Commission Briefing Paper 4M-01
Review of Proposals and Alternative Concepts for Significant Systematic Expansions to U.S. Ports and Waterway Infrastructure

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Introduction

This paper is part of a series of briefing papers to be prepared for the National Surface Transportation Policy and Revenue Study Commission authorized in Section 1909 of SAFETEA-LU. The papers are intended to synthesize the state-of-the-practice consensus on the issues that are relevant to the Commission's charge outlined in Section 1909, and will serve as background material in developing the analyses to be presented in the final report of the Commission.

The objective of this paper is to identify, document and evaluate emerging concepts for systematic expansions to U.S. ports and waterway infrastructure that go beyond simple productivity enhancements, which could be applied to the waterborne (marine and inland river), intermodal rail, and non-conventional modes for freight distribution. The review of concepts for the systematic expansion of U.S. highway, transit, and freight and passenger rail infrastructure is addressed in separate briefing papers prepared for the Commission.

Background and Key Findings

In the past half century, market-driven changes in the maritime industry have impacted the operation of U.S. marine terminals and seaports throughout the world. The increasing size of cargo ships and the innovations in automated loading equipment have intensified competition among ports to increase productivity. However, U.S. port performance levels are significantly less than competing European and Asian ports. [1] Coming decades will see a reversal of that trend as economic and social pressures force the implementation of increased efficiency measures.

Key considerations for U.S. ports and waterway infrastructure are as follow:

- Technology exists to integrate port and inland distribution through dedicated corridors and information systems. This "systems integration" of port and intermodal infrastructure has a high probability of yielding significant future productivity gains.

- Urbanized port areas experience significant traffic congestion due to inland transport of freight. This congestion can often be mitigated by use of dedicated corridors and off-peak operations. However, the cost is usually borne by the carrier or the terminal operator, while the benefit is perceived to go to the local municipality.

- U.S. port land and waterfront resources are not being utilized at the productivity seen in many Asian and European ports. This can be remedied by investment in high density goods handling and storage equipment and by modifying or improving the way the terminal is operated. However, it is often difficult for the terminal operators to justify the investment based solely on economic return.

Alternative Concepts

Since the advent of containerization nearly fifty years ago, the freight shipping industry has seen multiple innovations and improvements in cargo handling technologies. Chief among these technologies are:

- Modern container gantry cranes
- Computerized container terminal operating systems
- High density storage
- Intermodal rail transfer

These innovations have been largely driven by the need for economic efficiency and return on investment. However, we are currently at a cusp, where congestion, shortage of land, and inland distribution constraints will require new innovations with potentially high development costs. New innovations have been proposed or implemented on a limited basis to answer those needs that fall into five categories:

- Integrated port-distribution systems
- Intelligent transportation systems and information technology
- Advanced port systems
- Port infrastructure enhancements
- Alternative vessel systems

- Each of these categories answers a different set of needs and presents its own challenges. The innovation currently under consideration are discussed by category as follows:

Integrated port-distribution systems

One of the most promising concepts for systemic expansion of the U.S. port infrastructure is the merger of port and inland distribution terminals into an integrated system. Several proposals have been initiated and are in the testing or implementation stage.

Agile Port System (APS) - The APS concept increases throughput capacity of marine terminals by transferring cargo direct from ship to rail and transporting the cargo to an inland site for sorting and distribution. This process allows more efficient ship to berth transfer and makes the port "agile" for a variety of cargo sources including military deployment.

Inland Corridors – Dedicated freight corridors from the port to an inland location can ease congestion in the urbanized areas surrounding the port and increase cargo velocity, thereby reducing the need for storage area. The best known of these is the Alameda Corridor in Southern California.

Electric Container Conveyor (ECCO) Maglev system - This system is an American-based modification of the passenger maglev in use in China and Germany. One application involves the

transport of containers from the Ports of Los Angeles/Long Beach to the Alameda Corridor, and another application currently under study is the transport of containers from the ports to an inland facility.

Linear Induction Motor (LIM) system – Linear motors are currently used widely for smaller scale, manufacturing applications, such as conveyance systems for sorting systems or assembly plants. However, the technology is scaleable to larger tasks, including container transfer within marine terminals, as well as to inland facilities. The high capacity of the system along with its potential for constant and uninterrupted service can offer a port-inland terminal linkage.

