobile truck X-ray device checks a container for contraband.

engine enforces data integrity and provides end users with proactive notification of any event or new data captured throughout the shipment life cycle. The system manages the exceptions to the plan and lets the nonexceptions flow through. This allows for tremendous scalability—that is, equally efficient application to small or large numbers of shipments—and also provides the basic data foundation for security decision making.

The system offers several benefits for supply chain security:

- ◆ Shipment data from the players in the supply chain are integrated into a single source.

- ◆ The trip plan schedules the shipment's point-to-point movement. Events are posted to the trip plan as they occur, and any revisions or changes in the schedule are captured. The system notifies security agencies and port authorities of any changes or unusual cargo movements if events are missing key data, if checkpoints are missed, or if any suspicious changes occur in the cargo flow. The data are evaluated according to the business rules defined by security agents and port authorities in generating alerts for cargo near sensitive areas, hazardous materials near populous areas, and the like.

- ◆ CBP and other agencies can use the system to monitor any irregularities and to stop suspicious shipments before further movement.

The actual events entering the system from the container transportation network feed into the trip plan for comparison against the schedule created at the booking. The trip plan becomes a dynamic source for alerting authorities and shippers to many different scenarios after a failure to comply with scheduled events, including route changes or diversions and missed checkpoints. Many U.S. shippers use this Horizon System to manage their supply chains through proactive and reactive alerts, scheduled and automated reports, and standard tracking of shipments.

Linking to Federal Agencies

These kinds of data layers could provide intelligence on how international container flows are moving. These data layers therefore are fundamental to the effective implementation of physical security by U.S. government authorities using scanners, seals, and other equipment. Too much emphasis has been placed on physical security—particularly on container seal technology—to achieve supply chain security.

Federal officials are realizing this—in early August, Jayson Ahern, a CBP assistant commissioner, said: “Until we have confidence about what’s in the

The screenshot shows a web-based interface for 'NETCAPTAIN ShipStat Reports'. The main heading is 'Container Status - SEAU854956-3'. Below this, there is a table with columns for 'Container No.', 'Status', 'Origin', 'Destination', 'Vessel', 'ETA', and 'EUA'. The 'Trip Plan' section below the table lists various ports and dates, including 'Tehran', 'Bremerhaven', 'Elizabeth', 'Little Ferry', 'Chicago', and 'Chicago'.

box...putting a device on the outside may or may not add much to security.” He advocated validating supply chains with advance shipping data and checking foreign suppliers through the Customs–Trade Partnership Against Terrorism.

This is a move in the right direction. Data systems must be implemented to track containers before the containers can be secure. The systems are available—the Horizon System for ocean carrier containers is but one example of a tracking system that can be tapped for basic security data. Instead, the U.S. Department of Homeland Security has sought to reinvent the wheel, with scattered results, often working with consultants outside of the transportation industry.

Securing Trade

The transportation industry has the technology, the knowledge, the experience, and the commitment to solve the security challenge. New cooperative security processes are needed for industry and government to build the necessary information-sharing and analysis tools. Government and industry need to work together—in the trenches and on Capitol Hill—to secure trade.

Only a joint approach can communicate the big picture. People, shippers, carriers, and the global economy rely on SAFE trade. Moving in the right direction together can establish lasting results for generations.

Americans led the world into the container revolution 50 years ago, proving that transportation could drive previously unimaginable levels of efficiency and value. The industry needs American leadership again, to work together with government in addressing this most critical challenge to the world economy. In the process, the global trade industry can show the world that cooperation to achieve shared goals across borders, between industry and government, is possible—and imperative—in a smaller world.

A Horizon System computer screen shows a trip plan tracking the progress of a 40-foot steel container from Tehran to the port of Bandar Abbas in Iran by truck; by ship to Bremerhaven, Germany, and via truck to another ship for Elizabeth, New Jersey; via truck to Little Ferry, New Jersey; then via rail to Chicago, Illinois; and final delivery by truck. The system evaluates any variations in the planned route and schedule and sends appropriate alerts at each checkpoint.

POINT OF VIEW presents opinions of contributing authors on transportation issues. The views expressed are not necessarily those of TRB or TR News. Readers are encouraged to comment in a letter to the editor on the issues and opinions presented.



A Chinese trucking company arrives at the factory, loads the order, along with orders from many other retailers, into a 40-foot container, which is bolted shut and fitted with a high-security seal. The container will not be opened again until it arrives at a U.S. distribution warehouse, unless U.S. or foreign customs officials decide to open and inspect it.



The freight forwarder determines it is most economical to truck the container to the Port of Tianjin for trans-Pacific shipment to the United States. The freight forwarder has contracted with a shipping line, which must submit documentation about the shipment at least 24 hours before the ship leaves port. This "manifest data" includes information such as exact contents, the exporter, the importer, and who is porting the cargo.

When the ship is 96 hours from Tacoma, the captain of the vessel prepares a report that includes details on each member of the 10- to 15-person crew, plus voyage, vessel, cargo, operational, and safety information. This report is sent to the U.S. Coast Guard, which—if it believes anything to be suspicious—will board the ship at sea to investigate.



Loaded onto a container ship, the container of shoes is bound for the Port of Tacoma. The trip takes 12 days.

This information is sent to the U.S. government, where officials from several federal agencies use intelligence data bases to rate and evaluate the risk level of each of the 11 million-plus containers that enter the United States each year. Risk-based analysis and intelligence is used to pre-screen, assess and examine 100 percent of suspicious containers.



Up to 120 longshore workers arrive to work the ship. They include crane operators, lashers, clerks, and cargo equipment operators. A terminal operator directs the longshore workers, as they unload each container.



Once cleared by U.S. Customs, longshore workers load the container on a truck chassis, which is picked up by a trucker. Leaving the Port, the container passes through a radiation portal monitor (RPM), which detects the presence of any radioactive material in the container. Once cleared, the truck and container leave the port.



U.S. Customs officials, armed with a careful evaluation of each container's documentation, instruct terminal operators to pull specific containers for further inspection. Inspection may include a physical inspection of the contents (a 6- to 40-hour procedure) or inspection by a VACIS (Vehicle and Cargo Inspection System) machine, which uses gamma-ray technology to look inside and confirm the contents of the container without opening it. A VACIS inspection takes three to five minutes.

Illustrations by Kathy Tomandi

Louis S. Thompson

Thompson, Galenson, and Associates, LLC

International rail consultant Louis Thompson has nearly 40 years of experience in the railroad and transportation industries. He began his career in 1968 in the office of the secretary of the U.S. Department of Transportation (DOT), serving first as a budget analyst. He then moved to the position of policy analyst, working with Congress and President Richard Nixon on the creation of the National Railroad Passenger Corporation, or Amtrak, the national intercity passenger rail system, and on the development of the original Northeast Corridor Transportation Project Report.

In 1973, Thompson left U.S. DOT to begin work with Richard J. Barber Associates, a Washington, D.C., consulting firm specializing in transportation and economic regulatory issues affecting federal and state agencies. In 1978, he returned to U.S. DOT, joining the Federal Railroad Administration (FRA) as director of the Northeast Corridor

economic issues involved in lending to developing railways around the world. He has served as an expert on energy in transport and in promoting the role of the private sector in countries that operate wholly state-owned railways.

