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Research Issues in Freight Transportation

Congestion and System Performance

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Research Issues in Freight Transportation

Congestion and System Performance

October 22–23, 2007
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Transportation Research Board
Freight Systems Group
Marine Group
Freight Transportation Data Committee

Kathleen Hancock, *Editor*
Virginia Polytechnic Institute and State University

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Preface

The movement of freight is an important national issue. Not only does freight movement contribute directly to the nation's and states' economies, but eventually all the goods and commodities delivered find their way into the businesses and households of America—therefore, freight affects the quality of life afforded Americans. The freight system is facing serious challenges. Congestion in ports, on access roads to intermodal facilities, and on the rail system has significant impacts on the productivity and competitiveness of the U.S. economy. Environmental issues where freight movement concentrates—such as in ports—are of increasing concern to the surrounding communities. Finding the funds to improve the nation's freight infrastructure relies increasingly on innovative financing mechanisms that combine public and private investment sources.

The nation's research universities have a great deal to offer in finding new solutions to the problems facing the freight system. The purpose of this workshop is to provide a forum for researchers, government officials, and private-sector representatives to exchange ideas on how the freight transportation system can be improved.

An ad hoc committee, chaired by Michael D. Meyer of Georgia Institute of Technology, and selected by the sponsoring committees, carried out the detailed planning for the workshop. This e-circular consists of individually attributed summaries and proposed research needs statements. No language should be construed as consensus findings or recommendations on the part of the workshop, the planning committee, or the sponsoring committees.

The planning committee represented academicians, researchers, analysts, and modelers. The 101 persons attending reflected organizational diversity as follows:

Academic	46%
Federal	22%
State	6%
MPO and local	6%
Consultant and private sector	8%
Rail and marine/port	6%
Other	5%

The Research and Innovative Technology Administration of the U.S. Department of Transportation provided funding to support travel and on-site expenses.

—Kathleen Hancock, *Editor*
Virginia Polytechnic Institute and State University

PUBLISHER'S NOTE

The views expressed in this publication are those of the authors and do not necessarily reflect the views of the Transportation Research Board or the National Academies of Sciences, Engineering, and Medicine. This publication has not been subjected to the formal TRB peer-review process. Due to an administrative oversight, this report was not published right after it was completed in 2007. Therefore, some information about the different research projects and the institutional affiliations of the presenters and workshop participants may not be current. It was decided to release this publication as many of the freight research issues discussed still remain relevant today. A special thanks to Ed Strocko, Office of the Assistant Secretary for Research and Technology, Bureau of Transportation Statistics, U.S. Department of Transportation, for his careful review of this document; he helped ensure that the material reflects the state of freight research today.

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Introduction

MICHAEL D. MEYER
Georgia Institute of Technology

The movement of freight is an important national issue. Not only does freight movement contribute directly to the nation's and states' economies, but eventually all the goods and commodities delivered find their way into the businesses and households of America, and thus freight affects the quality of life afforded Americans. The freight system is facing serious challenges. Congestion in ports, on access roads to intermodal facilities, and on the rail system has significant impacts on the productivity and competitiveness of the U.S. economy. Environmental issues where freight movement concentrates—such as in ports—are becoming of greater concern to the surrounding communities. Finding the funds to improve the nation's freight infrastructure relies increasingly on innovative financing mechanisms that combine public and private investment sources.

The nation's research universities have a great deal to offer in finding new solutions to the problems facing the freight system. The purpose of this workshop is to provide a forum for researchers, government officials, and private-sector representatives to exchange ideas on how the freight transportation system can be improved.

This is the second University Transportation Center–oriented workshop organized by TRB and supported by the U.S. Department of Transportation (DOT) Research and Innovative Technology Administration. The workshop objectives are to:

- Improve collaboration among researchers;
- Encourage interaction and synergies among universities, government, private interests, and TRB committees;
- Define freight-related research opportunities of interest to academia, government, and the private sector; and
- Identify future freight-related critical issues for U.S. DOT personnel and other government staff, including state and metropolitan planning organization staff.

The workshop will serve as a major point of departure for the transportation research community, with participants from all levels of government, the private sector, and the academic community identifying needed freight and logistics research topics.

INTRODUCTORY ADDRESS

Congestion and System Performance Initiatives at the U.S. Department of Transportation

KELLY LEONE
Research and Innovative Technology Administration

Good morning. On behalf of the Research and Innovative Technology Administration (RITA) at the U. S. Department of Transportation (DOT), I am pleased to welcome you to this workshop on Research Issues in Freight Transportation–Congestion and System Performance We are pleased to have the participation of the U.S. DOT-sponsored universities, such as the University Transportation Centers (UTCs), the Federal Aviation Administration's Centers of Excellence, and universities funded under RITA's Remote Sensing in Transportation Program We are also pleased with the level of participation from other U.S. DOT modal administrations, other government agencies, TRB committees, as well as industry representatives from the freight industry.

This is the second of what we are informally calling "spotlight" workshops. They are so named because we hope to use them as one important way that we in the department can shine a bright light on all the excellent work the universities are doing in critical areas. We have over 40 university researchers here this week and I am very pleased that there will be an opportunity for them to present the results of their research, to talk about what they were working on, and for them to meet U.S. DOT and state DOT officials working on freight issues.

Many of us close to the universities are well aware of the work that the UTCs have been doing for years on many of the important areas of transportation. These workshops are an opportunity to make this work more visible to the rest of the department. These workshops are one of the steps that RITA is taking to ensure that the department program staff and DOT officials know about the work of the UTCs and that the UTCs are aware of the department's research needs and priorities.

Freight transportation is one of these important DOT priorities. Secretary Peters has included the identification and implementation of strategies to improve freight transportation as one of the key components of the National Strategy to Reduce Congestion. Of particular relevance to freight transportation are the Corridors of the Future initiative, the Southern California Freight Congestion initiative, the Border Congestion initiatives, and the Operations and Technology Improvements initiative. For example, the Corridors of the Future initiative is aimed at developing innovative national and regional approaches to reduce congestion and improve the efficiency of freight delivery. The selected corridors carry 22.7% of the nation's daily Interstate travel.

As another example of how we are changing the way that research is conducted at the department, we have just established working groups on eight areas for pursuit of intermodal research. We are actively seeking the interest of experts in our UTCs to become involved in the discussions of these working groups. These eight areas include the following:

- Safe transportation in an aging society;
- Human factors research;
- Enhanced safety data and knowledge;

- Congestion reduction policy research and technologies;
- Energy efficiency and alternative fuels;
- Positioning, navigation, and timing systems; and
- System resilience and global logistics.

Over the next 2 days, you will be working to create an environment for increased communication and collaboration among researchers involved in freight research; you will be have the opportunity to identify the synergies among U.S. DOT-sponsored universities conducting freight research; you will help identify research opportunities that have potential to enhance the mobility of freight; and you will help to create an information base on the universities conducting freight research, development, and technology for use by U.S. DOT, other government agencies, TRB, and industry.

The productivity of the freight system to provide timely and reliable service depends not only on the efficiency of individual modal systems and the effectiveness of the laws and regulations under which they operate, but also on the efficiency of intermodal facilities that govern the effectiveness of their connections to one another. U.S. intermodal freight transportation links the various modes to meet customers' market needs by providing integrated origin-to-destination service. It utilizes advanced technologies and operating systems designed to enhance productivity, reduce transportation costs, increase service speed, and quality for shippers and lower prices for consumers.

We will do what we can to provide leadership in the coordination of federal transportation research, including maintaining close dialogue with the private sector and state and local governments, to ensure that DOT research funding reflects the priorities of freight transportation users and providers.

I have every reason to believe that these 2 days will be successful and that they will result in a better understanding of what is going on in freight research and that some new, strong partnerships will be forged during this workshop. Again, thank you for your active participation in this meeting.

SESSION SUMMARY

Measuring the Impact of Congestion on the Economy

SUSIE LAHSENE
Port of Portland, Presider

DAVID GANOVSKI
Maryland Department of Transportation, Recorder

MATTHEW L. GARRETT
Oregon Department of Transportation

ROBERT SAPPIO
Trans-Pacific Trade, APL

TIM LOMAX
Texas Transportation Institute

OPENING COMMENTS

Freight movement is the economy in motion. The globalization of trade has resulted in dramatic growth in freight movement in the United States. Coupled with passenger demand, freight has put unprecedented pressure on the nation's transportation systems, both public and private. Our ability to keep up with this demand will directly affect our economic viability and attractiveness in a global environment. Congestion shrinks market areas and access to labor. More importantly it diminishes business competitiveness by affecting routes and reliability, while increasing land and logistics costs. We must do more to solve congestion issues—it is a matter of economic prosperity, opportunity, and survival.

A STATE DEPARTMENT OF TRANSPORTATION PERSPECTIVE
Matthew L. Garrett, Oregon Department of Transportation

Looking back, the 1956 Highway Act began a legacy of highway construction, with the need to build for future levels a part of this bill. Initially users became accustomed to excess capacity, but that changed when funding levels dropped;1960 spending on highways equaled 2.5% of the state's personal income declined to just .08% in the 1990s. Costs of construction have soared, creating a need for new and innovative ways to deal with congestion. Congestion drives up costs of doing business in Oregon—whether personal travel or freight movements. Transportation plays a vital role in fostering economic activity and affects the state's ability to compete. One in five jobs in Oregon (over 400,000 jobs) is directly transportation related or reliant on efficient transportation systems. Oregon freight is projected to grow by 80% by 2030, however, changes already occurring show evidence that industry is moving to less congested areas in Washington State. People are "voting with their feet." In addition, studies in 2003 identified bridge cracking

in some areas, raising concerns and resulting in some weight limits being lowered to 80,000 gross vehicle weight on I-4 and I-84. As a result, trucks took longer routes, many through small towns that were never designed for such traffic. Oregon Department of Transportation (DOT) went to Oregon State University (OSU) for assistance. OSU developed a model to explain the adverse impacts of bridge weight limits. As a result the Oregon Transportation Investment Act was passed, providing $2.5 billion, of which $1.6 billion has been spent on bridges over the past 3 years. Other work with OSU reveal the need for improved data, understanding of freight flows, and intelligent transportation systems (ITS). New partnerships in modeling are occurring, as is a new transportation research and education consortium. In 2006, Oregon DOT forged a 25-year State Transportation Plan outlining facilities, services, and needs and a Statewide Cost of Congestion Study in 2007. Current needs are improved data; truck-only options; best paybacks; and a fully engaged state freight commission.

A CARRIER'S PERSPECTIVE
Robert Sappio, Trans-Pacific Trade, APL

"Freight is a global problem and predictability is a must." Currently Vietnam, India, Hong Kong, and Singapore are all very congested. Many global investments are directed toward the Far East forcing this growth. Today, many vessels have a capacity of 8,000 TEUs (20-ft equivalent containers). Economies of scale dictate that more 10,000 TEU vessels will be coming online, creating portside issues including labor, adequate-sized cranes, and railroads inland infrastructure capacity.

Today most U.S. ports are already at or near capacity, and APL's position is that the key focus should be improving productivity (TEUs per acre). Currently Europe and Asia are doubling U.S. efficiency. APL expects a big shift of trade to the east coast, up 15% per year. The Panama Canal's expansion will not be completed until 2015 or later. Meanwhile the Suez is improving to provide alternate routes to the east coast from the Far East. East–west train movement velocity has and is decreasing as rail capacity is strained, but meanwhile intermodal rates are up 20%.

Other important factors with potential impacts on international trade include reopening of ILA in July 2008; U.S. presidential election in 2008; and the possible elimination of Steamship Line Conferences by the European Union's 2008 Conference.

A RESEARCHERS PERSPECTIVE
Tim Lomax, Texas Transportation Institute

Lomax cautioned that "this is only one researcher's perspective." Congestion is getting worse. There are huge benefits in solving current and future congestion issues because quality of life, economic development, homes, schools, safety, and security are all impacted. In the United States in 2005 we wasted 2.9 billion gallons of fuel. Hours in congestion have increased from .8 billion in 1982 to 4.2 billion in 2005. He estimates $15 billion in costs in urban truck delay or 195 million truck hours. Our current choices are to grow or to hope for a recession (a bad option). Congestion also affects emergency evacuation plans. Major causes of congestion are bottlenecks and incidents that account for 65% of the problem, and work zones and weather represent 25% more.

As to the solution, no one fix has been found. Fixes vary by region and time of day. Fixes are all about access to jobs, workers, and markets. He asks, “How would we operate if there were no trust fund?” His recommended next steps include discussion of benefits. What do I get for my gas tax increases? He feels the best story tellers will win recognition and funding sources. Meanwhile, the problem is bad and getting worse.

WRAP-UP

The purpose of this effort was to reframe the question around the value of transportation investment to economic prosperity instead of simply convenience. Fifty years ago we knew the importance of transportation to our future. We also knew the importance of investing in that future. I would argue that we are at a similar point today—one that demands the same kind of vision—investment in the transportation system is both an economic benefit and an economic imperative if we value control over our destiny.

SESSION SUMMARY

What Are We Doing About It?