SeaPoint automated ship to barge system – For river ports such as New Orleans or large estuary systems such as San Francisco Bay or Chesapeake Bay it could be possible to use automated cranes to transfer directly from a ship to multiple smaller barges for local distribution. The container storage and sorting functions that normally are conducted on land could be conducted as a part of the barge delivery process.

Intelligent transportation systems and information technology

The use of information technology can often preclude inefficient container movements and reduce the land area necessary for storage and distribution of cargo. These technologies either increase the cargo velocity, increase the density of the cargo storage, or allow cargo in transit to arrive at the port on a just-in-time basis.

Advanced traffic management using electronic data interchange (EDI) - EDI provides in-transit cargo visibility via an electronic medium such as the internet. EDI allows shipping lines, haulage companies, carriers, and terminal operators. to actively and effectively balance transportation and logistics demand and supply in order to minimize congestion and maximize capacity and flexibility.

Automatic vehicle and container identification systems - Radio frequency identification devices (RFID), automated equipment identification (AEI) tags, and bar code systems are used for remote identification of equipment and control of container and chassis inventory. Overall, these technologies provide real-time information, in-transit visibility, vehicle and cargo identification and location, and shipment tracking.

Virtual container yards – The purpose of a virtual container yard is to post critical information on cargo and container status and location; facilitate communication between participating parties and permit container interchanges to take place without redundant moves. The Port of Long Beach plans to initiate a virtual system next year for control of empty containers.

Appointment/notification systems - These systems consist of a communication network that relays cargo arrival and departure information to rail and trucking companies, which allows vehicles to be dispatched when the container is available for loading. These systems speed up entrance procedures, reduce queues and bottlenecks in the terminals, increase velocity and reduce truck emissions.

Automated exports systems (Smart Port) - AES is a U.S. Customs Service test program that allows shippers to enter export declaration information electronically and submit it directly, expediting container inspections at ports. Kansas City's SmartPort has become the preferred model to follow for streamlining cargo processing through information assimilation.

Off-peak and extended port operations (Pier Pass) – Port administrations can provide financial inducements and penalties to encourage longer terminal hours of operation and off peak port traffic on the highways. The Ports of Long Beach and Los Angeles have initiated such a system to reduce freeway congestion.

Advanced port systems

Many systems have been proposed for applying advanced materials handling technologies to port operations. In general, these can be categorized as overhead handling system, rack storage systems, or fully automated terminals that use a combination of storage and automated shuttle carriers. Generally, this advanced port automation is designed to result in higher storage density on the terminal.

Grid Rail Container Handling System - The system consists of overhead container handling shuttles moving on an overhead rail grid using linear induction motors. The system allows dense container stacking, with fast storage and retrieval. Systems using the grid rail concept include AutoGO by Titan Global Technologies and Speedport designed by ACTA.

Automated container terminal - An automated container terminal can consist of various combination of automatic container handling equipment. Automated Guided Vehicles (AGV) are unmanned vehicles that move containers between the wharf and the storage. Automated Stacking Cranes (ASC) move on rails and are used in terminal operations for the retrieval and storage of containers. Combined, they form a fully automated container terminal.

Automated storage/retrieval systems (AS/RS) – AS/RS is a storage system that uses fixed-path storage and retrieval machines (SRM) running on one or more rails between fixed arrays of storage racks. The SRM simultaneously moves horizontally and vertically to reach the desired location. Implementing AS/RS in a container terminal could improve space utilization and reduce cycle time in container terminal operations.

Port infrastructure enhancements

Terminal acreage has become a premium in most ports due to a combination of urban pressures on existing waterfront, environmental concerns for vanishing wetlands, and growing demand for additional cargo. Therefore, there are several measures that have been taken or could been taken to increase the efficiency of the existing marine terminal property.

High Density Gantry Systems – Container ports usually store import and export cargo for anywhere from three to ten days. High density rubber tired gantries (RTG) and rail mounted gantries (RMG) are being developed and deployed that can increase terminal storage capability by a factor of nearly 150% over what is commonly in use in the U.S.

