

## A SUMMARY OF INFRASTRUCTURE IMPACTS ASSOCIATED WITH CONTAINERSHIPS ON THE TEXAS TRANSPORTATION SYSTEM

The decade of the 1990s was characterized by substantial growth in U.S. and world trade, much of it moved by intermodal containers. Transportation systems play a critical role in this trade expansion, helping to lower ton-mile costs, ensure higher service levels required by shippers, and improve all transportation modes. The growing demand for containerized shipping stimulated the introduction of larger containerships into the maritime industry which was predicted to have far-reaching effects on the landside and waterside traffic patterns of ports serving such ships.

The purpose of this project is to examine the infrastructure impacts and operational requirements associated with increased maritime freight movement and larger container vessels, as they affect the Texas transportation system. The project is designed to assist decision makers in (1) addressing the planning, institutional, and financial issues associated with increased containerized freight traffic, and (2) assessing the demands on the multimodal transportation system in Texas, contingent on the operation of greater numbers of containerships in the Gulf of Mexico. The planning process for any transportation infrastructure project requires multiple steps in which project planners start at the most general level of study and methodically work their way down to detailed plans and analyses. This project fits within the range of feasibility studies and prepares reports for moving into the major investment study (MIS) stage.

The research conducted in the project can be broadly classified into four categories corresponding to the four main deliverables in the project, (a) an extensive review of mega-containership literature, (b) the development of a load center and contain-

erport evaluation process, (c) the impacts of containership size, service routes, and demand on Texas Gulf Ports, and (d) the development of a GIS-based modeling system to assess the landside impacts of port expansions. The following sections discuss the work undertaken, the results, and recommendations by the research team within this framework.

### What We Did...

#### Review of Mega-Containership Literature

The first step in the project involved an extensive review of mega-containership literature and annotated bibliography examining global trade, the changing maritime sector, and preliminary analysis of trade data and port policies. The research team sought to examine the economics of trade and maritime systems and to address the development of containerization with a focus on mega-containerships. The literature review, as presented in report 1833-1, focused on the following elements:

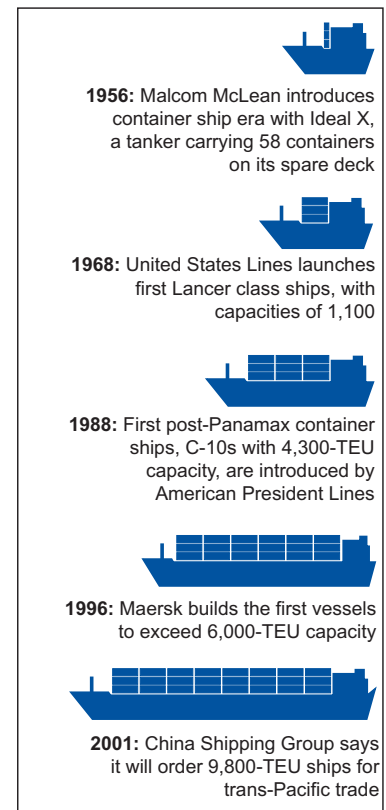
- The trends in world trade and the way in which commodities are shipped across world trading routes.
- The changing world of the ship owner, particularly as it relates to strategic alliances and the demise of the conference system.
- The operations of mega-containerships and the need for a port-vessel interface that enables maritime operations to benefit from the various scale economies produced by mega-containership operations.
- Logistics and global container routes.

In addition to providing valuable insights into the maritime trade industry, the literature review also helped

identify a variety of economic indicators that play a role in the load center selection process.

#### Identification Process and Evaluation Framework for Texas Gulf Containerports

This element of the project developed a process for determining whether a candidate port could become a containership load center on the Texas Gulf—one of the original desires of the sponsor—and subsequently produced a port evaluation process useful to all Texas ports providing (or wishing to provide) containership services.



Ships not drawn to scale

Figure 1: How containerships have grown  
(Source: JoC Week; Jan. 15-21)

The selection and evaluation processes had several goals, which included establishing a sound foundation both in pragmatism and in theory, fairness, relevance, and accessibility.