HEATHER NACHTMANN
University of Arkansas, Presider

JOSEPH SCHOFER
Northwestern University, Recorder

EDWARD MCCORMACK
University of Washington

BRUCE WANG
University of Wisconsin, Madison

GENEVIEVE GIULIANO
University of Southern California

THOMAS O'BRIEN
California State University, Long Beach

DEVELOPING TRUCK MOBILITY BENCHMARKS IN WASHINGTON STATE
Edward McCormack

The objectives of this research are to measure the effects of roadway improvements on recurring congestion experienced by trucks and to identify additional opportunities for improvements. The approach uses readily available data sources describing truck volumes, speeds, and travel times in the Seattle metropolitan area and elsewhere in Washington state.

Data on truck performance in the traffic stream are scarce and tend to be project or locally oriented, rather than networkwide. Yet there are important data sources that can be tapped—loop detectors, permanent count stations, and GPS navigators coupled with transponders on trucks. While on-board systems are intended for such purposes as fleet management, toll collection, weigh-in-motion, and border crossing clearance, such data offer a potentially rich and inexpensive source of more general truck performance measures.

Transponders offer the advantage that truck operators have incentives to purchase these for vehicle tracking and rapid clearance. To make use of such data, there is a need for roadside transponder readers to query vehicles as they pass, record data, and provide a basis for comparing vehicle passages to gauge roadway performance. The primary disadvantage of this data source is limited network coverage, particularly outside urban areas and in some cases, on road sections of special interest.

However, the cost of transponder readers has been coming down rapidly, making both permanent and portable roadside readers a feasible option for gathering truck performance data. Together, transponders and readers provide near–real-time data at reasonable cost.

In this research, roadside readers were networked to compare passage times of vehicles. The analysis algorithm "anonymized" data to protect privacy. Data were screened to identify the fastest truck passage over a section for a given time period, and this was assumed to be the valid performance measure; trucks making slower passages were assumed to do so for other, voluntary reasons, thus eliminating biases caused by trucks making stops between roadside readers.

In addition to road sections, reader data was used to assess processing time at selected border crossings.

Twenty-four logging GPS units were installed on volunteer trucks for 6 months to evaluate specific routes and locations of interest. Some additional GPS tracking data were purchased from vendors providing tracking to truck operators. This on-board logger data was useful for understanding route switching due to congestion and the extent to which different routes provided better performance outcomes.

This research demonstrated the feasibility of gathering truck performance data from available and relatively inexpensive sources. In the future, the work will develop quantitative truck performance measures, expand the statewide performance measurement program, and work more closely with the trucking industry to examine particular routes and problem locations. The intent is to expand the coverage of truck performance data with additional roadside readers and the purchase of commercial tracking data. The program is expected to identify sources of truck delays and suggest ways to reduce it.

Challenges include reducing the granularity of tracking data, gaining cooperation of truck operators, and creating performance measures useful for transportation agencies.

EDITOR'S NOTE: Since the time this Spotlight Workshop was held, there have been vast advances in the use of these data sources for measuring system performance of trucks as foreshadowed in this summary.

MISSISSIPPI VALLEY FREIGHT TRAVELER INFORMATION CLEARINGHOUSE

Bruce Wang, Peter Rafferty, and Teresa Adams

This research describes a plan for creating a one-stop Internet information center to support truck freight operations in the 10-state Mississippi Valley region. The information would support route planning and real-time routing decisions based on information about road closures, conditions, and congestion. Information is intended to provide 1 to 2 h advance notice to support routing decisions at key decision points on the network at which path options exist, and, where appropriate, to suggest alternate routes.

Information in the clearinghouse source may include static factors such as size and weight restrictions, sensitive areas (school zones and neighborhoods), as well as variable factors such as road construction activities, special events, weather and pavement conditions, and traffic congestion (e.g., travel times). Fixed resources important for trucking operations, such as rest areas and parking facilities would also be listed. All of this information would be gathered and integrated in a single, web-based information source.

This work is in progress, and future tasks include identifying data sources, assessing data collection and updating mechanisms, determining user needs, identifying critical routing decision points, and exploring sustainability issues. The products of the work are expected to include

documentation of existing data sources and architectures, a plan for early deployment, estimated resource requirements, and scenarios to test data requirements and applications.

EDITOR'S NOTE: Since the time this Spotlight Workshop was held, there have been notable advances and commercialization of freight traveler information.

IMPACTS OF THE LONG BEACH AND LOS ANGELES PORTS PierPASS PROGRAM

Genevieve Giuliano and Thomas O'Brien

This study evaluated the impacts of a program to manage truck congestion at the ports of Long Beach and Los Angeles, California. Rapid growths of international trade, port capacity restrictions, and environmental consequences of congestion have together motivated actions to reduce congestion at the busiest container port in the United States.

Congestion is exacerbated because drayage operations to move containers and chassis in and out of the ports have been restricted to day shift hours—Monday through Friday, 03:00 until 18:00. In response, a pricing scheme was established under a voluntary agreement among the marine terminal operators. The intent was to provide an incentive to shift some freight operations outside normal hours. The pricing scheme, PierPASS, charged $40 per 20-ft equivalent unit (TEU) during the peak hours (subsequently increased to $50/TEU).

Hourly gate use by trucks during off peak hours was measured before and after PierPASS implementation. Trends showed a shift to off-peak operations from about 35% to 45% of all operations. Hourly truck volumes on I-710 serving the Port of Long Beach showed a reduction in the midday period, and an associated increase off peak. Weekend truck volumes went up after the introduction of PierPASS.

The effects on the local network vehicle miles and vehicle hours of travel (VMT and VHT) were estimated using a TransCAD simulation under various scenarios to consider the effect of growth in trade and the introduction of PierPass. The pricing program contributed to offsetting some growth effects, reduced traffic during the midday period and shifted it to night, increasing nighttime VMT and VHT. It reached stated diversion targets and produced important impacts on the highway system.

Truckers and warehouse operators had to adjust and absorb increased costs because of the need to work longer and less desirable hours. Some community residents objected to the shift of traffic into more sensitive hours. Terminal operators got some credit for being responsive to local congestion problems.

EDITOR'S NOTE: Since the time this Spotlight Worksho[was held, PierPASS has made some modifications to the off-peak program and the program continues to operate as of 2017.

SESSION SUMMARY

Implementation Strategies and Operational Modes

CHRISTINA S. CASGAR
San Diego Council of Governments, Presider

THOMAS WAKEMAN
Stevens Institute of Technology, Recorder

MARIA BOILE
The State University of New Jersey

SOTIRIOS THEOFANIS
The State University of New Jersey

TERESA ADAMS
University of Wisconsin, Madison

CHELSEA (CHIP) WHITE
Georgia Institute of Technology

SUMMARY OF PRESENTATIONS

This session examined new institutional models for university–government–industry collaborations for implementing strategies to improve freight mobility. Three examples were presented that described the institutional partnerships, their activities, and the benefits of their efforts on current or future operations. Christina S. Casgar, Good Movement Policy Manager, San Diego Council of Governments, presided and opened the session with a quote from Susie Lahsene that she had been given the day before: "Freight is the economy in motion." Casgar acknowledged the veracity of the statement and briefly discussed the need for partnerships in facing today's freight transportation challenges. Thereafter, she introduced the entire morning panel and asked the first speaker to begin.

PARTNERSHIP TO MAXIMIZE PORT INDUSTRY PERFORMANCE: CAN ADVANCED RESEARCH METHODS ASSIST IN PRACTICE? THE CASE OF PORT OF NEW YORK AND NEW JERSEY

Maria Boile, Sotirios Theofanis, and Robert James

Maria Boile characterized the collaborative project as an effort to quantify traffic impacts and prioritize capital and operational improvement activities to enhance freight flow efficiencies at the Port of New York and New Jersey. She described the project's supporters starting with the Port Authority of New York and New Jersey and four primary partners [New Jersey Department of Transportation (DOT), New York Shipping Association, Maher Terminals, and TRANSCOM]

as well as mentioning outreach to several other region stakeholders. Roles of these partners were briefly discussed.

Rutgers' Maritime Infrastructure Engineering and Management Program (MIEMP) leads the 3-year activities under a grant from the National Science Foundation (NSF). Maria described the overall project progress: first, the international supply chain movements in the New York–New Jersey metropolitan region were conceptually mapped, model networks were developed, and now microsimulations are being used to examine port industry performance. The import supply was segmented into three tiers working with the Port Authority: Tier I from the berth to the port terminal fence line (under port operator control); Tier II from the fence line to the first point of rest, e.g., roads or rail to an international distribution center (under local–state government and CONRAIL control); and Tier III from the distribution center or warehouse to the shelf–business (under cargo owner's control).

MIEMP's current work is focusing on a mix of Tier I and Tier II road moves. Road networks for micro-, meso-, and macroscales were developed using data from government agencies (particularly the North Jersey Transportation Planning Authority) and terminal operators. Micro- and mesoscale simulations were and continue to be conducted to examine individual truck local movements, routes to the first point of rest, congestion delays, etc., in an effort to identify actions that might improve port performance. Operational timing (24/7) options are being analyzed. Various strategies are being assessed with respect to the influence of terminal gate operations, virtual container yards, location and operations of freight villages, inland port facilities, truck restrictions, and roadway expansion options.

The partnership is demonstrating that academia can contribute to business and operational strategy development by applying research tools to predict outcomes of potential courses of action that government and industry could use to improve port performance. Boile concluded her comments by describing MIEMP's activities in further developing their modeling tools, implementing results, and sustaining their institutional partnership.

MISSISSIPPI VALLEY FREIGHT COALITION: FACILITATING UNIVERSITY–INDUSTRY–GOVERNMENT PARTNERSHIPS

Teresa Adams

Similar to the first presentation, the second presentation was about a university-lead collaboration to improve freight mobility. In this case, however, the scale jumped from a single port complex to a multistate region. The National Center for Freight and Infrastructure Research and Education (CFIRE) is a consortium of academic institutions including University of Wisconsin–Madison, University of Wisconsin–Milwaukee, University of Wisconsin–Superior, University of Toledo, and the University of Illinois–Chicago. CFIRE supports research to improve freight movement, increase freight capacity, and improve public sector decision-making related to freight. Teresa Adams began her talk by answering the question of why a broad-base multiinstitutional partnership was essential to the Mississippi Valley region—"…to provide a regional voice" and "regional connectivity."

Adams described the importance of agricultural products and manufacturing enterprises to the economic health of the Midwest states. She discussed the linkages between freight transportation in the Midwest and the regional and the national economies. However the region's goods are facing growing international competition in the marketplace while simultaneously facing

growing congestion and bottlenecks on all modes. Since freight does not know either jurisdictional or modal boundaries, it was prudent to organize the involved stakeholders including those across state-lines and extending to the local level to address these competitive issues.

The Mississippi Valley Freight Coalition (MVFC) began with high-level support and active participation among the state DOTs. The first workshop was held in April 2002. The MVFC organization is state directed but has significant FHWA involvement. CFIRE acts as the facilitator. It quickly became apparent that "pooled funding" was necessary to meet the cross-jurisdictional challenges of freight mobility. That requirement led to the development and ratification of a Memorandum of Understanding among the partners in November 2006. Committees were established for the executive, technical, and customer partners. CFIRE not only took the role of facilitator but also leveraged available federal funding [utilizing their University Transportation Center (UTC) designation] and provided multidisciplinary expertise to the organization. Adams also mentioned CFIRE's role as educator through their focus on future workforce development and providing UTC students access to the MVFC's activities.

Adams described the current tasks under the MVFC agenda including work to increase public and political understanding of the freight mobility issues in the region such as presenting testimony to the National Commission on Surface Transportation and attending peer forums. There are activities relating to acting as a multistate clearinghouse for freight traveler information, and undertaking research on parking issues, multimodal bottlenecks, container vehicle load limits, etc., and continuing to build relationships among the partners. She emphasized the importance of sustaining communications among the participants to maintain a regional development agenda. Adams concluded her presentation mentioning that activities are also underway to create regional standing of the Mississippi Valley as a unique freight corridor with its own importance and economic contributions.

APPLYING OPERATIONS RESEARCH TO IMPROVE LOGISTICS EFFICIENCY
Chelsea (Chip) C. White III and Hayriye Ayhan

As with the first presentation, the final presentation addressed local freight mobility and congestions issues with respect to truck dray movements. Unlike the first presentation, this presentation described university–industry efforts to use real-time control of the supply chain. Chip White began his presentation by acknowledging that the concept of real-time control was conceived by the Intermodal Freight Technology Working Group and was initially for coordinating cross-town traffic to reduce empty moves between terminals. This talk discussed the potential partnership between university researchers and trucking fleets for a pilot study to be conducted in Kansas City for cross-town moves.

White described the frequent requirement for multiple truck moves with international freight including land–bridge interruptions. He discussed the importance of truck moves in cross-town operations and their impact on congestion, pollution, and safety. He suggested that increasing drayage fleet efficiency mitigates these impacts, and using real-time traffic data to improve real-time fleet routing and scheduling of truck movements was possible. White described the results of a simulated use of real-time traffic data for in-bound truck moves into an auto assembly plant in southeast Michigan to illustrate the positive effects of the technique. He mentioned the Georgia Institute of Technology project to examine the usefulness of the concept in the Kansas City area.