“Two issues I dealt with when working with World Bank clients around the world were reforming the state enterprises—so that they understood how markets and finances could contribute to better public management—and promoting a better balance between the public and private sectors,” Thompson recalls. “The spectrum of countries, cultures, and railroads involved was significant because what is acceptable and workable in one country may not be up for discussion in another. You need a good set of professional tools, but also a working set of cultural antennae.”

Thompson retired from the World Bank in 2003, and established a consulting company, Thompson, Galenson, and

Associates, LLC. Although the company has worked with the World Bank, its efforts have been primarily directed toward assisting other clients in the United States and Europe.

Thompson has been involved with TRB for more than 20 years. He has served on several TRB–National Research Council committees, and chaired the Committee for Review



“Two issues I dealt with when working with World Bank clients around the world were reforming state enterprises—so that they understood how markets and finances can contribute to better public management—and promoting a better balance between public and private sectors.”

Implementation Project (NECIP), a \$2.5 billion effort to upgrade rail passenger service between Washington, D.C., and Boston. Thompson was promoted to manage FRA’s supervision of the Amtrak budget and other financing programs for rail activities. He believes that the creation of Amtrak in 1971 helped to separate the role of government from that of private freight railroads.

“Experience here and abroad shows that the traditional view of railroads as self-contained monoliths can profitably be expanded to incorporate track use by independent operators, such as Amtrak; some kinds of infrastructure separation with access by competing and non-competing operators; and franchised or concessioned operation by the private sector.”

During his time with FRA, Thompson also served as deputy administrator and acting administrator for policy development. He managed the completion of the NECIP, and was involved in the development of the Staggers Act and in the privatization of Conrail.

In 1986, after 8 years with FRA, Thompson joined the World Bank as a railways adviser, overseeing the policy and

of the Federal Railroad Administration Research, Development, and Demonstration Programs.

He also has contributed his expertise and leadership to several of TRB’s standing technical activities committees, including the International Activities Committee, the Intercity Rail Passenger Systems Committee, and the Freight Transportation Economics and Regulation Committee.

Thompson graduated from the Massachusetts Institute of Technology with a bachelor’s degree in chemical engineering in 1963 and earned a master’s degree in business administration from Harvard University in 1965. He has published widely on rail reform, energy efficiency in transportation, and concessioning or franchising in railroad operations.

Thompson has received FRA administrator’s awards for outstanding performance, and for excellence in promoting opportunities for minority businesses; the U.S. DOT secretary’s Award for Outstanding Performance; and the Presidential Award for Outstanding Performance. In 1999, he received the World Bank President’s Award for Excellence for his work on the concessioning of railways in Latin America and Africa.

J. Susie Lahsene

Port of Portland

A transportation and land use policy manager for the Port of Portland, J. Susie Lahsene has the challenge of translating findings on global trade trends into transportation improvements or land use policies that support the port's ability to meet industry demands for competitive market access.

Lahsene joined the Port of Portland in 1992, after serving as a transportation planning manager for Multnomah County, Oregon. Her arrival at the port coincided with Congress' passing of the federal Intermodal Surface Transportation Efficiency Act (ISTEA). ISTEA presented an intermodal approach to highway and transportation funding and provided a way for ports and metropolitan planning organizations around the United States to work with lawmakers to renew surface transportation programs, rebuild and improve transportation infrastructure, and ensure access to global markets.



“Good, well-presented research can be very persuasive.... Research can provide a foundation for an approach to a problem that may otherwise not be considered.”

“I came to the Port of Portland at a truly exciting time,” Lahsene recalls. “In my position with the port, I had the pleasure of blazing a trail to regional, state, and federal policy tables to educate people on the importance of transportation to global competitiveness, and organizing the Port of Portland’s transportation investment strategy.”

The cornerstone of the investment strategy is the 1994 Port of Portland Transportation Improvement Plan (PTIP), a 20-year examination of Portland’s road, rail, and waterway transportation improvements. As a leader of the PTIP team, Lahsene participated in the creation of the plan, which serves as a communication strategy for the port’s shareholders, drawing attention to bottlenecks in the road and rail systems that could affect the business competitiveness of the port, the region, and the state of Oregon.

The plan raised awareness within the business community about the importance of investing in the transportation system, Lahsene notes, and the port has received increased federal, state, and local funding to address access needs.

During the summer of 2005, the Oregon legislature passed another landmark piece of transportation legislation—a bill titled Connect Oregon. The law allocated funding of \$100 mil-

lion in lottery-backed bonds for nonroad freight needs in the areas of rail, air, and water transportation. In addition to her role as vice chair of the state’s freight advisory committee that initially reviewed all of the submitted projects for funding, Lahsene served as a member of a final review committee that examined approximately 100 transportation-related project proposals, totaling more than \$240 million, to create a list of candidate projects aimed at freight improvement. The Oregon Transportation Commission approved three of the projects submitted by Lahsene’s committee.

“Through this process, I learned a lot about freight and business needs throughout the state of Oregon,” Lahsene recalls. “As freight volumes across the country grow, the need for improved funding is key to the success of businesses and carriers.”

Lahsene believes that research, studies, and planning efforts are crucial to her work and to helping the port meet its objectives by providing information that can assist policy makers on port-related land use and transportation issues.

“Good, well-presented research can be very persuasive,” she points out. “Because port operations are not well understood, and the issue of freight mobility is quite fresh, research can provide a foundation for an approach to a problem that may otherwise not be considered.”

Lahsene notes an example: “Research on freight modeling and freight data collection has helped inform policy makers about key freight choke points in our region, and recent research on the cost of congestion to business productivity has linked business decisions to the availability of transportation system capacity, effectively changing the nature of debate on the subject in Portland.”

Since 1997, Lahsene has been a member of TRB’s Urban Freight Transportation Committee, serving as chair from 1999 to 2005. She currently chairs the Committee on Freight Demand Modeling and cochairs the Task Force on Innovations in Freight Transportation Modeling. She also is a member of the Freight Systems Group and the National Cooperative Highway Research Program’s Project Panel on Transportation Vision 2010 and Beyond.

Lahsene received a bachelor’s degree in urban studies and a master’s degree in urban and regional planning from the Virginia Polytechnic Institute and State University in 1977 and 1980, respectively. She received a master’s degree in business administration from the University of Portland in 1989. A past contributor to *TR News*, her article, “New Economy, New Vision for Transportation,” can be found in the September–October 2001 issue.



Preventing Pavement Failure Caused by Hot-Mix Asphalt Temperature Differentials

Washington State's Systematic Approach

STEVE MUENCH AND KIM WILLOUGHBY

Muench is Assistant Professor, Civil and Environmental Engineering, University of Washington, Seattle. Willoughby is Research Manager, Washington State Department of Transportation, Olympia.

In recent years, large numbers of hot-mix asphalt (HMA) paving projects in Washington and other states in the United States and around the world have experienced what is generally called cyclic or end-of-load segregation, a cyclic occurrence of low-density areas in the mat. These low-density areas tend to fail prematurely through fatigue cracking, raveling, or both, which can be costly on high-volume Interstate routes.