Some of the questions addressed in this process are: Which “parameters” should be included in the selection process and how should they relate to one another? What is the better approach—heuristic or non-heuristic methods? What should the scoring procedure look like? What kind of weighting methods should be applied to the scoring matrix?

This analysis is meant to identify the constraints to port expansions and to produce a starting point for addressing these problems. This approach focused on the supply side—the operational requirements to handle containerships, port infrastructure, and feasibility of a port serving as a load center or containerport. It was recognized, however, that in evolving transportation strategies, policies, and investment levels (whether private or public), it must be recognized that global container movements constitute a system wherein both supply and demand need to be jointly considered when evaluating containerport operations.

#### [Impacts of Containership Size, Service Routes, and Demand on Texas Gulf Ports](#)

The research team first considered the world container fleet and the two-year order book for new container vessels. This provided insight into the likely supply of container slots on the world routes and allowed conclusions to be drawn on its impact on various markets, including the Texas Gulf. Containership characteristics and technology were also examined to estimate the operating costs for vessels of varying size. The team obtained a specially designed database from Lloyds of London, which allowed the identification of current container routes and vessel size in the North Atlantic and U.S. Gulf. This, combined with other data sources, allowed an assessment of container moves in the U.S. Atlantic and Gulf regions, together with the impact of the larger ships now being introduced on route structure. Finally, some forecasting scenarios were developed to predict likely volumes in the Texas Gulf and the need for a mega-containership load center in that region.

#### [Development of GIS-Based Modeling System](#)

An evaluation of the potential landside traffic impacts of international economic expansion in maritime container freight trade is also necessary to plan an efficient

and productive transportation system. The focus of this part of the project was to contribute toward such impacts by developing a modeling system that can forecast the effects of port expansions, market changes, and network changes on the statewide transportation network.

The research team turned its efforts to developing a port-oriented modeling system that could take as inputs a) the commodity types and trade volumes (throughputs) moving into the port under consideration, b) the markets served by the port and the socio-demographics of the markets, and c) the level-of-service offered by alternative modes from the port to the markets served by the port. The desired outputs from the system are the freight-related traffic changes on the transportation network resulting from changes in one or more inputs. The two main steps involved in developing these models were estimation, which was preceded by extensive data collection, and application. The objective in the estimation stage was to determine the impact of relevant exogenous variables (such as travel impedance, distance of haul, shipment size and county socio-economic characteristics) on the fraction of tonnage moved by rail (as opposed to the fraction moved by road). A binary fractional split model was used for this purpose with quasi-likelihood estimation techniques estimated for seven aggregate commodity types.

#### [What We Found...](#)

The wide variety of issues addressed in this project resulted in five reports, which summarize both findings and recommendations, together with a GIS TransCAD modeling system.

#### [Report 1833-1](#)

This report examined the economies of scale associated with the largest containerships now entering world service and concluded that they were unlikely to be used on liner schedules to Texas ports in the immediate future—defined as a decade. However, the research recognized that global container trade would continue to grow and remain an important element in state transportation planning. On the basis of the findings reported in 1833-1, TxDOT agreed to expand the focus of the research to include all Texas ports handling containers. The annotated bibliography provided corroborative evidence to support a “knock down” effect in world container shipping, whereby the largest ships would be positioned on the northern hemispheric routes, displacing vessels, which would take their place on North Atlantic routes, offering greater speeds but not higher containership

volumes and sizes.

#### [Report 1833-2](#)

This report describes the load center identification and container port evaluation processes. The load center selection matrix includes the following criteria: a) infrastructure requirements (marine access, port operations, etc.), b) environmental impacts (ecological impacts, dredging impacts, etc.), c) locational demand and landside access (market area, proximity to central cities and Mexico, land access, etc.), and d) port finance (estimated costs, public or private port, grants and financial characteristics). The purpose of the container port evaluation process is to provide port operators and landside planners with an organized and methodical approach for considering facility improvements. The evaluation procedure provides an impetus for debate and decision-making, while minimizing the pursuit of unreasonable goals. An evaluation team composed of the port operator, representatives from TxDOT, local transportation planners, and Metropolitan Planning Organization (MPO) planners should collectively carry out the steps of the port evaluation process.