White introduced Hayriye Ayhan to discuss the methodology to be applied to routing decisions. Hayriye explained that a finite horizon Markov decision process would be used to solve the nonstationary stochastic shortest-path problem. The solution would be generated with real-time traffic information obtained from sensors in trucks and loops that had been previously buried in the local roads. Cooperation with the data owner from the roadway sensors would be integrated with the truck sensor data as input data for the decision process. She proceeded to present the equations used in the Markov decision process and explaining that the calculation of the "optimal policy" for truck routing would occur while the truck is underway. Decision for the individual trucker to turn right, left, or go straight would be determined by the "policy" calculated by the Markov process. A table was displayed that illustrated the potential vehicle usage reductions that could be achieved by application of real-time traffic data for several times during the day. These results suggested that savings of approximately 16% were possible during the period of heaviest flow. The conclusions offered were that vehicle routing integrated with real-time information technologies would benefit cross-town freight movement. Another conclusion was that university researchers, government agencies, and freight transportation operators working together could improve traffic flows for freight. Furthermore, this approach had many other applications including private vehicle routing, emergency situations, and other real-time information technology business uses.

SESSION SUMMARY

Conclusion and Summary

MICHAEL D. MEYER
Georgia Institute of Technology

This workshop[focused on an important challenge facing the U.S. transportation system—congestion and system performance as they relate to the movement of freight and goods. In the 2 days of discussion, workshop participants made numerous observations to help define the research opportunities that could contribute to improved system performance. The following summary is organized in four sections relating to the focus of workshop activities.

MAJOR THEMES

Workshop participants identified a long list of issues and factors that are important considerations when thinking about freight-related research that could have a positive impact on the freight sector.

Context Factors

- Understanding the costs throughout the supply chain is an important point of departure for influencing logistics decisions and freight flows. This includes looking at the total costs in the supply chain, the individual cost components and the costs associated with environmental mitigation.
- Many of the participants noted that the cost of fuel has had a significant impact on logistics decisions and this will likely continue in the future. There is thus a need to focus on this important input in overall cost accounting and to examine both technologies and service strategies that improve fuel efficiency or reduce fuel consumption.
- One of the greatest challenges likely to face the freight sector relates to environmental sustainability and green approaches to distribution and production. This relates to the relationship between freight movement and the natural environment; less-polluting and more-efficient technologies, especially fuel; community impacts; and land use issues. This discussion led to a stated need for descriptions of best practices in each of these areas.

Decision-Making Environment

- The public decision-making process requires that the benefits of improvements to any transportation system be clearly understood and articulated. This is especially true for public investment in facilities or services that will benefit the freight sector, an area that has traditionally not received public attention.
- Several carriers and shippers noted the important of “external” factors in influencing freight transport decisions, ranging from congestion on port access roads to a varying monetary climate throughout the world (such as the value of the U.S. dollar in international markets). The

point that being made was that even though many models focus on the internal transport production process, it is often these external factors that have more influence on final logistics decisions.

- A representative from WalMart described the dynamic nature of the logistics decisions made by one of the largest shippers (and carriers) in the United States. The logistics strategy is frequently examined and modified based on the conditions being faced at any particular point in time, as well as an estimate of what the near future will bring with respect to production factors (such as the price of fuel).
- With respect to both public and private organizations, how does one incorporate a performance management perspective into the decision-making process? Performance management was distinguished from simply using performance measures.
- Given the global and national scale of logistics and freight decisions, there is a need for a national perspective on where national investments should be made to enhance the competitiveness of the U.S. economy. However, this begs the question of how does one make such a decision and on what types of investments.

Analysis Methods and Tools

- Not surprisingly, workshop participants noted the importance of quality data and data-driven analysis, as well as incorporating approaches for dealing with uncertainty in the analysis methods.
- Freight network modeling needs to provide results that are of direct interest and use to those making service planning decisions. In addition, model results can examine overall network efficiencies and productivity. This is particularly important for service strategies that change over relatively short time periods. However, it is important to understand the there are many different levels and types of models and analysis tools that relate to the types of decisions being made on freight movement (Figure 1).

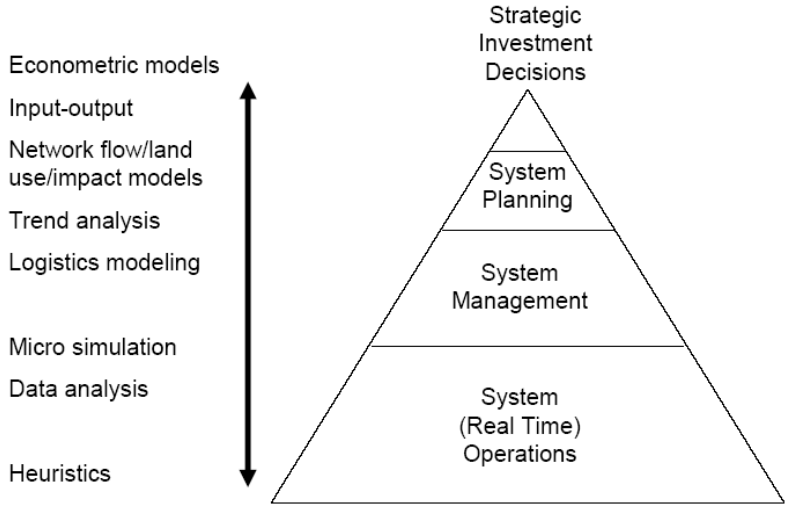

FIGURE 1 Different types of analysis tools relating to levels of decision-making.

- A systems perspective is essential in examining the real interactions that occur in freight flows. This implies an analysis focus on important variables, variable relationships and linkages, network definitions and representation of service factors, etc. In particular, this requires building connectivity into the network model. Two examples that workshop participants identified as an example of the systems nature of freight analysis were the impact of larger container vessels and new free trade agreements on the magnitude and distribution of freight flows in the world.
- Although many network models report on speed and flows, the more important measures are network path reliability and the flexibility–redundancy in network design.

Institutional Issue

- Much of the institutional-related discussion related to the role of public investment in benefitting freight movements. Important questions included: what can the public sector do to improve freight efficiency? How can public investment be defined and presented as a "business case"? How can public and private benefits be allocated to the different actors involved in an investment? How have both public and private firms collaborated successfully with respect to freight investments? What are the different types of funding strategies that can be considered? What lessons can be drawn from historical experience with different approaches to influence freight flows—regulations, incentives, etc.?

OTHER ISSUES FACING THE FREIGHT SECTOR

Given the limited amount of time available to workshop participants, not all of the pressing issues facing the freight sector received sufficient attention in the workshop discussions. Participants were thus asked to identify those issues that they felt were important today or even more so in the future (especially those that related to potential research). The following topics were noted by a number of individual participants as being important.

- Security and the need to provide secure entry into the United States, but in a way that does not seriously interfere with freight flows. Concerns were expressed on better understanding the balance between security needs and operational efficiency, especially at ports and border crossings. This topic also related to the importance of network resiliency and redundancy when an incident does occur.
- Although data was noted as an important issue, continued and more-robust discussions are needed regarding real-time data collection and the linkage of this data to traffic management centers. What are the best strategies for data mining? There was a perception that there is a high potential pay-off in the use of advanced technologies in providing data collection and data base management capability.
- Different types of strategies that could be used to improve accessibility and efficiency of freight movements, especially at ports were also discussed. What is the impact of congestion pricing on truck and freight movement? This is especially important during peak flow periods. In addition, a very important question was asked on what happens if congestion is not reduced significantly? What are the implications to the economy? To logistics decisions? To regions?

- Although institutional issues were identified as an overarching issue, there was little discussion on how one implements a multi-jurisdictional strategy, and on the types of strategies that might be appropriate for rural and small communities. Who wins and loses when international trade increases? What form of compensation is necessary for those who bear the costs of this increased trade, but not the benefits? In addition, and linking to the data collection topic, some workshop participants felt there was a real need to incorporate freight data more effectively in the transportation planning process.
- Multiple levels of decision-making were identified that could have some influence on freight movements (Figure 2). What are the types of metrics that might be appropriate at different scales and levels of decision-making?
- A number of participants noted that the major focus of the workshop was on research, but that the freight industry was also facing significant human resource needs and that universities can play an important role in this issue through short courses, certificate programs, curricula, etc.

RESEARCH DIRECTIONS

The workshop devoted time to discussions on research directions and how to improve collaborative research on topics of interest to the freight sector. The following sections summarize the conclusions made in several topical categories.

Topics Not Well Researched

A few workshop participants thought that most, if not all, of the issues described above deserved more attention from the research community. In particular, they noted that the topics not well researched included such issues as understanding the institutional and policy strategies used

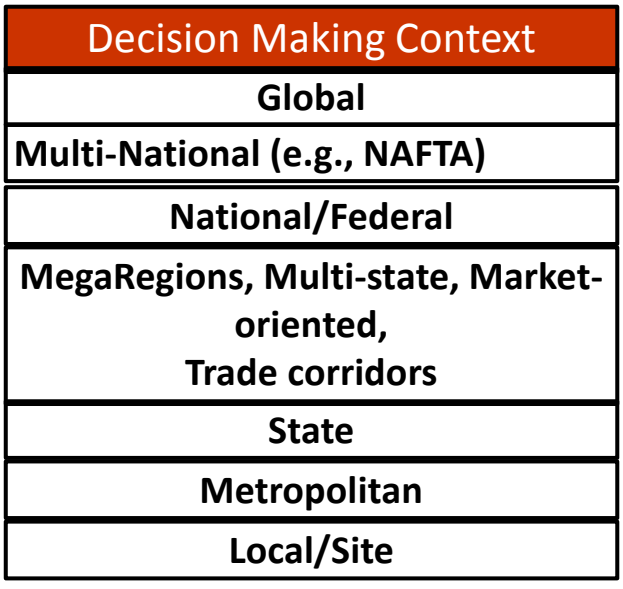

FIGURE 2 Different levels of decision-making and scales of analysis.

elsewhere in the world and how they could be applied in a U.S. context; delineating the characteristics of successful collaborations between public and private organizations that have benefited the freight sector; identifying the impacts of global market changes on the national, regional, state, and metropolitan economies; improving nodal operations (such as port operations) through nonconventional strategies; and using "almost-good-data" for network analysis.

Research Topics Most Appropriate for University Research

A major purpose of this workshop was to identify research directions and projects that could become part of a structured university research program on freight and logistics issues. The types of research projects that were identified as being most appropriate for university research community include the following:

- New concepts, strategic thinking, and innovative analysis approaches, especially as they relate to larger scale, multijurisdictional applications;
- Evaluations of innovative implemented strategies and projects;
- Case studies, syntheses, and documentation of state of the practice of freight-related strategies;
- Interdisciplinary policy and institutional analyses of implemented strategies, with special focus on distributional impacts; also for politically controversial "lightening rod" issues; and
- Technology applications and material sciences.

Research Topics Most Appropriate for Government–Industry–University Collaboration

Participants understood that the most-effective research on freight and logistics issues would most likely include collaborative relationships with government and industry groups. However, several types of topics were considered most conducive to such collaboration, including public policy issues relating to intermodal transportation and those relating to community impacts; proof-of-concept projects; decision support frameworks that encompass the wide range of potential impacts; data resource design and development; program evaluation; social, community, and sustainability issues; and projects that examine moving technology to application.

Characteristics of Successful Collaboration

Given the need for collaboration in many of the types of research projects that focus on freight issues, workshop participants next described the characteristics of successful collaboration. Many of these characteristics are really applicable for all types of research, not just those relating to collaborative efforts on freight topics. The characteristics included the following:

- Providing research results that clearly benefit the participants and sponsors, building upon the strengths and capabilities of the research participants.
- Establishing early on what the expected results should accomplish.
- Building a consensus and bringing different agency agendas together on a common interpretation of research results.
- Providing research results that are actionable and that can be implemented in a reasonable timeframe.

- Creating long-term relationships that can lead to further research; participant should leave a particular research project with improved understandings or skills.

Although these characteristics of collaboration seem obvious, a number of workshop participants also identified many barriers to such efforts, many of which are inherent to a university-based research program. The more common issues included such things as intellectual property rights, use of graduate students (who will only be on a project for a short time), need for scholarly products, building of trust and credibility, and the need for funding for basic research (given that most research sponsors are more interested in applied research). With respect to collaborative freight research, the issues included managing the expectations of very different agencies and organizations, dealing with the challenge of research results not meeting the expectations of research sponsors, and an often disciplinary-focused research effort on what is inherently a multidisciplinary issue.