The Problem

At first, aggregate segregation was considered the cause of premature failure of HMA pavements, but observations in Washington State and elsewhere suggested a second, and perhaps more prevalent, cause: construction-related temperature differentials that

produce low-density areas (Figure 1). These areas are susceptible to isolated damage in an otherwise serviceable pavement.

Although patching provides temporary relief, the remedy is to resurface earlier than anticipated. Research and records in the Washington State Department of Transportation (DOT) pavement management system show that temperature differentials, depending on the severity, can reduce expected pavement life by 20 to 80 percent.

Solution

The Washington State DOT research began with an investigation of temperature differentials and culminated in the development of a rational specification.



FIGURE 1 Cyclic low-density spots just after construction.

Stage 1: Discovery (1995)

Cyclic segregation first received close attention on a large paving project on Interstate 5 north of Olympia in 1994. The visible problem served as the catalyst for formal research.

The investigation used handheld temperature measuring devices to determine the cause of prevalent cyclic segregation and discovered large temperature differentials in the mat after placement. Nuclear density checks showed that the cooler areas of the mix had lower densities than the rest of the mat.

Stage 2: Determination of Cause (1998)

An infrared camera was used to locate cool areas in the mat on four Washington State DOT projects (Figure 2). The cool areas then were sampled and tested for mix properties.

Construction-related HMA temperature differentials resulted in the placement of a significantly cooler portion of HMA mass into the mat. The cooler mass came from the surface layer or crust that typically develops during the transport of HMA from the mixing plant to the job site. Originally it was thought that the paver blended this crust sufficiently into the rest of the HMA, but many observations showed this did not happen. Instead, the cold HMA passed through the paver relatively intact and was placed in concentrated areas of the mat. These cold locations generally resisted adequate compaction, resulting in concentrations of higher air voids and open surface textures that were more susceptible to deterioration from traffic and the environment.

The cool areas did not show symptoms of aggregate segregation. Observations found that air voids increased by 1.6 to 7.8 percent in the cool areas compared with the mat as a whole.

Stage 3: Contributing Construction Factors (1999)

An infrared camera was used to view 35 Washington State DOT projects, and detailed data were collected to identify patterns in the occurrence of temperature differentials and construction operations. Temperature differentials of up to 68°F were observed with a resultant increase of up to 4.5 percent in air voids.

Remixing the HMA before placement reduced or eliminated temperature differentials, but some material transfer vehicles (MTVs) did a better job of remixing than others (Figure 3). Good compaction practices and higher HMA mix temperatures—which allowed additional compaction time—were found to reduce the density differences attributed to temperature differentials.

Stage 4: Identification Procedure (2000)

The temperature differentials easily identified with

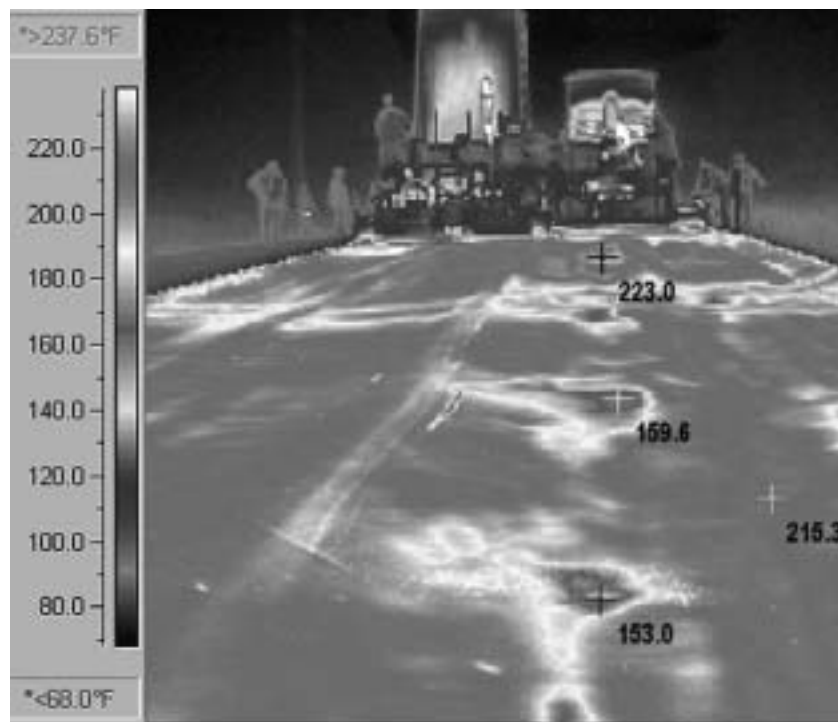


FIGURE 2 Infrared image showing classic temperature differentials. The cold spots are an average 60°F cooler than the mat as a whole. These spots are likely to fail before the rest of the mat.

an infrared camera do not always signify low-density areas. Therefore a method was developed to identify temperature differentials with handheld devices such as an infrared camera or temperature gun and then immediately investigate the potential low-density areas. The method was tested on 17 projects and found to work well. A threshold value was developed—when the temperature differential was 25°F or more, troublesome low densities were likely, with increases in air voids of greater than 4 percent occurring 82 percent of the time. Below the 25°F threshold, low densities were not likely.

Stage 5: Specification (2002–2006)

Standard random quality assurance sampling could not identify the low densities resulting from temperature differentials because the areas were small in size and the causes were recurrent. Washington State DOT therefore developed a three-step specification to counter the detrimental effect of temperature differentials:

- ◆ Locate temperature differentials with a handheld infrared camera or temperature gun.
- ◆ If the temperature differential between a particular location and the surrounding mat is 25°F or greater, perform nuclear density testing at the cool spot.
- ◆ If the densities are verified as unacceptably low, with a minimum of four locations per density lot, a

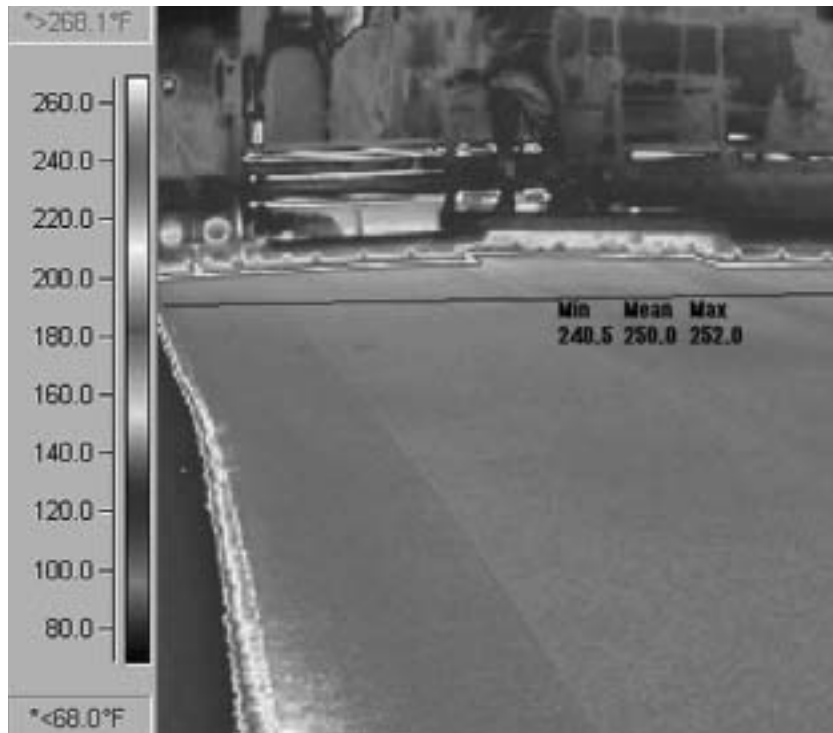


FIGURE 3 Infrared image showing a mat with uniform temperature as a result of remixing in a material transfer vehicle before the paver.

penalty of 15 percent of the HMA unit price for the affected lot of material is assessed on the contractor.