Chassis pools – A shared chassis pool is a regional pool of intermodal container chassis that can be used by different companies and truckers eliminating the need for truckers to bring their own chassis or shipping lines from storing chassis on their terminals.

Inland ports - Inland ports are remote centers that capture non-local cargo transported from marine terminals via express rail services while avoiding coastal congestion. Inland ports serve as satellites for cargo collection and distribution which lowers container dwell times on the terminal and reduces inventory costs.

"Ship-in-a-slip" system – The ship-in-a-slip concept is an indented berth that allows a ship to be berthed in a slip and serviced from both sides. With this configuration, as many as nine cranes can operate on the ship at one time, nearly doubling the vessel to wharf productivity.

Tandem-lift cranes – Gantry cranes equipped with tandem lift spreaders offer the opportunity to increase the productivity of each lift cycle, due to its ability to twin-lift 40' or 45' containers, or simultaneously lift two or four 20' containers. Under current OSHA regulations, tandem lifting of loaded containers is prohibited in the U.S.

Collapsible containers - Several conceptual designs of foldable containers have been proposed and two of these are currently being introduced to the market. The potential efficiencies of operating collapsible containers could lower marine and surface transport costs with a more efficient use of space at terminals and aboard ships.

Alternative vessel systems

Since the advent of containerization there have been many advances in container ship design. The implementation of some of these advances in U.S. foreign and domestic container trade could improve port productivity or relieve highway and rail congestion.

"Mega" container ships – Container ship evolution has produced larger and larger vessels in the past three decades, with the largest of these now nearly 10 times the capacity of first generation ships. The economies of scale that drive this trend are substantial, therefore the trend can be expected to continue. Larger ships will require higher cargo velocity at the port to accommodate the surge that occurs during a vessel call.

Container-on-barge - Container-on-barge, otherwise known as short-sea shipping, is a highly successful alternative for road and rail freight movements in Europe, the Pacific Northwest, and other places in the world. The use of container barges allows for the transport of high value commodities typical of interstate truck traffic.

Mid-stream transfer - The operation of cargo and containers to and from vessels alongside, usually where a larger vessel is distributing to smaller "feeder" vessels. Mid-stream transfer is used in the U.S. for bulk products and in Asia for containers.

High speed ships – Several initiatives are underway to develop high speed container ships to fill the niche between conventional container shipping and air freight. Generally, high speed ships

require a dedicated marine terminal having specialized high speed container loading/off-loading equipment.

Evaluation of Alternative Concepts

An objective evaluation of alternatives can be made that is based on the current published literature. This evaluation cannot judge the viability of the concepts, but rather their current state of development. In some cases, the categories are not mutually exclusive and some concepts can fall into more than one category.

Category #1: Speculative, but credible and possible in the future (to the extent that we currently understand the technology)

Category #2: Under serious consideration, but not currently viable

Category #3: Under development or in the demonstration project stage

Category #4: In service overseas, but not implemented in the U.S.

Category #5: Being tested or used on a limited basis in the U.S.

Evaluation Matrix

ALTERNATIVE CONCEPTS	CATEGORY				
	# 1 Speculative But Credible	# 2 Under Serious Consideration	# 3 Under Development	# 4 In Service Oversees	# 5 Being Tested or Used in the U.S.
Agile Port System (APS)			X		X
Dedicated Freight Corridors					X
Electric Container Conveyor (ECCO)	X				
Maglev system Linear Induction Motor (LIM) system	X				
SeaPoint automated ship to barge system			X		
Advanced traffic management using electronic data interchange (EDI)					X
Automatic vehicle and container identification systems					X
Virtual container yards		X			
Appointment/notification systems				X	X
Automated exports systems (Smart Port)					X
Grid Rail Container Handling System			X		
Automated container terminal				X	X
Automated storage/retrieval systems (AS/RS)	X				
High Density Gantry Systems				X	X
Chassis pools					X
Inland ports					X
"Ship-in-a-slip" system		X			
Tandem-lift cranes				X	
Collapsible containers	X				
“Mega” container ships				X	X
Container-on-barge				X	X
Mid-stream transfer				X	
High speed ships			X		

Conclusions

Of the innovations previously discussed, some are likely to have an impact on U.S. ports and inland intermodal operations in the near future. These include alternatives with potential economic benefits that will justify their cost or alternatives whose social benefits exceed the public cost of implementation. A brief discussion of each, and their impacts follow.