RESEARCH AGENDA

Workshop participants provided their individual thoughts on a freight research agenda that encompassed a broad range of topics deserving of attention. In no particular order of priority, the freight research agenda includes the following:

- Broad relationships between economic factors and freight transportation demand. A changing global market, and perhaps more importantly the often rapidly changing variables that influence logistics decisions, need to be better understood and incorporated into our world view of the supply chain.
- Environmental sustainability and the strategies the freight sector can apply to become more environmentally neutral. What metrics can be used to measure this? What are the effects of such strategies on the overall supply chain?
- Freight planning and analysis frameworks. Participants felt strongly that the freight planning process needed to be strengthened, including the use of improved data, new optimization tools, use of return on investment analysis, and better feedback into the planning process of the effectiveness of newly tried strategies.
- Technology applications. The role and application of new technologies to managing the supply chain as well as the public infrastructure that supports freight movements is an area that will continually change. There was a sense at the workshop that technology applications could be a very important key to the future efficiency of freight movement in the United States.
- Institutional structures and issues. The respective roles of public and private organizations and the funding strategies used by each will continue to be an important topic for research in the foreseeable future.
- Workforce issues. An aging population and changing population demographics will mean that the future workforce in the freight sector will be very different than that of today. There was a sense among conference participants that important studies can be done in understanding the implications of these changes on the freight industry and, in particular, combine these studies with the technology focus from above.

Finally, although the focus of this workshop was on research, many participants noted that universities can play many different roles and contribute in a variety of ways. The most noted role was as an educator and trainer of the next generation of transportation professionals. In addition, universities can act as a neutral forum or evaluator in considering controversial topics. The most important characteristic for all of these efforts was the collaborative nature of the identification of key issues facing the freight sector.

POSTER SUMMARY

Modeling Truck Traffic Volume Growth Congestion

MICHAEL ANDERSON
University of Alabama at Huntsville

PROJECT DESCRIPTION

Modeling the statewide transportation infrastructure system is an important element in the identification of congestion locations and programming of funds to avert future congestion. As Alabama continues to grow its manufacturing economy, as has recently been occurring in the automotive and aerospace sectors, the number of heavy vehicles traveling on Alabama roadways will continue to rise, straining already limited infrastructure. This project is developing improved modeling tools consisting of a traditional travel demand modeling software coupled with a discrete event microsimulation program to develop potential growth scenarios to analyze the resulting traffic congestion. The results from the successful completion of this project will include modeled scenarios identifying key congestion chokepoints and the establishment of a modeling tool that can effectively examine additional alternative scenarios in the future.

BACKGROUND

The ability to make reasonable decisions regarding transportation investment is limited by the quality and quantity of information available on the transportation infrastructure. The ability to accurately model transportation systems, identify congestion choke points, and define needed capacity shortfalls is vital to the decision-making needs to support the transportation systems for both people and goods.

The movement of freight in a timely and efficient manner is quickly becoming one of the critical components of the U.S. economy. Heavy vehicles, 18-wheel trucks, are the backbone of the logistics and economic success of industry in the United States. National projections are that freight shipments will double in the next 10 years. The increase in freight will have a significant impact on the level of congestion along the national transportation infrastructure and will require innovative congestion mitigation solutions. A detailed understanding of the impact of the projected increase in truck traffic on the existing highway system is needed to examine in the potential outcomes and develop a focused plan to accommodate the anticipated increase.

PROCESS

The methodology studied in this research is the application and combination of urban planning model with a discrete event simulation. The urban planning model was used, with forecasted industry cluster data, to generate freight trips and distribute the trips based on survey results

from representatives of the major industries in Alabama. Then, the trip exchange matrix is passed to a discrete event simulation model that determined the time-of-day congestion locations on the existing infrastructure. The discrete event simulation also provides a visual communication tool for educating the general population and governing officials not involved in the transportation industry.

This project will build upon existing transportation analysis and planning tools developed at the University of Alabama in Huntsville under a grant from the U.S. Department of Transportation to develop a model to examine statewide freight transportation. The first of these tools is a statewide zone structure, using counties, and a highway network developed in TRANPLAN, a generally accepted travel demand model, which has been modified and enhanced to support a statewide freight analysis. The travel demand model will be used to distribute freight trip productions and attractions developed form a disaggregation of the Freight Analysis Framework Version 2 between the various counties in Alabama.

The second tool is the Alabama Transportation Infrastructure Model (ATIM). The ATIM is an analytical tool that utilizes discrete-event simulation to model traffic flows over multiple 24-hour periods. By using discrete-event simulation, the ATIM is able to incorporate the stochastic random variation inherent in transportation systems with the raw traffic data collected by government, industry, and academic entities. This random variation is visible in the complex interactions of freight movement across the transportation infrastructure network and through intermodal transfer points. Freight traffic and passenger automobile traffic are independently calculated, and combined, to simulate overall traffic flows on the roadways. Railway and waterway transportation systems are also modeled to show the dynamics between the multiple shipping modes.

The research effort conducted in this project will develop a seamless interface between the two models to allow for easy sharing of volume, route and origin–destination data. The integration of these models will produce a tool capable of quickly analyzing scenarios and events on the transportation infrastructure that can be used to evaluate alternative solutions.

FINDINGS AND CONCLUSIONS

The results of the combined urban planning and discrete event simulation models is a tool with the ability to quickly evaluate options for infrastructure improvements and provide input to return on investment questions when deciding where to invest scarce infrastructure funds. The identification of congestion chokepoints within Alabama as well as a listing of high priority capacity improvements needed to ensure the continued mobility of the state highway infrastructure system are numerous and a validated tools with the capabilities presented in this summary is desperately needed. The interface that is under development will be capable of passing data between the programs allows for the efficient transfer of data, while preserving the nature of the individual programs.

FURTHER ACTION

The combined system is developed and being tested with various scenarios. Future actions involve the refinement of the interface and the interrelationships between the two model types.

Further enhancement of both models will also require continued refinement of the interface programs.

ACKNOWLEDGMENT

This research was sponsored by the University Transportation Center for Alabama.

POSTER SUMMARY

Evaluation of Strategies for Efficient Cargo Movement and Public Policy Implications

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TOM O'BRIEN
University of Southern California and California State University, Long Beach

DESCRIPTION

The current paper presents a summary of selected research projects at the Center for Metropolitan Transportation Research (METRANS, a joint center between the University of Southern California and California State University, Long Beach) on issues related to evaluation of strategies for efficient cargo movement in metropolitan areas and public policy implications. In particular, we present studies on the terminal gate appointment system, on wages and working conditions of drivers at the port of Long Beach, and on short sea shipping

BACKGROUND

The research conducted here, is in response to the pressing needs for mitigating traffic congestion in the areas around container terminals, and for improving efficiencies within the terminals.

The elimination of international trade barriers, lower tariffs, and shifting centers of global manufacturing and consumption has led to new dynamics in intermodal shipping. Worldwide container trade is growing at 9.5% annually, and by 2010, it is expected that 90% of all liner freight will be shipped in containers. Every major port is expected to double or triple its container traffic by 2020, which in turn will result in higher traffic congestion and increased air pollution. If we focus our attention on the three main container port complexes on the West Coast (Long Beach and Los Angeles, California; Seattle and Tacoma, Washington; and Oakland, California), we see that they handle almost 50% of the container traffic in the United States [a combined volume of 17,000,000 20-ft equivalent units (TEU) for the West Coast out of 35,500,000 TEU total volume for the nation in 2003]. The port complex of Long Beach and Los Angeles, the largest container port in the nation and the third in the world, handles 33% of the total container traffic in the United States. This huge volume moving from the local ports to the final destinations creates major congestion problems throughout the local transportation networks, and has very serious effects not only at the local and regional levels, but on a national scale as well.

The research has been sponsored by METRANS, a University Transportation Center funded by the U.S. Department of Transportation and the California Department of Transportation.

PROCESS

Many of the research projects at METRANS obtain field data on various aspects of port-related activities. Field data are used to compare and evaluate strategies that have already been implemented or are under study, regarding their effectiveness and their public policy implications. The studies presented in this paper include:

1. Terminal gate appointment system. The California Assembly Bill AB-2650 imposes a fine on terminals if trucks waited longer than 30 min to enter the gates. Implementation of a gate appointment system for trucks was one means available to terminals to avoid possible fines. The objectives of the appointment system are to reduce truck waiting and idling time outside marine terminal gates, and to distribute truck traffic more smoothly throughout the day to ameliorate the peaking phenomenon. In our research we conducted a comprehensive evaluation of AB-2650 to assess:
    a. The impact of appointment system on air quality;
    b. The response of trucking community; and
    c. The effectiveness of regulating trucks outside the gate as a means of changing terminal behavior inside the gate.
2. Wages and working conditions of drivers at the Port of Long Beach. Surveys of truck drivers at the Port of Long Beach were conducted in 2004. Using independent variables such as driver experience, tenure, race, place of birth (U.S. born or not), firm size, owner operator, destination terminal, etc., and compiling the data from the survey responses, we constructed statistical models of earnings, waiting time during a trip to–from the port, and safety of chassis provided to the truck driver.
3. Short sea shipping. In our research we assess what potential short sea shipping holds for alleviating the congestion occurring on Southern California's regional surface transportation system. Focusing on specific commodity and market segments, a number of shipments could be shifted to short sea shipping movements. Specific opportunities in Southern California are found with the redirecting of empty container flows to secondary ports, as well as with international movements to and from the manufacturing areas on the U.S.–Mexico border. Consideration was given to which type of maritime and port operation might be best suited for these market segments, and the use of roll on–roll off vessels was determined to be suitable for initial operations.

FINDINGS AND CONCLUSIONS

1. Terminal gate appointment system. Our evaluation showed that a wide range of appointment policies are implemented across terminals. Appointments are primarily used for import pick-ups (42% of total transactions involve appointments). Appointments do not directly translate into reduced turn time. There is no evidence that transactions with appointments are shorter than those without appointments.
2. Wages and working conditions of drivers at the Port of Long Beach. Our research shows that the truck drivers, lower paid than truckers nationally, receive no returns to experience or tenure and spend, on average, 48% of their work day waiting to get into and out of the port. Paid by the trip, there is little incentive for firms to use drivers' time efficiently and a great deal

of pressure for drivers to complete trips quickly. We find that drivers who own their trucks have a higher probability of accepting unsafe chassis and taking them on the road. We conclude that the inefficient use of drivers' time leads to negative externalities of pollution and unsafe driving.

3. Short sea shipping. The study finds support for implementation on the West Coast, and argues in favor of the establishment of regional port systems to provide an appropriate institutional apparatus for the coordination of public and private investments in short sea shipping.

NEXT STEPS

The future use of appointments will depend upon both legislative pressures and the need to better accommodate increased container throughput during off-peak hours.

Regarding the short sea shipping services, they could be introduced as part of a regional port system. Such a system would strengthen and add sustainability to the region's container handling capacity, create alternative commercial corridors away from the most congested urban centers, and increase the reliability and security of the transportation system. Some likely next steps could be taken to determine how regional port systems might be formed and administrated, to quantify the economic development benefits that would accrue by this to both the private and public sectors, to determine the level of landside transportation and marine port investments necessary to establish a regional port system and implement short sea shipping operations, and to identify the legislative measures required to authorize a regional port system. These steps would serve the interests of nearly all stakeholders involved in regional transportation and logistics, and provide the West Coast with a more reliable marine transportation system and one that is closely integrated with landside transportation systems.

POSTER SUMMARY

Research Needs Reported by Industry

MATTHEW R. CUDDY
JOSEPH L. SCHOFER
Northwestern University

PROJECT DESCRIPTION

This research was conducted to identify key challenges facing the transportation industry as seen by its senior executives. We surveyed top-level executives in companies involved in various aspects of transportation—shippers, carriers from all modes, finance, consultants, and other service providers. All of these executives are members of the 90-person Business Advisory Committee (BAC) of Northwestern University's Transportation Center; nearly all of them work exclusively with freight. The aim was to develop a better understanding of industry problems and research needs, and to use that information to inform an academic research program.

BACKGROUND

The Transportation Center has maintained a long-standing relationship with the transportation industry through its BAC, which provides advice and guidance on academic and research programs, and serves as a window on the industry for faculty and students. As a part of a program to reinvent the center, a proactive exploration of industry research needs and priorities was initiated to find common areas of interests and capabilities between leading industry representatives and Transportation Center faculty and students. A survey instrument was designed to test the hypotheses that executive surveys could elicit productive research priorities that would indicate opportunities for scholarly work.

PROCESS

In October 2006, an open-ended survey was disseminated electronically to the members of the BAC. The survey contained two items of general interest:

1. What are the most significant transportation-related challenges that your company will face in the next 5 years?
2. What new methods, information, and understanding could help you meet these challenges?

Response rates were boosted by repeated e-mails and personal contacts. Responses were collected until January 2007. Ninety-four surveys were sent out and 30 responses were received. Responses were analyzed and organized, returned to the members of the BAC for confirmation and as a progress report, and distributed to faculty and staff.

FINDINGS AND CONCLUSIONS

Across transportation industry modes and roles, we found three consistent priority areas:

- Congestion, capacity, and infrastructure;
- Workforce recruitment and retention; and
- Changing regulatory environments.

Generally, policy statements from the various industries approximate our survey results. The American Transportation Research Institute annually conducts a survey of truck fleet operators. In the 2006 survey results, driver shortages and retention ranked first and third respectively. Highway congestion, infrastructure, and funding ranked fifth, seventh, and ninth. Hours-of-service regulation ranked fourth. The 2006 annual report of the Air Transport Association cites air traffic control modernization as its top priority, for reasons of capacity and safety. The Association of American Railroads website emphasizes infrastructure regulation and policy.