Temperature differentials always have been present in HMA pavement construction to some degree. Washington State DOT personnel and the research team have had 30 years of experience with cyclic open-textured HMA. Some early occurrences may have been misidentified as aggregate segregation, which is another problem. Improvements made in the past 20 years—with better construction quality, the elimination of more pressing problems, and tighter HMA and aggregate specifications—have highlighted the detrimental effects of temperature differentials and the low-density areas that result.

Application

In Washington State, the specification detailed in Stage 5 is a standard in all 2006 paving contracts. A slightly modified version of the specification has been used in more than 60 select HMA paving projects since 2002.

Washington State DOT has seen an increase in the use of MTVs and a decrease in temperature and density differentials. Although using an MTV does not guarantee that temperature differentials will be eliminated, temperature differentials observed during construction have decreased significantly, as have the early failures that they cause.

Benefits

Since 1995 Washington State DOT research on cyclic segregation in HMA pavements has identified the following:

- ◆ The cause of cyclic segregation, which results in low-density areas;
- ◆ The mechanism of the formation of low-density areas; and
- ◆ The contributing construction factors.

Washington State DOT also developed a systematic method of identification and a rational specification to eliminate the problem.

The cost savings of eliminating temperature differentials are difficult to estimate. Washington State DOT uses approximately 1.5 million tons of HMA for paving in each construction season at a current average cost of \$60 per ton. If reducing temperature differentials could prevent a potential 20 percent loss of pavement life on half of the state's projects, the savings would amount to approximately \$9 million per year.

Related Websites

- ◆ Complete project report: <http://depts.washington.edu/trac/bulkdisk/pdf/476.1.pdf>
- ◆ Summary of the investigation: www.wsdot.wa.gov/biz/mats/Pavement/Technotes/TemperatureDifferentialTechNote2001.pdf
- ◆ Summary of the specification: www.wsdot.wa.gov/biz/mats/Pavement/Technotes/CyclicDensitySpec2004.PDF
- ◆ Images from infrared camera investigations by other states—notably Maryland, Texas, Minnesota, Connecticut, and California: <http://sptc.ce.washington.edu/InfraredImages/search.asp>

For more information about this research article, please contact Kim Willoughby, WSDOT Research Manager, 310 Maple Park Avenue SE, P.O. Box 47372, Olympia, WA 98504-7372, telephone 360-705-7978, fax 360-705-6911, e-mail willouk@wsdot.wa.gov.

EDITOR'S NOTE: Appreciation is expressed to G. P. Jayaprakash, Transportation Research Board, for his effort in developing this article.

Suggestions for "Research Pays Off" topics are welcome. Contact G. P. Jayaprakash, Transportation Research Board, Keck 488, 500 Fifth Street, NW, Washington, DC 20001 (telephone 202-334-2952, e-mail gjayaprakash@nas.edu).

NEWS BRIEFS

New Rail Brake Technology Gains Regulators' Support

The Federal Railroad Administration (FRA) is planning to revise federal rail safety regulations to facilitate the installation of electronically controlled pneumatic (ECP) brake systems on railcars. ECP brake systems can apply braking force instantaneously to every car in a train, helping to prevent derailments and to reduce train stopping distances by approximately 60 percent. In contrast, current air-brake technology applies braking force sequentially, from one car to the next. On longer trains, this can result in longer stopping distances and increased fuel consumption.

In 2005, 14 percent of all rail accidents caused by human error on main-line tracks involved misuse of the automatic braking system or improper train handling. ECP braking systems may prevent many accidents caused by emergency braking and loss of brake air pressure. Additionally, the systems are capable of performing self-checkups to identify necessary maintenance.

FRA plans to issue a notice of proposed rulemaking in 2007 to revise federal brake system safety standards and to encourage investment in ECP technology. With the hope of realizing the safety benefits of ECP as soon as possible, FRA is considering plans from railroads interested in using ECP brake systems before the proposed rule changes are completed.

For more information and to view a report on the benefits of ECP braking systems, visit www.fra.dot.gov.

Report Offers Recommendations for Federal Research Management

The U.S. Department of Transportation's (DOT) newest agency, the Research and Innovative Technology Administration (RITA), should develop performance goals, an implementation strategy, and an evaluation process for managing and ensuring the effectiveness of research, development, and technology (RD&T) activities, according to recommendations in an August 2006 transportation research report from the Government Accountability Office (GAO).

Created by Congress in 2005 under the Norman Y. Mineta Research and Special Programs Improvement Act, RITA replaced the

Research and Special Programs Administration and works to coordinate, facilitate, and review U.S. DOT's RD&T activities.

The report maintains that the agency should continue to develop performance goals; delineate how its coordination, facilitation, and review practices will further DOT's mission; and develop a method to identify primary users of the Bureau of Transportation Statistics (BTS), to solicit user feedback, and to determine how to implement user feedback to improve BTS data products such as the Commodity Flow Survey and the National Atlas Transportation Database.

To view a complete copy of the August 2006 report, visit www.gao.gov/new.items/d06917.pdf.

PEOPLE IN TRANSPORTATION

Brohl Is First Director of Marine System Secretariat

Helen A. Brohl has been appointed first executive director of the Executive Secretariat to the Committee on the Marine Transportation System (CMTS). Created by President Bush's Ocean Action Plan of December 2004, CMTS comprises 10 cabinet-level departments and is



designed to create a partnership of federal agencies with responsibility for the Marine Transportation System (MTS)—waterways, ports, and their intermodal connections—to ensure that the development and implementation of national MTS policies are consistent with national needs.

Brohl served 6 years as president of the National Association of Maritime Organizations and 10 years as executive director of the United States Great Lakes Shipping Association. She also was national coordinator for the Marine Navigation Safety Coalition, comprising more than 60 organizations promoting maritime safety through hydrographic services such as charting, mapping, and real-time water level monitoring.