Agile Ports, Dedicated Corridors, Inland Ports and other integrated port-inland developments: Probably the most significant development in the near future will be the integration of the marine container ports with dedicated inland distribution infrastructure. This integration will increase

marine operation and cargo distribution efficiencies while reducing local port traffic congestion. However, it will require substantial investment in common user infrastructure that cannot or will not be supported by the private sector without direct investment and coordination on the state and federal level.

Advanced Traffic Management, Appointment Systems, and other IT based logistics management tools: Many of the Nation's port municipalities will be looking at IT based logistics and traffic management tools to reduce city congestion due to port traffic. These tools are being developed to manage truck arrivals and off-peak gate operations as well as to reduce unnecessary truck trips. Currently, there is a conflict between the ports and terminal operators that are expected to implement and operate such systems and the municipalities that are seen as the direct beneficiaries. Additionally, there is reluctance on the part of carriers and cargo owners to relinquish the data necessary to operate a logistics management system that may provide an advantage to their competitors. These impediments to implementation of IT based systems will probably only be overcome through intervention on the local, state and possibly federal level.

High Density Gantry Systems, Terminal Automation, and other high density storage modes: Many North American ports are beginning to densify their storage through the use of advanced container handling equipment. However, this is an expensive proposition and is often not supported by local labor. Increased utilization of scarce port land is going to require both political and financial support in order to bring U.S. productivity rates to world standards.

CONSOLIDATED COMMENTS FROM MEMBERS OF THE BLUE RIBBON PANEL OF TRANSPORTATION EXPERTS - PAPER 4M-01

One reviewer commented as follows:

The paper lays out a good, wide variety of options to improve the ability to move waterborne cargo. It would be valuable if a corollary discussion took place that addresses the issue of cost, both with respect to this paper as well as to the concept of system capacity, in general, be it for cargo, trucks, autos or transit passengers. The theme that "it's going to cost everyone more" needs to be inculcated into discussions.

The paper has a slight slant towards cargo movement, but, for example, while the paper notes that dedicated corridors and off-peak operations are seen as a benefit to the local community while the carrier or terminal operator bears the cost, the fact is that the carrier/shipper/terminal operator also benefit from the reduced congestion. Here again, however, the concept that it's going to cost the consumer more, whether via taxes, tolls or higher priced goods at the market, needs to be included in the discussions.

While not specifically the focus of this paper, some of the ITS-related options have a corollary security benefit, that could be noted. E.g., RFID tags can, with other infrastructure investments, be used to ensure that a vehicle has been checked, has not gone "off course", and does not need to be checked again along its route, saving time for the operator and allowing police or other inspection agents to concentrate on those vehicles that have not been previously inspected.

While the Jones Act is addressed in another paper, a discussion of the advantages of repealing it would be useful in this paper as well.

Another reviewer commented as follows:

Congestion can be resolved with better planning and policies and not just with new capacity. Two examples:

- We have, and continue to create, capacity problems by poor land use planning and poor policies. Congestion on I-78 from Pa to NJ to NY has increased substantially since we have railed goods coming into Ports Newark and Elizabeth to in land ports in Allentown, Pa for distribution; and then turns around and trucks the goods for New England, NJ and NY back to these areas on I-78. Why, because Newark and Elizabeth didn't want the distribution activities in their communities. So now everyone pays.

- The Jones Act, addressed in a separate paper, is also applicable here in the discussion of congestion. Short sea shipping would be a major tool for increasing capacity on roads such as I-95 and could also revitalize dying ports such as Boston's. Instead we cling to and "historic" act that has outlived its usefulness and clog our roads with unnecessary truck movements on the corridors such as I-95.

[1] Blair Garcia and Theodore Prince, "Clearing the Way," *Containerization International*, Vol. 38, No. 4 (Apr., 2005), 76-79.