Nonetheless, this custom survey of transportation executives did produce concrete results that are guiding the Transportation Center's research agenda. Seed money was offered to faculty to encourage them to engage in research identified in this survey. Two summer projects were supported, one in traffic data management and one in congestion pricing by a trucking company.

FURTHER ACTION

These responses have become the basis for an enhanced dialog with the transportation industry, and for shifting ways of talking about applied research in transportation and logistics. The Transportation Center’s leadership is planning, for example, small-group symposia to bring industry respondents with shared concerns together with Northwestern academics for brainstorming and problem formulation sessions.

APPENDIX: SAMPLE OF DETAILED RESPONSES: TRANSPORTATION-RELATED CHALLENGES

- Infrastructure–congestion (18 total responses):
  - Coping with local and regional opposition to infrastructure projects (rail carrier);
  - Government investment in waterway infrastructure (waterway carrier);
  - Port capacity (shipper, consultant);
  - Rail infrastructure limitations (shipper, consultant, rail carriers);
  - Ever-increasing traffic density of U.S. airspace (air carrier); and
  - Infrastructure at border crossings inadequate to cope with major volumes (other).
- Recruiting and retention at all levels, in the face of accelerating retirements (eight responses).
- Regulation (six total responses):
  - Responding to regulatory pressures on the spirit and letter of the Staggers Act (rail carriers);

  - Excessively restrictive returns on equity allowed by the Federal Energy Regulatory Commission (pipeline); and
  - Continued tightening of requirements for environmental and security reasons. (highway carrier).
- Consolidation and interfirm relationships:
  - Consolidation of the industries which are our target customers—finding the right person at the right time and business changes. Understanding the critical events that lead to change in their supply chain (highway carrier).
  - Interline relationships–mergers, acquisitions, strategic partnerships (rail carrier, shipper).
- Security in the supply chain ("security and logistics") (shipper).
- Freight visibility throughout the entire supply chain (consultant).
- Inventory volatility due to sailing schedules, production runs, port security, and dray issues (consultant).
- Industrywide asset renewal: will the industry overbuild again (waterway carrier)?
- Improving service performance (rail carrier).
- Improvements in equipment velocity or productivity: which is more important (rail carrier)?
- How to continue steady safety improvements (rail carrier)?

RESEARCH NEEDS SYNTHESIZED FROM SURVEY RESULTS

Ensuring Sufficient Capacity: Concerns for All Modes, Networks, and Terminals

- Methods for financing capital investments:
  - Achieving sufficient return on investment to buy needed private infrastructure capacity, and guarding against unnecessary regulatory constraints on prices–earnings.
  - Shaping public policy to ensure sufficient government investment in public infrastructure. Evaluating the case for public investment in terms of economic and social benefits.
- Practical decision-support tools for setting investment priorities, selecting projects and policies:
  - Avoiding overbuilding in infrastructure renewal—investing with care.
- Project implementation tools—strategies for building support, overcoming obstacles, and fostering effective public–private partnerships.
- Operational strategies for getting the most throughputs from fixed infrastructure.

Improving Operational Performance for Efficiency, Fuel Economy, and Safety

- Tools for shipment consolidation, dispatch, and routing and
- Information technologies.

Securing and Deploying the Workforce Necessary to Survive and Thrive

- Strategies for attracting and retaining skilled workers.

- Response to large-scale retirements.
- Approaches for negotiating realistic work rules and wage rates.
- Avenues and incentives for attracting young people to career opportunities in transportation and logistics.

Dealing With Regulations and the Prospect of Re-Regulation

- Measures of costs and benefits of environmental and security regulations.
- Responses to regulatory restrictions on return on investment.
- Responses to relaxation of regulations on truck size and weight.
- Strategies for defusing re-regulation of railroads.

Managing Supply Chains

- Methods to deal with inventory volatility.
- Actions to ensure security in supply chains.
- Performance measures applicable across the supply chain.

Anticipating and Responding to Change

- Strategies for maintaining, managing, and developing interfirm relationships in the context of continued consolidation.
- Methods to predict future technology, markets, resources and prices, policies, and regulations.
- Studies to identify best practices across organizations and modes: surveys, case studies.

POSTER SUMMARY

Glucose Intolerance and Commercial Truck Crashes

JEFF FOSTER
University of Alabama at Birmingham

PROJECT DESCRIPTION

There is considerable controversy about the relation between diabetes and commercial truck crashes and no information about the crash risk of those with impaired glucose tolerance. We conducted a 1-year pilot (prospective cohort) study to determine the relationship between being a commercial truck driver (CTD) with impaired glucose tolerance and the risk of being involved in a commercial truck crash.

BACKGROUND

The United States Commercial Trucking Industry accounts for ~$250 billion annually, 75% of goods shipped in the country based on value, and 66% of goods based on weight. In the United States, there are nearly 1.8 million commercial truck drivers and 7 million commercial trucks driving 200 trillion miles annually. There are over 400,000 police reported truck crashes annually in the United States, with approximately 5,000 fatalities and 86,000 injuries. Roughly 14% of large truck drivers were involved in crashes in the United States for 2003. Commercial trucks account for a large number of crashes in the United States. Specifically, trucks make up approximately 3.0% of all vehicles on the road, but are responsible for about 7.0% of all crashes and are involved in substantially more fatal crashes per 100 million vehicle miles traveled (2.2 versus 1.8 per 100 million vehicle miles). As with most crashes that occur in the United States, the majority of commercial truck crashes (80%) are non-fatal and involve property damage only. Large commercial truck crashes cost $20 to $25 billion annually in damages alone (total personal property, health status, etc.). A Federal Motor Carriers Association study performed in 2003 estimates that the average cost per large commercial truck crash in the United States was $62,613. Most studies have shown that age, drive time, trailer type, and driving during certain times of the day increase the risk for being involved in a crash.

Research was conducted in concert with private trucking companies and was made possible through a grant from the University of Alabama at Birmingham's Injury Control Research Center.

EFFECTS OF DIABETES

One possible cause of commercial truck crashes is the manifestation of glucose intolerance and its treatment. This has been of such concern that insulin-dependent diabetics have been prohibited from interstate commercial truck driving. An estimated 7.0% of the U.S. population is affected by diabetes; the prevalence of diabetes increases with age. Additionally, it is estimated

that another 6.2 million U.S. residents have undiagnosed diabetes. The prevalence of diabetes, both diagnosed and undiagnosed among truck drivers is unknown, but we estimate there may be as many as 126,000 CTDs with diabetes, many of them undiagnosed.

Impaired glucose tolerance and impaired fasting glucose form an intermediate stage in the natural history of diabetes mellitus. Anywhere from 10% to 15% of adults in the United States have one of the aforementioned conditions. Drivers with impaired glucose tolerance may constitute a larger risk group for crashes. We estimate there may be as many as 270,000 CTDs in the United States with impaired glucose tolerance.

The manifestations of and treatment for diabetes and impaired blood glucose levels may result in hyperglycemia (elevated blood sugar) or hypoglycemia (low blood sugar). Diabetes is known to increase risk of premature death, heart disease, stroke, renal failure, hypertension, visual impairment, nephropathy, and neuropathy. All of these could adversely affect driving performance. Acutely impaired blood glucose levels can adversely affect cognitive and physical performance by causing blurred vision, fatigue, nausea–vomiting, disorientation, dizziness, and shakiness. Any of these symptoms could adversely affect driving performance.

PROCESS

We conducted a 1-year pilot study involving 85 CTDs from Alabama and surrounding states. Participants were recruited through trucking companies, and completed a baseline questionnaire containing items to document general characteristics such as age, race, sex, height, and weight, along with questions regarding current diabetes status, knowledge of diabetes, and medication history. Questions in the driving history section gathered information on drivers' truck type, trailer type, drive time, and distance driven, along with self-reported information on prior crash history. Along with the questionnaire participants were required to undergo a test to determine their baseline glucose tolerance utilizing HbA1c, a specific subtype of hemoglobin. HbA1c is highly sensitive and accurate measure of blood glucose allowing us the flexibility and convenience of obtaining a single measurement in a population that is highly mobile and therefore less likely to be compliant with a fasting blood glucose measure or an oral glucose tolerance test.

At the end of 6 months drivers were contacted to obtain follow-up information regarding their current driving characteristics, known diabetes status and treatment, and truck crash history over the previous time period. Crash information was validated through services that utilize the Commercial Driver License Information System, a national clearing house for commercial driver license records. Upon completion of data collection the data set was cleaned and analyzed via multiple logistic regression; primary focus being given to the relationship between glucose tolerance status and crash-risk controlling for relevant confounders.

FINDINGS AND CONCLUSIONS

The pilot study focused on (1) developing and refining consent forms and recruitment literature through meetings with owners of commercial trucking companies and truck driver focus groups; (2) testing and refining recruitment measures through owners or truck stops–rest-areas; (3) obtaining commitments from owners of trucking companies enabling the research team to

approach their drivers and request their participation; (4) testing and refining data collection methods, specifically the way the questionnaire is administered (self versus interviewer), and development of a Spanish language version.

Our initial analysis shows that 15.29% of drivers tested in our above normal range (>6.5% HbA1c). This 15.29% corresponds to current projectecd national levels of glucose intolerance and is approximately what we expected. The overall crash history reported by drivers and confirmed via a CDL check is 53%.

FURTHER ACTION

The purpose of this pilot study was to investigate the potential for a larger-scale study. A large-scale study investigating the true relationship between diabetes and commercial truck crashes is important for many reasons, one being that current federal regulations prohibit Interstate travel by diagnosed insulin-dependent diabetics. In the interests of safety the U.S. trucking industry, driver regulations should be based on sound science. This research is crucial because the federal regulation which prohibited insulin-using CTDs from engaging in commercial, Interstate travel has recently been modified permitting those using insulin to apply for a federal waiver to continue driving between states. Moreover, federal regulations do not prohibit insulin-dependent CTDs from driving intrastate. Because the commercial truck industry is so important to the U.S. economy, the frequency and cost of commercial truck crashes is high, and the prevalence of glucose intolerance in the United States is increasing, a larger-scale study, similar to the one we have discussed, would be helpful to ascertain whether glucose intolerance is a the contributory factor to these crashes.

A study about the role of impaired glucose tolerance in commercial truck crashes would be beneficial. Such a study could be carried out by following 2,000 currently licensed CTDs (intrastate and Interstate) whose glucose-tolerance status will be assessed by both physician diagnosis and treatment, or an impaired HbA1c. The results of this study would have important impact, not only on public health, but potentially on important public policy affecting the lives of many.

POSTER SUMMARY

Improved Freight Modeling of Containerized Cargo Shipments Between Ocean Port, Handling Facility, and Final Market for Regional Policy and Planning

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PROJECT DESCRIPTION

The purpose of this research is to understand the dynamics of regional freight movements through the development of a regional freight model. The model mimics the economic choices shippers make between modes and whether to ship direct or transload. The model is a tool for transportation planners to consider the impact of changes to the transportation system. With the model we can answer questions such as

- How would a truck-only lane on SR-167 affect the ratio of shippers that choose to transload containers originating at the Port of Seattle?
- If the truck-only lane is built, what is the impact on travel times?
- What will the cost of real estate mean to transloading behavior in Puget Sound? How will counties choices to limit warehousing activity affect the traffic burden?

BACKGROUND

There are many freight models that capture national goods movements with reasonable precision. Also, individual company behavior is fairly predictable given knowledge of the company's import volume, type of good, and operating characteristic. However, there are few models that consider the movement of goods at a less than state scale, and we are aware of only one other model that considers shippers economic choices in modeling goods movement. We found the literature lacking in its ability to illustrate how freight movements by many shippers affect regional goods movement. Most freight models have been developed from passenger travel models and poorly replicate goods movement dynamics.

PROCESS

1. Literature review. A thorough review of existing freight transportation models was conducted. Of the models available for consideration of goods movement at a regional scale,

none captured the trade-off between transportation cost and inventory cost considered by supply chain managers in making logistics choices. Rob Leachman of University of California, Berkeley, has developed a national model of goods movement that is based on this economic choice.

2. Data collection and review. A thorough review of existing data sources that could support the development of a Puget Sound freight model was conducted. There are many sources of data including state and federal agencies and private companies. These are either surveys, required data submissions for regulatory purposes, or data collected on an ongoing basis by sensors. We have relied on operational data from the Ports of Seattle and Tacoma, pricing data from the railroads and private trucking companies, publicly available real estate and infrastructure data, and traffic volume data from city, county, and state agencies.

3. Model development. The model consists of two origin nodes (the Ports of Seattle and Tacoma) and four transportation choices;

- Direct shipping by a truck,
- Direct shipping by rail,
- Rail stopping initially at a warehouse, and
- Truck stopping initially at a warehouse.