MULTIPURPOSE PROJECT—An award-winning Marysville, Kansas, grade separation and flood control project celebrated completion with a ribbon-cutting on April 10 at the U.S. Route 77 overpass. Participating were representatives of the groups that partnered on the project: (left to right) Steve Lord, director of road operations; Dick Davidson, chairman of the Union Pacific Corporation; Harold Stones, from the office of Senator Pat Roberts (D); Lou Edwards, Marysville mayor; Deb Miller, Kansas Secretary of Transportation; Representative Jerry Moran (R); Lt. Col. Kelly Butler, U.S. Army Corps of Engineers; and Cameron Scott, North Platte service unit general superintendent.

The \$87 million overpass, flood control, and railroad track relocation project was created in response to traffic and flooding problems that have plagued Marysville for years. The project included modification of the U.S. Route 36 and 77 corridor through and west of the city, relocation of double mainline Union Pacific Railroad tracks from the downtown area, and construction of a levee to protect the city from the recurring floodwaters of the Big Blue River.

TRB HIGHLIGHTS

Highlighting Critical Issues in Transportation

Critical issues in transportation were the focus of the TRB Summer Conference, July 9–11, in La Jolla, California. The conference drew more than 400 attendees, who participated in more than 60 meetings of TRB standing committees, groups, and sections and networked with peers in a variety of transportation-related disciplines. Session themes included:

- ◆ Sustainable financing of transportation infrastructure;
- ◆ Sustainable financing through public–private partnerships;
- ◆ The impacts of fuel prices on the transportation industry and its consumers;
- ◆ Transportation workforce and education;
- ◆ Epidemics;
- ◆ Institutional adaptations to new issues and missions; and
- ◆ Infrastructure lessons learned, with rankings and priorities.

The conference included the annual TRB Summer Ports, Waterways, Freight, and International Trade

Conference and the Joint Summer Meeting of the TRB Planning, Finance, Administration, Freight, and Management Committees.

Innovative Safety Program Catches On

In the United States, persons 65 years old and older constitute the fastest-growing segment of the population. As more in the United States reach retirement age, many may need to reconsider their transportation options, because it may no longer be safe for them to drive. The summer 2006 *Ignition*—



COOPERATIVE RESEARCH PROGRAMS NEWS



In-street pedestrian crossing signs

Pedestrian Safety Project Gains Achievement Award

In recognition of a joint project on improving pedestrian safety at unsignalized crossings, TRB's Transit Cooperative Research Program (TCRP) and National Cooperative Highway Research Program (NCHRP) have received the Institute of Transportation Engineers' Transportation Achievement Award for Pedestrians.

The project, TCRP D-08 and NCHRP 03-71, and its report, *Improving Pedestrian Safety at Unsignalized Crossings*, examines selected engineering treatments at unsignalized high-speed and high-volume roadway pedestrian crossings, and will assist transportation professionals in selecting engineering treatments to improve safety for pedestrians at these types of crossings.

For more information, visit http://www.trb.org/news/blurb_detail.asp?id=6630.

Addressing Need for Guidance on Chip Seals

Emulsion-based chip seals are used as flexible pavement preservation treatments to seal fine cracks in the

underlying pavement's surface and to prevent water from penetrating into the base and subgrade layers.

Although extensive research is available, chip-seal design in the United States remains empirical. Effective use of chip seals has been hampered by the lack of nationally accepted guidance for their design and construction, as well as by the lack of appropriate specifications and testing procedures for constituent materials.

In response to the need for identifying factors that influence chip-seal design, to document design and construction practices, and to delineate necessary testing and specifications, Colorado State University has been awarded a \$349,933, 30-month contract (NCHRP Project 14-17, FY 2006) to develop a manual for the design and construction practices of emulsion-based chip seals for pavement preservation. The manual will be limited in scope to the application of chip seals to asphalt-surfaced pavements and will be recommended for adoption by the American Association of State Highway and Transportation Officials.

For further information, contact Amir N. Hanna, TRB, 202-334-1892, ahanna@nas.edu.

the quarterly news magazine of TRB's Innovations Deserving Exploratory Analysis (IDEA) program—highlights the Independent Transportation Network of America (ITNAmerica), a project that seeks to improve community safety by offering an alternative for senior citizens who do not or should not drive.

For an annual membership fee of \$35, the national nonprofit organization provides a car and driver at any time, day or night, for persons 65 years old and older. Born from a Portland, Maine, pilot project demonstrated by Katherine Freund with funding from the IDEA program, the ITNAmerica system has inspired similar networks in California, Florida, New Jersey, and South Carolina.

Also featured in the latest *Ignition* is the High-Speed Rail IDEA Project 53, which is testing a magnetic sensor for safety use at rail crossings. A silicon wafer clad with a thin film of nickel-iron alloy, the sensor, when exposed to a magnetic field, could activate grade-crossing warning systems by detecting the location and speed of an oncoming train or the nearby movement of any ferrous metal mass, such as a motor vehicle.

For more information, visit http://www.trb.org/news/blurb_detail.asp?id=3982.



SAFETY RESEARCH—Kenneth Campbell, Senior Program Officer for the Strategic Highway Research Program II (SHRP II), responds to questions at the SHRP II Safety Research Symposium on August 18 in Washington, D.C. SHRP II is a targeted, short-term, results-oriented research program created by Congress to advance U.S. highway performance and safety. SHRP II seeks to generate innovation in the areas of highway renewal, safety, reliability, and capacity.



SETTING AN AGENDA—The Transit Cooperative Research Program (TCRP) Screening Panel met on August 25 in the National Academies' Keck Center to determine the TCRP problem statements that will be considered at an October 2006 meeting. Panelists included (*clockwise from left*) David Clawson, American Association of State Highway and Transportation Officials; Lisa Colbert, Federal Transit Administration; Chris Zeilinger, Community Transportation Association of America; Chris Jenks, TRB; Barry Barker, Transit Authority of River City, Louisville, Kentucky; Anna Barry, Massachusetts Bay Transportation Authority; Rosemary Covington, D.C. Department of Transportation; and Paul Larrousse, National Transit Institute.

CALENDAR

TRB Meetings
2006**November**

- 5-7 International Joint Conference on Synergies for an Efficient Waterways System in Europe and the United States*
Brussels, Belgium
- 12-14 Key Issues in Transportation Programming: 2nd National Conference
Seattle, Washington
- 28- Dec. 1 2nd Conference on Incident and Special Events Management
Newport, California

December

- 5-7 2006 Highway Geophysics Conference*
St. Louis, Missouri
- 6-8 TRB-FAA Aviation Environmental Design Tool and Aviation Environmental Portfolio Management Tool Workshop
Washington, D.C.

2007**January**

- 16-19 Geosynthetics Conference 2007*
Washington, D.C.
- 20 Data Analysis Working Group (DAWG) Forum on Pavement Performance Data Analysis
Washington, D.C.
A. Robert Raab
- 21-25 TRB 86th Annual Meeting
Washington, D.C.
Linda Karson

February

- 8-9 Disaster Planning for the Carless*
New Orleans, Louisiana
Richard Pain

April

- 9th Annual Harbor Safety Committee Conference*
Chicago, Illinois
Joedy Cambridge

- 25-26 National Summit on Agricultural and Food Truck Transport for the Future*
Washington, D.C.