#### [Report 1833-3](#)

The degree of consolidation in the containership liner market, together with the growth of container demand, will heavily influence the size of containership that is placed on any of the North Atlantic and Gulf routes. The deployment of large post-Panamax vessels might well take place in stages, beginning in the North Atlantic (at New York-New Jersey) and moving down to the Mid-Atlantic (Charleston or Savannah) as market conditions permit. It is clear from the analysis that the key ports in the North and Mid-Atlantic regions are better positioned than Gulf ports to service mega-containerships, since they already have the demand, routes, geographic location, and markets to serve larger containerships.

The geographic position of the Gulf Coast, which is some distance from the main Atlantic trade routes, together with the limitations of the regional markets served by Gulf ports, means that Texas locations are not obvious candidates for mega-containership deployment. This is not simply a question of draught depth at various Gulf ports. Currently, the North Atlantic liner schedules have Gulf ports that are either last or first in the string and are therefore rarely fully loaded. And because they are not fully loaded, their draught requirements are less; it would thus be theoretically possible to operate mega-containership liner schedules to ports with



draughts under 50 feet. However, the more important constraint in the Gulf is container demand and the numbers do not appear to support the implementation of very large containerships on Gulf routes.

The continuing globalization in shipping, together with consolidation in liner shipping and the opportunities for larger vessels exhibiting economies of scale, will impact the Gulf in the next 20 years. This potential can be described in three areas.

1. There is likely to be continued strong growth in container movements between the U.S. Gulf and Latin American and Caribbean markets. In some of the latter, these containers will be relayed or transshipped from other markets, which implies that the links between the Caribbean and Texas ports will be better served by feeder ships or conventional Panamax containerships than by very large containerships.
2. There is likely to be moderate-to-modest growth in container demand between Gulf ports and European, Mediterranean, and Middle East markets. This growth may be better served by faster regular containerships capable of maintaining 25 knots or more frequent service schedules of Panamax vessels rather than bigger containerships.
3. Currently the rather slow large liner schedule with Houston could be replaced by a significantly faster vessel of similar size, which could either reduce the numbers of ships needed for each string or speed up the service between the Gulf origins with the foreign market destinations.

Despite the growth of container traffic with Texas Gulf ports, the research results to date suggest that Panamax vessels will adequately service this trade for at least the next decade. European, Mediterranean, and Middle East groups might eventually use mega-containerships on their liner schedules, although it should be remembered that it is perfectly feasible (and economical) to offer a Gulf-based service using faster 4,000 TEU Panamax vessels and improved liner schedules.

#### [Report 1833-4](#)

The economics of trade expansions as they affect port operations were analyzed in great detail. An evaluation of the potential landside traffic impacts of international economic expansion in maritime container freight trade is necessary to plan an efficient and productive transportation system. The focus of this part of the project was to contribute toward such an evaluation of the

potential landside traffic impacts by developing a modeling system capable of forecasting the effects of port expansions, market changes, and network changes on the statewide transportation network.

The research team turned its efforts to developing a port-oriented modeling system that could take the following inputs: a) the commodity types and trade volumes (throughputs) moving into the port under consideration, b) the markets served by the port and the socio-demographics of the markets, and c) the level-of-service offered by alternative modes from the port to the markets served by the port. The desired outputs from the system are the freight-related traffic changes on the transportation network resulting from changes in one or more inputs. The two main steps involved in developing these models were estimation, which was preceded by extensive data collection, and application. The objective in the estimation stage was to determine the impact of relevant exogenous variables (such as travel impedance, distance of haul, shipment size and county socio-economic characteristics) on the fraction of tonnage moved by rail (as opposed to the fraction moved by road). A binary fractional split model was used for this purpose with quasi-likelihood estimation techniques. The mode split models were estimated for seven aggregate commodity types, as described in report 1833-4.