Final destinations are considered to be 21 locations distributed throughout the United States. Allocation of commodity flows is made based on population and average income in each region. Larger population and higher income area have more purchasing power; therefore, a larger volume of commodity movement is assigned to that location. The model considers transportation and inventory cost and calculates the least-cost transportation choice for each importer and exporter. The model then overlays these choices on the transportation network to consider the total traffic burden. Transportation cost is based on truck and rail rates provided by the industry. Inventory cost is based on the volume and value of goods moved. The model considers both pipeline and safety stock when calculating inventory cost.

4. Model validation and application. The model has been validated through comparison with known importer behavior. The transportation choices of a low, medium, and high value shipper as well as a low-, medium-, and high-volume shipper are known and the model is able to predict these nine choices. We have used the model to consider the following scenarios, which are discussed in the findings and conclusions below.

a. An increase in land values in the Puget Sound region;
b. The introduction of a truck only toll lane on SR-167; and
c. Consolidation of shipping companies.

FINDINGS AND CONCLUSIONS

The model shows that it is usually cost-effective to deliver by direct truck when the distance from port of entry to the final destination is less than approximately 500 mi. However, transloading by truck becomes the least-cost alternative when the volume of goods is more than 70 20-ft equivalent units (TEU) per week per destination (a large importer). Large importers benefit most from transloading because of benefits of economy of scale. Importers of high-value goods are most likely to ship direct due to the high cost of inventory when using a transloading strategy.

Regarding three scenarios above, the model run indicates the following results.

1. An increase in land values in the Puget Sound region. Logically, an increase in land values in the Puget Sound region would affect shippers to move warehouse somewhere affordable assuming a similar transportation cost. When replicating current conditions in the model, land values in the Kent area are set at approximately $\$0.03/ft^2$ higher than in the Sumner area. This cost difference is not large enough to cause a strong preference for location, therefore the decision to utilize a warehouse in Kent or Sumner depends primarily on operational factors such as transportation cost and congestion.
2. The introduction of a truck only toll lane on SR-167. SR-167 connects the ports of Seattle and Tacoma with the Kent warehousing district. The transportation cost to trucking companies would increase due to tolls paid for use of the roadway but inventory costs may decrease due to reduced travel times and reduced travel time uncertainties. The anticipated improvements in travel times and in travel time reliability are small, and within the current slack in the drayage trucking industry would not provide a transformative improvement, so the operational improvement is negligible. Given that drayage trucks are currently primarily owner operated, the operational benefit in time reduction goes to the truck driver. We plan to consider the use of alternative routes in light of a SR-167 toll lane, and the use of other warehousing regions.
3. Consolidation of shipping companies. Consolidation of shipping companies would reduce the number of small shippers while increasing the number of medium and large shippers, and increase the use of warehouses. In the model a large shipper of more than 200 TEU per week per region can benefit from transloading because of large volume of containers. The model also shows a large shipper is able to diversify logistics strategies using direct truck, transloading truck–rail, or direct rail options for uncertainty.

NEXT STEPS

The advantage of using this model is to be able to examine interesting what-if scenarios and uncertainties with change in variables or adding more variables simultaneously. We have presented a few examples here, but there are many more that could be considered. For example, what the impact will be of increasing fuel costs, bans on warehousing facilities, and other roadway capacity improvements.

We hope to develop ideas for further scenario analysis, and gather input on whether significant parameters should be added or removed from the model. We would like to see the methodology deployed for other regions of the country and identify possible applications.

POSTER SUMMARY

Argos
Dynamic Composition of Web Services for Goods Movement Analysis and Planning

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University of Southern Texas

PROJECT DESCRIPTION

The Argos Project seeks to develop new modeling tools for metropolitan goods movement analysis and planning using state-of-the-art computer science tools and a new approach for estimating freight flows on a highway network. Adequate models for metropolitan freight transportation planning are not yet well developed. In this research we explore the potential of web services workflows for developing intrametropolitan freight flow models that are easily updated and based on widely available data sources. This poster summarizes our work on two topics: workflow composition of the Argos planner, which automatically generates a freight origin-destination matrix that is used to generate a freight network assignment, and use of freight accessibility measures, an intermediate product of the Argos planner, to test impacts of economic activity on residential land values.

BACKGROUND

Economic restructuring and globalization have vastly increased the volume of commodity flows by all transport modes. Increased freight flows have had significant impacts on metropolitan areas. Traffic at major freight generators (ports, airports, rail yards, warehouse–distribution nodes) has greatly increased, adding to congestion and impacting surrounding neighborhoods. Increased train traffic interrupts road traffic and often conflicts with demands for passenger commuter service. Increased truck traffic is associated with added highway congestion, more delay due to accidents, and accelerated highway deterioration. As freight flows and their impacts increase, transportation planners, managers, and operators have a greater interest in developing better methods for tracking and monitoring commodity flows, and for analyzing these flows as they impact transportation nodes and networks.

There is also a growing interest in metropolitan freight flows among urban researchers. The increased importance of international trade leads to questions of costs and impacts of commodity flows on regions and local areas; relationships between supply chains, flows, and firm location behavior; costs and benefits of international trade; and impacts of goods movement on urban form and land values.

Current freight flow estimation and analysis methods have several problems, some related to data and some related to the estimation methods themselves. The Argos Project, funded by the National Science Foundation, combines computer science and social science to develop better, more-efficient methods for freight flow estimation. Our work includes data integration and automation techniques to make possible continuously updated and detailed freight flow estimates (*1*). We use a local-area input–output model and combine its information with available import/export commodity flow data from secondary sources to estimate detailed commodity flow matrices (*2*). Finally, we use accessibility measures produced by the Argos planner to test hypotheses regarding residential land values and economic activity.

PROCESS

Argos Planner

We have developed a general approach to construct data processing workflows, where the data sources and data processing operations are represented as web services. These services consume and produce relational tables, and thus are able to represent general computations. We describe each service as relational formulas in an expressive logic using terms from ontology of the application domain. These logical descriptions enable the Argos planner to automatically construct a computational workflow in response to a user data request, as illustrated in Figure 1.

We used the Argos automated workflow to generate inputs to our intrametropolitan freight flow model using 2001 data for the Los Angeles region. The origin–destination

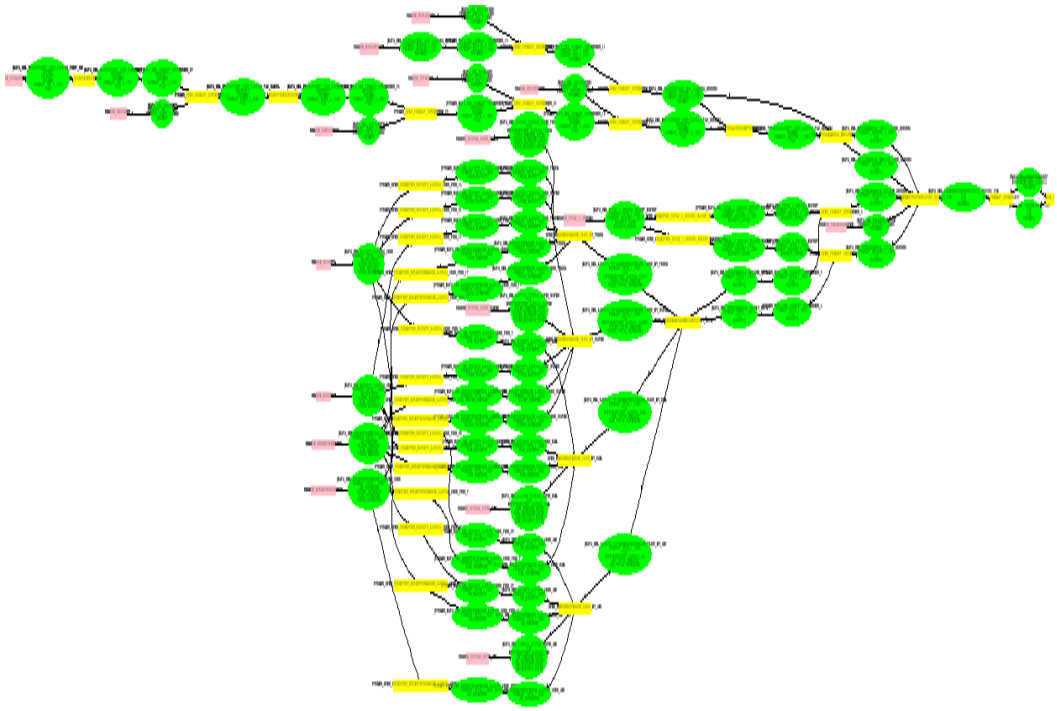

FIGURE 1 Automatically generated work flow.

matrix was input to a conventional network assignment model, and freight volumes were estimated. Results were good: simple correlation of estimated and actual counts across 18 screenlines is 0.80.

Economic Accessibility and Land Values

One of the goals of the Argos Project was to demonstrate the use of the Argos planner in other applications. Development of the computational workflow generated various measure of economic activity that could be used to develop measures of industry sector accessibility. Urban economic theory posits relationships between land values and accessibility. We estimated the impact of various industry sector measures on residential land values using a multilevel modeling approach (Table 1). The models were applied to residential sales in the Los Angeles region.

We find that most of the variation in residential land values is accounted for by distance to the coast, a proxy for amenities. Accessibility impacts are significant and differ by sector. For example, heavy manufacturing and resource extraction have a negative impact on housing price, while retail services, finance, health care, and entertainment have a positive effect.

FINDINGS AND CONCLUSIONS

We have developed a new method for automated composition of workflows, and we have applied the method to the problem of freight flow estimation, using the Los Angeles region as a case study. We have developed a new method for estimating intrametropolitan freight flows that relies primarily on easy to access, regularly updated secondary data sources. We have also shown that the intermediate products of the workflow can be applied to other problems, in this case the relationship between economic activities and residential land values.

FURTHER ACTIONS

Our further research includes various tests of the robustness of our modeling system, e.g. scalability and transferability. We are now developing scenarios to test the use of the model for

TABLE 1 Impact of Accessibility Measures on Residential Land Prices

Job factor 1: Heavy manufacturing	n/s
Job factor 2: Manufacturing	–
Job factor 3: Retail–services	+
Job factor 4: Resource Extraction	–
Job factor 5: Communication	+
Job factor 6: Construction	+
Job factor 7: Utilities	+
Job factor 8: Professional and other services	–
Freight factor 1: Heavy manufacturing	–
Freight factor 2: Light manufacturing	+

Sketch-level planning at the metropolitan level. Extensions of the research include integrating the model with emissions and air quality estimations.

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POSTER SUMMARY

North American Freight Transportation Data
Report of a Transportation Research Board Workshop

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PROJECT DESCRIPTION

North American freight transportation data are important for understanding cross-border issues between Canada, Mexico, and the United States. Two TRB standing committees, the Committee on Freight Data and the Committee on International Trade and Transportation, initiated a workshop to allow data users and providers to discuss freight transportation data from a North American perspective, highlighting recent changes in government-supplied data sources, and assessing users needs for today and the future. The workshop showcased recent and innovative applications of cross-border and freight flow data to address important transportation, policy, and development issues and offered an interactive format for a diverse set of participants to engage in productive dialogue.

BACKGROUND

Several groups are concerned with North American trade activity and the statistics that quantify it, including the following:

- Trade community: importers, exporters, intermediaries;
- Transportation industry: carriers, facility operators, railroads, and truckers;
- Government: national, state, local regulators and planners; and
- Others: consultants, media, lawyers, researchers, bankers, and equity investors.

Their interests overlap but mirror their roles as users, providers, regulators, and facilitators. Their common need is for information on cross-border trade activity that is comprehensive and consistent over time. Federal freight transportation data programs have been developed to provide this needed information and address questions such as:

- What are existing and potential markets?
- What infrastructure is needed?
- What are implications from and for policy decisions?

- What are the emerging trends? What's changing?
- What resources are needed? Where to deploy them?
- Are we collecting all revenues due?
- What is the competition doing?

These programs also satisfy congressional mandates and reduce patchwork data collection by states and metropolitan planning organizations.

The desired outcome from the workshop is to assure that North American freight data continues to help decision-makers address growing problems such as:

- Worsening congestion;
- Deteriorating travel times–delivery time reliability;
- Increasing freight transportation–logistics costs;
- Increased complexity of supply and services chains; and
- Increased impacts of gateway activity on communities and related trade corridors.

USES OF FREIGHT DATA

Showcased applications that use North American freight data to support decisions in several dimensions and levels addressed the following:

- Problem identification and priority setting for problem solving;
- Operations management;
- Design of improved crossing facilities and access networks;
- Design and evaluation of investments in border facilities and networks;
- Assessment of economic development and environmental impacts of current and proposed facilities and policies;
- Security and safety analyses; and
- Broader, before–after evaluations to support future decisions, e.g., assessment of the consequences of privatization of Mexican railroads, and evaluations of changes in the design or operations of border crossing facilities.

FREIGHT DATA ISSUES AND OPPORTUNITIES

Agencies across and among countries face similar concerns about cross border freight flows and the operation of border crossings. This commonality suggests the value of stronger communications to

- Exchange ideas;
- Share methods;
- Pursue more integrated joint efforts to develop better tools; and
- Advocate for the required freight data.