May

- 6-9 11th National Transportation Planning Applications Conference
Daytona Beach, Florida
Kimberly Fisher

June

- 3-8 1st North American Landslide Conference*
Vail, Colorado

- 4-6 3rd National and 1st International Conference on Performance Measurement
Irvine, California
Martine Micozzi

- 18-21 TRANSED 2007—The 11th International Conference on Mobility and Transport for Elderly and Disabled People*
Montreal, Quebec, Canada
Martine Micozzi

- 24-27 3rd Urban Street Symposium
Seattle, Washington
Richard Cunard

- 24-27 9th International Conference on Low-Volume Roads
Austin, Texas

July

- 7-9 TRB 2007 Joint Summer Meeting
Chicago, Illinois
Mark Norman

- 8-11 46th Annual Workshop on Transportation Law
Philadelphia, Pennsylvania
James McDaniel

- 9-11 2007 Transportation Planning and Air Quality Conference*
Orlando, Florida

August

- 19-21 Meaningful Transit Input into Transportation Planning and Land Use: Best Practices
Peter Shaw

September

- 25-27 8th International Symposium on Cold Region Development: ISCORD 2007*
Tampere, Finland

2008**January**

- 13-17 TRB 87th Annual Meeting
Washington, D.C.
Linda Karson

June

- 23-28 7th International Conference on Managing Pavement and Other Roadway Assets*
Calgary, Alberta, Canada

August

- 11-16 6th International Conference on Case Histories in Geotechnical Engineering*
Washington, D.C.

Additional information on TRB meetings, including calls for abstracts, meeting registration, and hotel reservations, is available at www.TRB.org/calendar. To reach the TRB staff contacts, telephone 202-334-2934, fax 202-334-2003, or e-mail lkarson@nas.edu. Meetings listed without a TRB staff contact have direct links from the TRB calendar web page.

*TRB is cosponsor of the meeting.

The Box

Marc Levinson. Princeton University Press, 2006; 376 pp.; \$24.95; 0-691-12324-1. Economist Levinson traces out the story of the shipping container, beginning with iconoclastic entrepreneur Malcom McLean, the container's inventor and founder of the intermodal cargo transporter, SeaLand Incorporated.



The container's development from an impractical idea to a massive industry of cost-efficient goods transport is examined, as are the decade of struggle leading to the container's wide adoption; its role in globalization and in the rise of the Asian "tiger" economies; its effect on transportation costs and the economy; and container-related port security issues, including the U.S. government's 2006 negotiations with a Dubai-based company regarding a bid to take over terminal operations at several U.S. ports.

Uncommon Carriers

John McPhee. FSG, 2006; 248 pp.; \$24; 0-374-28039-8. First published as a series of articles in *The New Yorker* magazine, this seven-chapter book recounts McPhee's experiences with persons working in various capacities in the freight transportation industry.

The author recounts a journey on the road from Atlanta to Tacoma with a chemical tanker operator; attends ship-handling school at a pond in the French Alps, where ship captains refine their skills on 20-foot scale models; spends time at UPS Air's distribution hub at the Louisville International Airport; travels up the Illinois River on a towboat; rides in the cabs of coal trains in Nebraska, Kansas, and Wyoming; and follows in the footsteps of Henry David Thoreau, traveling by canoe up the canal-and-lock commercial waterways of the Merrimack and Concord rivers.

**Hurricane Katrina: Performance of Transportation Systems**

Edited by Reginald DesRoches. American Society of Civil Engineers, 2006; 76 pp.; \$49; 0-7844-0879-3. During Hurricane Katrina, the infrastructure of Louisiana and the Gulf Coast suffered heavy damage that was not limited to the levees of New Orleans. Bridges sustained damage and collapse, and many roadways were impeded by piles of rock and debris. This book provides a comprehensive evaluation of the Gulf Coast's bridge, railroad, and roadway performance after the hurricane.

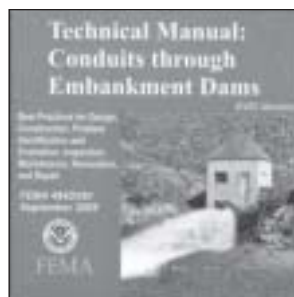


Topics include an overview of the hurricane damage; an examination of the Gulf Coast's emergency preparedness; highway bridges, railroad, and roadway performance and repair; rerouting and traffic demands; impacts on new design; and a discussion of the lessons learned.

Technical Manual: Conduits Through Embankment Dams

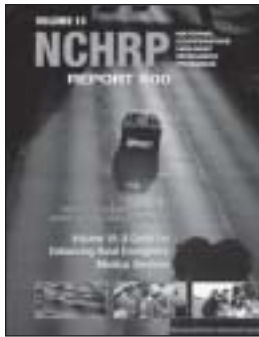
Federal Emergency Management Agency, 2006; DVD. Conduits convey water from a reservoir through, under, or around an embankment dam in a controlled manner. Thousands of conduits through embankment dams in the United States are aging and deteriorating, and suffer from poor construction and infrequent inspection.

To address growing concerns, the Federal Emergency Management Agency has released this technical manual to provide procedures and guidance for best practices concerning design, evaluation, inspection, maintenance, renovation, and repair associated with conduits through embankment dams. The manual is intended for use by personnel familiar with embankment dams and conduits, such as designers, inspectors, construction oversight personnel, and dam safety engineers.



The books in this section are not TRB publications. To order, contact the publisher listed.

TRB PUBLICATIONS



Guidance for Implementation of the AASHTO Strategic Highway Safety Plan: A Guide for Enhancing Rural Emergency Medical Services
NCHRP Report 500, Volume 15

This volume of *NCHRP Report 500* presents strategies to enhance rural emergency medical services to increase survivability of highway crashes. These strategies are intended to cost relatively little and to be ready to implement in a short time.

126 pp.; TRB affiliates, \$18.75; nonaffiliates, \$25. Subscriber category: safety and human performance (IVB).



Surface Transportation Security: System Security Awareness for Transportation Employees
NCHRP Report 525, Volume 7

Volume 7 of *NCHRP Report 525* is a CD-based, interactive, multimedia training course to help transportation employees, supervisors, and managers define their roles and responsibilities in transportation system security, recognize suspicious activities and objects, observe and report relevant information, and minimize harm to themselves and others. Course modules focus on system security, reducing vulnerability, identifying suspicious activity and suspicious objects, setting top priorities, and preparation.

2006; TRB affiliates, \$11.25; nonaffiliates, \$15. Subscriber categories: planning and administration (IA); highway operations, capacity, and traffic control (IVA); safety and human performance (IVB); security (X).



Value Engineering Applications in Transportation
NCHRP Synthesis 352

This synthesis recognizes the reported best practices, key strengths, and challenges of current value engineering (VE) study processes and agency programs in the United States and Canada. It is intended to serve as a guide to those agencies interested in applying VE and/or improving the effectiveness of VE in their projects and programs. Key topics discussed include policies, guidelines, and selection; education and awareness; applications; implementation; monitoring; and future needs.

2005; 125 pp.; TRB affiliates, \$15; nonaffiliates, \$20. Subscriber categories: planning and administration (IA); highway and facility design (IIA).