#### [Report 1833-5](#)

The final product is the GIS-based modeling system in TransCAD, the user guide for which is available in report 1833-5. The application of the estimated modal split model to any Texas Port is conceptually straightforward. The inputs required at this stage are: a) trade volumes or “throughput” of the port (both outbound and inbound) by commodity type, b) the markets served by the port and their respective socio-demographics, and c) the level-of-service attributes for travel by truck and rail between the port and each market. These inputs can correspond to a projected situation at a future time. The predicted mode splits are then translated into rail and truck freight movements on the statewide transportation networks using a network assignment procedure.

#### *The Researchers Recommend...*

Two groups of recommendations are made, one covering the potential implementation of products derived from this project and the other covering more broadly based planning and policy issues.

1. Implement a field test of the evaluation method reported in Report 1833-2. In

addition, the tragic events of September 11 have also heightened the need for security in any port evaluation.

2. Implement the GIS TransCAD planning routine as reported in 1833-5. This could be undertaken using the data provided by the ports, developed as a product of current studies sponsored by TxDOT. Or, the planning routine could use new data being reported by the Bureau of Transportation Statistics, or simply be included in new research projects undertaken in the future.
3. The results of this project should be incorporated into the State Transportation Plan to strengthen links to Texas ports handling containers. Containers are going to remain a key element in globalized trade and increasing volumes of containers will be routed onto Texas highways from Gulf ports unless an effective multi-modal strategy is derived.
4. Work should continue to develop a stronger understanding of Texas Gulf port landside issues, particularly as they relate to highways, rail, and barge modes. Currently, a majority of container moves in Texas are undertaken by trucks on highways, and trucks will continue to be the predominant mode in the coming decade. However, there is a strong opportunity to move some of the traffic onto rail within the state (particularly to the Dallas-Fort Worth region) and there may be increasing opportunities to move numbers of containers (particularly empty containers) by barge along the Gulf Intercoastal Waterway.
5. Finally, the dynamic nature of the maritime industry was clearly demonstrated during the time of this project which moved from a period of growth, mergers, and the pursuit of efficiency to bankruptcies, layoffs and a substantial reduction in container moves-and therefore revenue-as the world economies slowed down. This strongly suggests that there should be continued monitoring of this sector by TxDOT in order to keep the Texas Transportation System multi-modal and capable of adjusting to the various demands placed upon it.



## For More Details...

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The research is documented in the following reports:

- 1833-1** *Mega-Containerships and Mega-Containerports in the Gulf of Mexico: A Literature Review and Annotated Bibliography* May 1999; Revised, October 1999; 2nd Revision, May 2000
- 1833-2** *An Identification Process and Evaluation Framework for Texas Gulf Containerships* November 1999; Revised, June 1999; 2nd Revision, December 2000
- 1833-3** *Impacts of Containership Size, Service Routes and Demand on Texas Gulf Ports* March 2001, Revised December 2000
- 1833-4** *Freight Modal Split Modeling: Conceptual Framework, Model Structure, and Data Sources* August 2000
- 1833-5** *Freight Modal Split: Estimation Results and Model Implementation* July 2001

To obtain copies of a report: CTR Library, Center for Transportation Research,  
(512) 232-3138, email: ctrlib@uts.cc.utexas.edu

## TxDOT Implementation Status August 2002

Four products were developed in this project:

1. Load center selection matrix
2. Evaluation framework for containerports
3. GIS-based platform to predict incremental link volumes in response to future port and transportation network scenarios
4. User guide to GIS-based software

All four products have been received. An implementation project has been approved to test the evaluation framework on several Texas ports. This will provide information on the impact of port operations on transportation infrastructure. The GIS platform is being evaluated by the TxDOT Transportation Planning Division (TPP) for use by planners in TPP and in TxDOT Districts that have ports.

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**Your Involvement Is Welcome!**

## Disclaimer

This research was performed in cooperation with the Texas Department of Transportation and the U. S. Department of Transportation, Federal Highway Administration. The content of this report reflects the views of the authors, who are responsible for the facts and accuracy of the data presented herein. The contents do not necessarily reflect the official view or policies of the FHWA or TxDOT. This report does not constitute a standard, specification, or regulation, nor is it intended for construction, bidding, or permit purposes. Trade names were used solely for information and not for product endorsement. The engineer in charge was Chandra R. Bhat (Texas No. pending).



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