Sharing practices in analysis and modeling of freight data is likely to lead to both economies and more rapid advances in the field. Data across agencies is commonly integrated in decision-support actions, emphasizing the synergistic value of a collaborative approach to maintaining national data programs.

Easy access to freight data is now available through the Internet and provides a reminder of the importance of having data in your pocket. Users, both analysts and decision-makers, often demand quick answers, and quick and easy data access supports these applications and encourages data use.

Current use of commercial GPS truck tracking data in Ontario illustrates several important opportunities and issues.

- Both private and public sectors are interested in freight data for operation management, problem identification, and priority setting.
- Rich data sources remain to be tapped for a broad spectrum of applications.
- Shared use of data can produce high value at relatively low cost.
- Public use of private-sector tracking data requires clear agreements on allowable applications and protection of proprietary data.
- When each side understands the value to the other negotiation of sharing agreements that bring mutual benefits are possible.

DATA USES, USERS, AND PROGRAM SUSTAINABILITY

Data programs are sustained by their users and the applications of the data. Both private and public sector users rely on North American freight data. Private uses parallel public applications: operations management, and strategic decisions about equipment, locations, and markets. Carriers and shippers use these data to help influence government decision-making. That these private users also benefit from the data needs to be communicated broadly to ensure future support for such data programs.

Applications are mostly based on data that are integrated from multiple sources. This integration is essential, particularly in terms of geographic and commodity detail. National data programs, including the Commodity Flow Survey and the Bureau of Transportation Statistics Transborder Freight Data program, are almost always at the core of these decisions. However, this foundational connection is not always revealed. This unrevealed or stealth use of essential national data sets is troublesome, because it fails to provide critical market signals in support of national data programs. In the competition for resources for all data programs, policy-makers need to understand the sources of the data they are using, and work to ensure that national data programs are maintained.

An emerging concern is the risk to continued availability of freight border-crossing data based on security issues. While ensuring the safety and security of our borders is essential, and good data will contribute to that objective, it is important to avoid blanket restrictions on the distribution of such data for public and private analysis and decision making. In the long term, the most serious threats to national security may be economic competition for resources and markets. An efficient, integrated, secure logistics system, well managed with accurate, comprehensive and timely data, may be the best protection for national interests. Any data access restrictions should be carefully considered with this broader view in mind.

LESSONS LEARNED

Progress has been made in the collection, organization, dissemination and application of North American trans-border freight data. This progress should motivate the collection and application for better data in more-advanced and responsive ways.

Collaborations offer good ways to focus efforts, learn from others, and accelerate the rate of progress in freight planning. The challenge is shared by business and governments, and each has something to offer the other. These issues and their solutions readily cross borders, making a North American effort logical and worthwhile.

The foundational role of national databases emphasizes the importance of securing and improving data sources for the future of freight planning and management.

NOTE: Proceedings from this 2007 workshop are published in *Transportation Research Circular E-C119: North American Freight Transportation Data Workshop* and can be accessed at http://onlinepubs.trb.org/onlinepubs/circulars/ec119.pdf.

WORKSHOP PLANNING COMMITTEE

- Paul Bingham, Chair, Global Insight, Inc.;
- Thomas Bolle, Research and Innovative Technology Administration;
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- Michael Sprung, Bureau of Transportation Statistics;
- Juan Carlos Villa, Texas Transportation Institute;
- Kathleen Hancock, Virginia Polytechnic Institute and State University; and
- Thomas Palmerlee, TRB Staff Representative.

POSTER SUMMARY

A Freight Planning Framework

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PROJECT DESCRIPTION

Effective freight transportation is vital to the economic growth of a region. Accurately modeling the impact of freight demand on the existing transportation infrastructure is paramount to identifying deficiencies in the system and can improve resource allocation to ensure congestion does not limit economic growth. This project focuses on improving transportation and freight modeling and decision-making by the development of a Freight Planning Framework (FPF) that employs existing federal freight data, and a variety of tools to develop statewide origin–destination (O-D) freight-flow patterns, freight-specific traffic models, a discrete-event simulation of freight activities, and system performance measures.

BACKGROUND

Traditional transportation planning activities often ignore freight in the modeling process or add freight as an afterthought. Freight planning applications, if included in the process, often rely on historically based projections that cannot account for major changes in the workforce or economy of the area. By design, trend-line forecasting assumes that what has happened in the past will happen in the future, a method rendered wholly inadequate in today's U.S. economy by the growth in global supply chains and international trade. Therefore, an approach to freight modeling that accounts for economic activity, and can be incorporated into the transportation planning process, or used independently, would better allocate resources to transportation infrastructure.

Transportation planning activities performed in almost every metropolitan planning organization nationwide, and many states that maintain statewide planning efforts, follow the traditional sequential four-step methodology. The four steps are; trip generation, trip distribution, modal split, and traffic assignment. In recent years, researchers attempted to optimize the process and improve forecasting results. Major areas of study include adding feedback loops to incorporate congestion effects, and the detailed examination of individual steps in an attempt to reduce the error in each step. Even as these improvements are shown to be successful, the underlying notion of the sequential, four-step model has remained.

PROCESS

Rather than basing transportation infrastructure decisions upon backward looking trend line forecasting, the FPF is designed to incorporate the interaction between economic activity, infrastructure, population, and congestion of a given region using a forward-looking industry

cluster-based analysis. The concept of using industry clusters for freight planning is relatively straightforward. By understanding how an industry cluster creates the need to access the transportation infrastructure for freight, it is possible to develop relationships that can be used to determine freight needs anywhere that industry cluster is present. Aggregating the known freight behaviors for all major industry clusters in an area provides a better approximation of the freight needs in that area. The FPF builds upon the traditional four-step transportation planning process by creating a forward looking approach to trip generation. Figure 1 provides a graphic depiction of the FPF.

The industry cluster based planning factors used in the FPF approach are value of shipments, personal income, population, and employment. These four factors are used because one single factor cannot adequately define the demand for freight system requirements. The factors employed must be capable of describing the freight-generation characteristics and the freight attraction characteristics of a region. For example, the use of employment as a proxy for the generation of freight does not take into account the effects of increased productivity associated with productivity or technology improvement activities of a company.

Data is critical to any reasonable analysis of freight activity. Currently, the best available freight data is the FHWA's Freight Analysis Framework (FAF) database. The second generation of the FAF, known as FAF2, is a continuation of the original FAF. The FAF2 provides commodity flow O-D and freight movement data on all highways within the FAF2 highway network, while avoiding the proprietary limitations of the original FAF. The O-D data covers

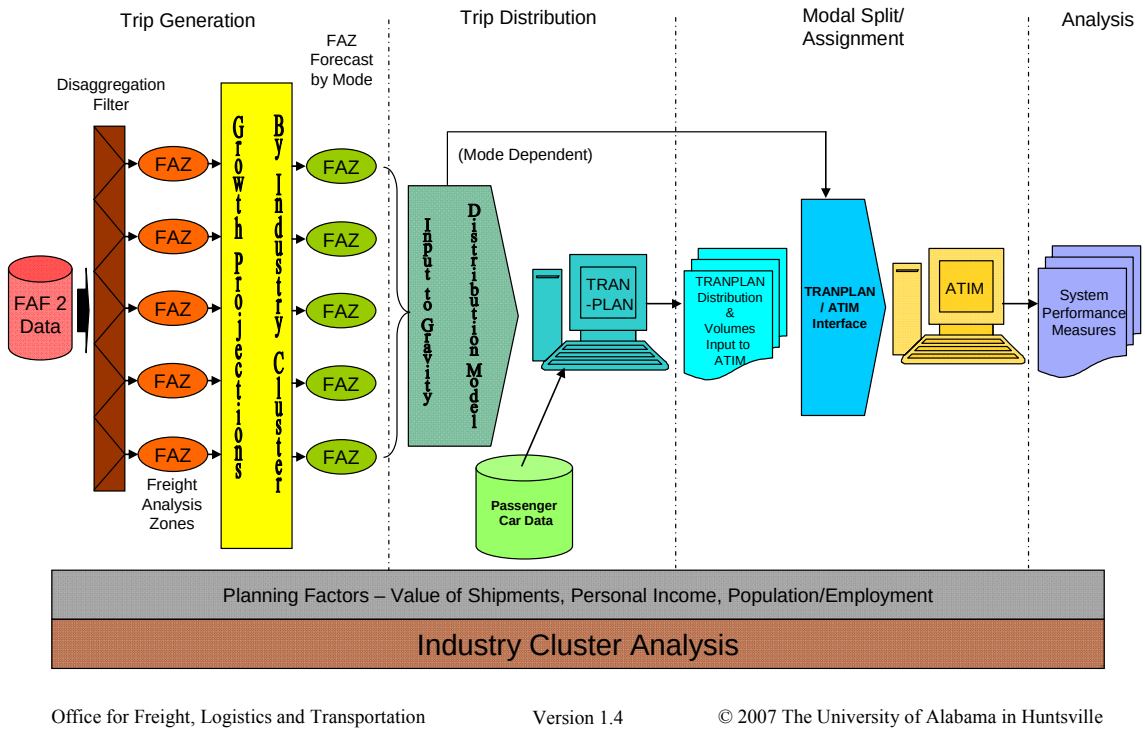

FIGURE 1 The FPF.

the base year (2002) and projections between 2010 and 2035 in 5-year intervals. In addition to FAF2, industry surveys are conducted to supplement the data. The surveys provide a clearer understanding of the activity of industries in a region, and the factors that affect freight generation and attraction. Appropriate conversion factors for determining the number of vehicles the data represents must be developed to use the FAF2 and survey data successfully.

Because the FAF2 database is highly aggregated, the usefulness of this data is limited for substate freight planning. It is important to derive the potential freight volume destined for, originating from, passing through, and internal to a state, and then disaggregate the data to a smaller geographic level. The disaggregation of the FAF2 is accomplished through the development of Freight Analysis Zones (FAZ) to capture the level of freight activity in an area. The FAZs are also the basis for the forecast, by industry clusters, used to predict the freight volume for periods in the future. To do this, an industry cluster forecast for the state is needed that can be segmented at the NACIS level and applied at the local level.

The local freight projections are distributed using a gravity model for both the base and future year alternatives. The freight O-D matrix is assigned to the transportation infrastructure network to determine the travel paths. Passenger car volumes are added to the freight traffic for separate roadway segments using a separate travel model.

With the freight volume distributed and assigned to specific roadways, the next step is to understand how the freight traffic affects, and is affected by, the transportation network and the built-in constraints of the system. This understanding is achieved by employing simulation resources. The tool used in the FPF is the Alabama Transportation Infrastructure Model (ATIM), developed by researchers at the University of Alabama in Huntsville. The ATIM is a discrete event simulation of the statewide multimodal freight transportation system, with the ability to rapidly evaluate the impact of system decisions.

Finally, the FPF provides the ability to measure the performance of the transportation system. The FPF is a tool for continuously improving the transportation system's ability to efficiently, effectively, and safely move people and freight. Improvement does not take place without a measurement system in place to quantify the performance.

FINDINGS AND CONCLUSIONS

There are several projects defining many of the parameters and methods involved in this framework including research on developing a methodology for disaggregation of FAF2 data to the local level and for forecasting final sector demand and pass through freight, and for developing system performance measures.

FURTHER ACTION

The design and methodology of the FPF and systems view of transportation—which relates economic activity, population, infrastructure, and congestion—are the key contributions of this project. Passenger car forecasting techniques have been studied and improved for over half a century, but freight modeling has often been neglected by the planning community or at best considered only at minimal levels. As discussed, this level of effort could result in misallocation of scarce transportation infrastructure investment resources.

The proposed FPF methodology takes freight flow data at the national level and structures it in a format usable for freight planning purposes at a variety of levels. This methodology is expected to be a valuable piece of the overall transportation planning toolbox in the future. Additional research of each component of the FPF would be beneficial to ensure the final product provides value added information and data to transportation planners in Alabama and throughout the nation.

ACKNOWLEDGMENT

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POSTER SUMMARY

Essentials of Analysis in the Control of Overloaded Trucks

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PROJECT DESCRIPTION

This project aims to develop a framework to analyse the issue of overloaded trucks in Mexico. As in many countries, even if a fine and penalties system exists to deter overloading, the limited surveillance capacity and the need to cover long road network extensions has proved to be a poor control in practice. The main objective of this project is to base a redesign of the current penalisation system as to improve its efficacy and so to alleviate the maintenance tasks faced by the Mexican Transportation Secretariat on the nontolled paved network, usually supported by public funding.

BACKGROUND

The Mexican Paved Network composition, having around 48.000 km, most of which (about 41.000 km) are nontolled, poses a hard maintenance load on the Mexican Secretariat of Transport. Even more, a recent controversy on the legal weight limit for the full-truck configuration (T3-S2-R4) fostered by truckers in order to increase this limit on the basis of productivity reasons has strained this situation since the end of 2006.

In view of this the Mexican Transportation Institute (IMT), a R&D institute linked to the SCT, decided on looking at the general problem of overloading control, considering its current research lines.