Inspection and Maintenance of Bridge Stay Cable Systems
NCHRP Synthesis 353

Both short- and long-term approaches to inspection and maintenance of bridge stay cable systems are identified and explained in this synthesis of prac-

tice. Topics include methods for inspections and assessments, repair and retrofit, methods for control of cable vibrations, identifying stay cable fatigue and failure, the effectiveness of various inspection and repair methods, the limitations of available technologies, and trends and recommendations for future study.

2005; 75 pp.; TRB affiliates, \$12.75; nonaffiliates, \$17. Subscriber categories: bridges, other structures, and hydraulics and hydrology (IIC); maintenance (IIIC).

e-Transit: Electronic Business Strategies for Public Transportation—The Successful Adoption of Web-Based Collaborative Software
TCRP Report 84, Volume 7

Through three case studies, this report describes how web-based tools have been used to assist in controlling and managing active and planned construction projects, including schedules and costs. Also examined are ways that web-based collaborative software has helped engineers to share knowledge across varied programs and contracts and to create and enhance supply chain relationships.

2005; 66 pp.; TRB affiliates, \$15.75; nonaffiliates, \$21. Subscriber category: public transit (VI).

Car-Sharing: Where and How It Succeeds
TCRP Report 108 (with supporting material on CD-ROM)

This report examines the development and implementation of car-sharing services. Issues addressed include the role of car-sharing in enhancing mobility; the characteristics of car-sharing participants and of the neighborhoods in which car-sharing has been established; and the environmental, economic, and social impacts of car-sharing. The report also looks at car-sharing promotional efforts, barriers to car-sharing and ways to mitigate the barriers, and procurement methods and evaluation techniques for achieving car-sharing goals. The CD-ROM packaged with the report includes an appendix with information about introducing organizations to car-sharing and encouraging partnerships to initiate car-sharing programs.

2005; 254 pp.; TRB affiliates, \$30.75; nonaffiliates, \$41. Subscriber categories: planning and administration (IA); public transit (VI).

A Guidebook for Developing and Sharing Transit Bus Maintenance Practices
TCRP Report 109

This report offers detailed instructions on how to develop a bus maintenance practice appropriate to

TRB PUBLICATIONS (continued)

the local operating environment and provides seven case studies of specific maintenance practices developed according to the guidebook process. Other instructions include how to access and use the online web board sponsored by TRB's Transit Fleet Maintenance Committee to develop maintenance practices and to share information on transit bus maintenance practices with representatives of other transit agencies.

2005; 112 pp.; TRB affiliates, \$18; nonaffiliates, \$24. Subscriber category: public transit (VI).

On-Board and Intercept Transit Survey Techniques
TCRP Synthesis 63

This synthesis documents and summarizes transit agencies' experiences with planning and implementing self-administered surveys distributed on board buses and railcars and in stations, as well as interviews conducted in these environments. The result is an overview of industry practice covering a range of issues to address in planning a survey.

2005; 91 pp.; TRB affiliates, \$14.25; nonaffiliates, \$19. Subscriber category: public transit (VI).

Commercial Motor Vehicle Driver Safety Belt Usage
CTBSSP Synthesis 8

This report identifies and documents (a) motivating factors that influence commercial motor vehicle (CMV) drivers in deciding whether to wear safety belts and (b) research and practices that address CMV safety belt use. In addition, ergonomic and human engineering factors related to the design and use of safety belts in CMVs are revised, along with approaches by truck manufacturers to facilitate safety belt use.

2005; 52 pp.; TRB affiliates, \$12; nonaffiliates, \$16. Subscriber categories: operations and safety (IV); public transit (VI); freight transportation (VIII).

Literature Review of Health and Fatigue Issues Associated with Commercial Motor Vehicle Driver Hours of Work

CTBSSP Synthesis 9

The Federal Motor Carrier Safety Administration specifically requested this literature review to provide information relating to the Hours of Service regulations issued in January 2004. The synthesis contains a general literature review of health issues from 1975 to the present and fatigue issues from January 2004 to the present associated with commercial vehicle driver hours of service. Also included is a literature review of references cited in response to a related FMCSA January 2005 Notice of Proposed Rulemaking. Strictly a literature review,

this synthesis does not contain any conclusions or recommendations.

2005; 195 pp.; TRB affiliates, \$21.75; nonaffiliates, \$29. Subscriber categories: operations and safety (IV); public transit (VI); freight transportation (VIII).

Railroads: Intercity Rail Passenger; Track Design and Maintenance; and Other Topics

Transportation Research Record 1916

Researchers address customers' reactions to the introduction of high-speed rail service in Korea, alternatives for railroad traffic simulation analysis, options for improving the energy efficiency of intermodal freight trains, the development of a new metric for release risk from a tank car, and methods for allocating costs of empty railcar movements.

2005; 95 pp.; TRB affiliates, \$33.75; nonaffiliates, \$45. Subscriber category: rail (VII).

Data Initiatives

Transportation Research Record 1917

Studies include the development of a more accurate, cost-effective methodology for estimating vehicle miles traveled, a reality-based approach to soliciting stated preference data, possible causes of loop errors under non-forced-flow traffic conditions, and wireless magnetic sensor networks as a low-cost alternative to inductive loops for traffic measurement.

2005; 204 pp.; TRB affiliates, \$42.75; nonaffiliates, \$57. Subscriber category: planning and administration (IA).

Traffic Control Devices, Visibility, and Rail-Highway Grade Crossings 2005

Transportation Research Record 1918

Research topics in this volume include factors affecting safety at rail-highway grade crossings, the legibility of unlit freeway guide signs, the flashing yellow arrow in traffic signal displays, radius-estimating techniques for horizontal curves, and the effectiveness of dynamic speed display signs.

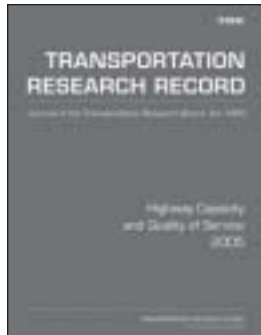
2005; 127 pp.; TRB affiliates, \$37.50; nonaffiliates, \$50. Subscriber category: highway operations, capacity, and traffic control (IVA).

Rigid and Flexible Pavement Design 2005

Transportation Research Record 1919

Authors provide an engineering solution for predicting the remaining failure strength of partially cracked concrete and an historical overview of methods for predicting cracking in concrete pavement. Findings are presented from several research projects on flexible pavement related to the AASHTO 2002 design guide.





TRB PUBLICATIONS (continued)

2005; 170 pp.; TRB affiliates, \$39.75; nonaffiliates, \$53. Subscriber category: *pavement design, management, and performance (IIB)*.

Highway Capacity and Quality of Service 2005 Transportation Research Record 1920

Issues addressed include improved methods for analyzing the capacity and service of interchange ramp terminals, the influence of nonmotorized road users on motor vehicles at intersections without traffic signals, and a calibration and validation process for the *Highway Capacity Manual* model for control delay at signalized intersection approaches.

2005; 130 pp.; TRB affiliates, \$37.50; nonaffiliates, \$50. Subscriber category: *highway operations, capacity, and traffic control (IVA)*.

Travel Demand 2005

Transportation Research Record 1921

Topics covered in this volume include a system for modeling commercial vehicle movements in a Canadian city, a proposal to incorporate trip-chaining behavior in network equilibrium models, the importance of parking cost in determining mode choice, and forecasting travel demand with a multimodal activity-based system developed for use in Florida.

2005; 140 pp.; TRB affiliates, \$37.50; nonaffiliates, \$50. Subscriber category: *planning and administration (IA)*.

Safety: Older Drivers; Traffic Law Enforcement; Management; School Transportation; Emergency Evacuation; Truck and Bus; and Motorcycles

Transportation Research Record 1922

Researchers examine the responses of cognitively impaired older drivers to emergency vehicles, the crash cost savings associated with red-light cameras, the design of safe roadways within and around schools in Texas, the modeling of contraflow freeway traffic under evacuation conditions, and the safety effects of separate roads for trucks.

2005; 187 pp.; TRB affiliates, \$41.25; nonaffiliates, \$55. Subscriber category: *safety and human performance (IVB)*.

Network Modeling 2005

Transportation Research Record 1923

Described are models for online dispatching and routing of emergency vehicles, estimating a truck origin-destination matrix based on the value of the commodity shipped, evaluating flexible transit system designs with microsimulation, planning advance strategies for the management of major freeway incidents, and predicting bus arrival times.

2005; 245 pp.; TRB affiliates, \$44.25; nonaffiliates, \$59. Subscriber category: *planning and administration (IA)*.

Management and Public Policy 2005

Transportation Research Record 1924

Studies explore ways that intelligent transportation devices—such as signs and ramp meters—could help older drivers use freeways; assess the potential demand for new academic programs in transportation and logistics in Rhode Island; examine whether transport megaprojects in Hong Kong and China could be designed to benefit local areas as well as global interests; and reveal how improvements to a New Jersey Transit rail line could decrease stress and job strain for commuters.

2005; 237 pp.; TRB affiliates, \$44.25; nonaffiliates, \$59. Subscriber category: *planning and administration (IA)*.

Freeway Operations, High-Occupancy Vehicle Systems, Traffic Signal Systems, and Regional Transportation Systems Management 2005

Transportation Research Record 1925

Researchers evaluate wireless location technology and its accuracy in estimating speeds, the results of removing bottlenecks Texas freeways, and strategies for integrating the operations of diamond-interchange and ramp-metering signals. Examining video vehicle detection technology at signalized intersections, the subject of the 2005 D. Grant Mickle Award paper, is also included in this volume.

2005; 271 pp.; TRB affiliates, \$47.25; nonaffiliates, \$63. Subscriber category: *highway operations, capacity, and traffic control (IVA)*.

Traveler Behavior and Values 2005

Transportation Research Record 1926

This volume contains a Fred Burggraf Award-winning paper describing the design of survey questions concerning advance travel activity planning and examines the results in detail. Other studies cover such topics as the use of Global Positioning System data for analyzing commuter route choices and the applicability at the national level of regional data on traveler preferences for park-and-ride facilities in the Netherlands.

2005; 259 pp.; TRB affiliates, \$45.75; nonaffiliates, \$61. Subscriber category: *planning and administration (IA)*.

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INFORMATION FOR CONTRIBUTORS TO

TR NEWS

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FEATURES are timely articles of interest to transportation professionals, including administrators, planners, researchers, and practitioners in government, academia, and industry. Articles are encouraged on innovations and state-of-the-art practices pertaining to transportation research and development in all modes (highways and bridges, public transit, aviation, rail, and others, such as pipelines, bicycles, pedestrians, etc.) and in all subject areas (planning and administration, design, materials and construction, facility maintenance, traffic control, safety, geology, law, environmental concerns, energy, etc.). Manuscripts should be no longer than 3,000 to 4,000 words (12 to 16 double-spaced, typed pages). Authors also should provide appropriate and professionally drawn line drawings, charts, or tables, and glossy, black-and-white, high-quality photographs with corresponding captions. Prospective authors are encouraged to submit a summary or outline of a proposed article for preliminary review.

RESEARCH PAYS OFF highlights research projects, studies, demonstrations, and improved methods or processes that provide innovative, cost-effective solutions to important transportation-related problems in all modes, whether they pertain to improved transport of people and goods or provision of better facilities and equipment that permits such transport. Articles should describe cases in which the application of project findings has resulted in benefits to transportation agencies or to the public, or in which substantial benefits are expected. Articles (approximately 750 to 1,000 words) should delineate the problem, research, and benefits, and be accompanied by one or two illustrations that may improve a reader's understanding of the article.

NEWS BRIEFS are short (100- to 750-word) items of interest and usually are not attributed to an author. They may be either text or photographs or a combination of both. Line drawings, charts, or tables may be used where appropriate. Articles may be related to construction, administration, planning, design, operations, maintenance, research, legal matters, or applications of special interest. Articles involving brand names or names of manufacturers may be determined to be inappropriate; however, no endorsement by TRB is implied when such information appears. Foreign news articles should describe projects or methods that have universal instead of local application.

POINT OF VIEW is an occasional series of authored opinions on current transportation issues. Articles (1,000 to 2,000 words) may be submitted with appropriate, high-quality illustrations, and are subject to review and editing. Readers are also invited to submit comments on published points of view.

CALENDAR covers (a) TRB-sponsored conferences, workshops, and symposia, and (b) functions sponsored by other agencies of interest to readers. Notices of meetings should be submitted at least 4 to 6 months before the event.

BOOKSHELF announces publications in the transportation field. Abstracts (100 to 200 words) should include title, author, publisher, address at which publication may be obtained, number of pages, price, and ISBN. Publishers are invited to submit copies of new publications for announcement.

LETTERS provide readers with the opportunity to comment on the information and views expressed in published articles, TRB activities, or transportation matters in general. All letters must be signed and contain constructive comments. Letters may be edited for style and space considerations.

SUBMISSION REQUIREMENTS: Manuscripts submitted for possible publication in *TR News* and any correspondence on editorial matters should be sent to the Director, Publications Office, Transportation Research Board, 500 Fifth Street, NW, Washington, DC 20001, telephone 202-334-2972, or e-mail jawan@nas.edu.

- ◆ All manuscripts should be supplied in 12-point type, double-spaced, in Microsoft Word 6.0 or WordPerfect 6.1 or higher versions, on a diskette or as an e-mail attachment.

- ◆ Submit original artwork if possible. Glossy, high-quality black-and-white photographs, color photographs, and slides are acceptable. Digital continuous-tone images must be submitted as TIFF or JPEG files and must be at least 3 in. by 5 in. with a resolution of 300 dpi or greater. A caption should be supplied for each graphic element.

- ◆ Use the units of measurement from the research described and provide conversions in parentheses, as appropriate. The International System of Units (SI), the updated version of the metric system, is preferred. In the text, the SI units should be followed, when appropriate, by the U.S. customary equivalent units in parentheses. In figures and tables, the base unit conversions should be provided in a footnote.

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