PROCESS

From a literature review on the overloading around the world, a research on modeling interactions between road users and road authority was developed at IMT, having as a central piece a bilevel optimization scheme with the road authority as the leader and the road user as the follower. For the leader, the decision variables chosen were the level of fines and the number of inspection points on the paved road network; for the follower the decision variable was the truck load factor. Objective functions for both leader and follower corresponded to their respective costs: road repair costs for the leader and operation costs for the follower. This research helped to identify both the actors intervening in the overloading problem, and the potential actions to improve the control on the overloading issue. The optimization model used to represent interactions among road users and road authority has suggested a mechanism to control overloading by an adequate mix of number of inspection points and fining levels subject to restrictions related to the perceived cost of travel by truckers.

FINDINGS AND CONCLUSIONS

The research has emphasised the conflict between the economic rationality guiding truckers to overload and the technical rationality of the weight regulations. Additionally, the analysis of the main elements to consider in the design of the penalties system has shed some light on basic principles of the penalties system as the sanction severity, the quick response of the authority in applying the fines and the persistency of the penalty scheme on the truckers' perception.

FURTHER ACTION

More research would aid in assessing potential strategies to improve the control and penalties system. Such strategies could include educational campaigns, ameliorated inspection schemes based on random surveillance and suitable combinations of fixed and mobile stations, and enhanced authority image on the road network system.

As a line of future research, this project can be framed in a more general study of the conflictive relationships between economic profitable violations to traffic regulations and the technical basis of these regulations. These regulations would address three common illegal practices observed around the world: speeding, overloading, and exceeding the legal driving time.

Any improvement of the corresponding controls on these illegal practices would render indexes of accidents, fatalities, and infrastructure damage ameliorated as compared to the actual values observed.

POSTER SUMMARY

Freight Modeling in Small- and Medium-Sized Metropolitan Planning Organizations

Update of the Fargo–Moorhead Metropolitan Area

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North Dakota State University

PROJECT DESCRIPTION

An efficient transportation system is indispensable for economic growth and sustainability for any region as it supports personal and freight mobility. Focusing on the freight sector, transportation plays a key role in moving commodities, supporting industries, and delivering goods to consumers. Following the economic gains of the last decades, freight traffic has experienced significant gains, greatly outpacing passenger traffic across much of the U.S. transportation system.

The increasing freight volumes pose significant challenges to the transportation system and need to be modeled in order to balance the needs of businesses, those of other users and the environment. There is an increasing need for models capable of forecasting freight in order to provide decision-makers with the best available tools for optimal decision-making pertaining to the transportation system. Freight models have witnessed significant but insufficient advances in recent years; but still lag significantly behind passenger equivalents in terms of data, methodologies, and applications in travel demand models. Data deficiencies, complexity of freight movements, and limited capital (both financial and human) are reasons given for the deficiency in freight modeling. The problem is exacerbated in small and medium-sized metropolitan planning organizations (MPOs) which are further constrained by these barriers to freight modeling. This research is an update on current efforts to develop a truck-based freight forecasting model for the Fargo–Moorhead metropolitan area. Particularly, this update focuses on data collection efforts, proposed methodology and current experiences with the whole process.

BACKGROUND

The absence of a freight component in travel demand models could significantly reduce the ability of these models to correctly forecast travel as freight and passenger trip-making behaviors are considerably different from each other. Methods such as those assuming a small portion of all traffic is truck traffic could severely overestimate highway capacities resulting in higher than anticipated future costs to both the private and public sectors. The Freight Analysis Framework (FAF) estimated urban truck vehicle miles traveled (VMT) increased at a higher rate (36%) than passenger VMT (25%) between 1993 and 2002. This trend is expected to continue with urban truck movements expected to increase at 3% annually compared to a 2.6% annual increase in passenger VMT. The passage of the Transportation Equity Act for the 21st century in 1998 and more recently the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for

Users in 2005 all emphasized inclusion of freight in transportation planning models for transportation planning agencies.

The overall goal of this research is to develop modeling procedures using state-of-the-art in freight methodologies with locally collected data to develop a standalone truck freight model for large trucks (vehicle class 8 and higher) that will be incorporated into a travel demand model. The Fargo–Moorhead (FM) area which is traversed by two Interstates and several local highways is being used as the case study area. The FM area is the largest metropolitan area in North Dakota with great potential and projections for future growth both in terms of population and businesses. Freight, and specifically truck traffic, is already an important component in the FM area transportation system. Truck traffic already accounts for more than 25% of the total average daily traffic on some area highway links. The Fargo–Moorhead Council of Government (FMCOG), the MPO for FM in coordination with the Advanced Traffic Analysis Center (ATAC) of North Dakota State University are cooperating to achieve the overall goal of the study. The FMCOG has the primary role of using its network with area agencies and businesses for supporting the data collection in this study and. The role of ATAC is developing and implementing the freight model into the FM Regional Travel Model.

RESEARCH PROCESS

The project was divided into four phases, including: conducting a comprehensive literature review of current freight modeling practices, developing a conceptual framework to model truck movement for the FM region, collecting data to support the model, and applying the model to the case study and collecting the results.

Data requirements may be divided into two categories: network data and socioeconomic data. Network data such as traffic counts, link-node network system, and network attributes (intersection control, geometry, and speed limits) have already been collected. Socioeconomic data are being collected primarily through surveys. One survey was administered to all freight generation businesses and the other one to truck drivers at truck stop. The survey to businesses is designed to obtain origin–destination (O-D) data, trip-generation data, and land use intensity data for trips with at least one end in the study area. The survey to truck drivers is to obtain O-D data for through trips and with intercept surveys being illegal in the state, it is the opinion of the researchers that truck stops will provide valuable insight on through truck trip O-Ds.

FINDINGS AND CONCLUSIONS

This paper is an update on the current efforts to model trucks in the FM area and the findings so far are related to the current stage of the process. The literature review revealed a lack of applications of freight travel demand models, especially in small and medium-sized urban areas. Using state of the art in travel demand models, a modeling framework has been developed and will be used to model truck movements when all data is available. The response rate for the survey to businesses was 56% which is higher than other studies that have cited the proprietary nature of freight data as a reason for low response rates. Another factor that may explain the 56% response rate was the fact that the questionnaire was just one page in length. There has also been

some interest from the freight industry after the FMCOG published information about the study in their quarterly newsletter.

FURTHER ACTION

Based on current experiences, the following observations can be made.

- Freight data collection should be included when data are being collected for passenger travel demand models. For example, truck counts, and socioeconomic data to support freight should be included.
- The freight model could be further enhanced by including trips that originate and terminate in the study area, mostly trips involving smaller trucks.
- Studies of all commercial trucks, not just freight moving trucks, would be beneficial as those studies could be included in travel demand models.
- Inclusion of private businesses in future data collection through the formation of a freight committee will enhance and simplify the data collection process and also provide input from the industry to the MPO as to what is important to them in terms of transportation projects.

POSTER SUMMARY

Dynamic Freight Routing Under Intelligent Transportation System Information for Congestion Avoidance

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PROJECT DESCRIPTION

Our research aims to address a major issue contributing to transportation network congestion that directly affects supply chain (SC) efficiency. This issue is the effect of "recurrent congestion" as well as "nonrecurrent congestion" (attributable to incidents such as accidents) in the transportation network (e.g., road network, railway network) and intermodal facilities (e.g., airports, railroad terminals, ports). We develop methods and tools to improve the logistics efficiency of SCs using real-time information available through current and future intelligent transportation systems (ITS) to avoid congestion in the transportation network infrastructure and intermodal facilities. Traditional methods such as capacity expansion with infrastructure investments (network and intermodal terminals) or buffering methods (e.g., inventory, headways, surplus fleet capacity) prove to be expensive coping mechanisms. Alternative to these, ITS can provide real-time information (on the congestion status of network and intermodal facilities) and navigation to users who can then avoid congestion and thereby reduce the impact of transportation delays. Our research group is developing and testing various state-of-the-art algorithms and heuristics for optimal routing and navigation of vehicles in dynamic transportation networks under ITS systems.

Our collaborators in this project are UPS, UPS Supply Chain Solutions, Ford's Material, Planning & Logistics (MP&L), C.H. Robinson, Michigan Department of Transportation (DOT)–ITS, Michigan DOT–Michigan ITS Center, and the Transportation Research Group of Wayne State University. In this project, we are also measuring the intermodal delivery reliability and quantify the impact of delays in intermodal freight transportation systems on the operations of selected carriers (UPS and C.H. Robinson) and just-in-time (JIT) SCs (Ford inbound and outbound logistics).

BACKGROUND

Over the last two decades, transformation in SCs to a pull-based demand sensing and response in global networks have necessitated efficient SC operations such as JIT deliveries and reduction of inventories, both in transit and in facilities. For example, our collaborator, Ford MP&L, reports that nearly 80% of all parts and assemblies supplied to vehicle assembly plants in the Detroit metropolitan area are JIT based and involve five to six deliveries per day per part (with no more than 3 h of inventory in most cases). Hence, the reliability and efficiency throughout the SC operations including transportation and distribution has become more-important than ever. The reliability of logistics operations is most affected by inefficiencies in the transportation network. Examples of transportation inefficiencies are late–early pickup–delivery and longer

transportation times, causing increased fuel costs, and driver costs. These inefficiencies have direct effects on the economics of logistics operations, but more importantly, they more significantly affect SC operations through missed deliveries, idled capacity–labor, and increased schedule nervousness. For example, Ford's MP&L reports the cost of idling a final vehicle assembly plant due to part shortages and missed deliveries to be $50,000 to $60,000/h.

The JIT and globalization trends have also changed national freight realities. According to U.S. DOT's 2002 Commodity Flow Survey, between 1993 and 2002, shipments by air (including intermodal truck–air shipments) grew the most whether measured by value, tons, or ton-miles.[1] The value of air freight shipments almost doubled (97%) during this time, followed by increases in intermodal combinations of 67%and trucking of 42%. By tonnage, air freight shipments increased 46%, followed by trucking with 26% and rail with 20%. Although trucking dominates the freight transportation system, these trends indicate that intermodal transportation is increasingly becoming more important. With the rising freight value per ton, shippers prefer more frequent and smaller JIT shipments, which put a premium on transportation system reliability and flexibility of inter-modal combinations. FHWA's research on freight also concludes that despite the infrastructure investment efforts, the efficiency, and reliability of the intermodal freight network, congestion remains a problem.[2]

Congestion (recurring and nonrecurring) is an important source of logistics system inefficiencies at all levels (local, national and global). Traditional methods of coping with congestion prove to be expensive and futile coping mechanisms. Alternatively, using the transportation network and facilities efficiently presents itself as an effective and cost-efficient approach. Current and potential future technology to measure–disseminate transportation system congestion information allows efficient user-based allocation of the load on the transportation network. Hence, using real-time congestion state information (network and intermodal facilities) for dynamic freight routing on transportation networks is preferable over traditional methods. While there several dynamic routing algorithms exist that can utilize real-time information, there are several shortcomings with these algorithms such as focusing only on road networks, not accounting for nonrecurring congestion, and being unscalable for practical applications.

PROCESS

For single-mode freight transportation on road networks, there exist several dynamic routing algorithms that can utilize real-time information. However, they fail to account for congestion resulting from nonrecurring events, such as accidents. Nonrecurrent congestion due to incidents (i.e., accidents, breakdowns) on the road network plays an important role on the delivery reliability within JIT SC operations. AASHTO reports that over half of all traffic congestion in urban areas occurs because of incidents (not because of traffic volumes).[3] Furthermore, the impact of nonrecurrent congestion has significant correlation with the recurrent congestion state. For instance, impact of a minor incident in low-density traffic would be insignificant compared to high-density case. Therefore an approach that accounts for both types of congestion is more realistic. We developed and implemented stochastic backward dynamic programming algorithms and heuristic methods (e.g., AO*) for dynamic routing by incorporating real-time information regarding nonrecurrent events. We did this through an incident shockwave model that estimates the impact of nonrecurrent events using dynamic ITS information on the link travel time, modeled as a time-varying stochastic incident delay. Currently, we are in the process of

developing computationally efficient shockwave models as well as heuristics for effective dynamic vehicle routing.

For dynamic routing on intermodal transportation networks, we have selected two problems. First one is the dynamic routing and airport–flight selection for a time-sensitive air cargo forwarder. We developed stochastic dynamic programming models and algorithms for forwarder's problem of dynamically choosing airport–flight pairs to ship the cargo. In this problem, both the historical and real-time airport and flight delay information is used to decide on the optimal road network routing and air-shipment policy. Second problem is dynamic container routing in global intermodal transportation network. We first developed a large-scale integer programming model to determine a static shipment policy for a containerized cargo from Asia to Michigan. We are developing a dynamic routing model that will allow container unloading–loading at different ports and mode selection (e.g., between rail and road) and load-splitting based on the real-time congestion information on the intermodal network.

FINDINGS AND CONCLUSIONS

In our implementation of dynamic routing models and algorithms on single-mode and intermodal networks, we found that accounting for nonrecurring congestion (from incidents such as accidents) along with recurring congestion has far more potential for system efficiency than modeling recurring congestion alone. However, these models become intractable for practical applications demanding sufficiently optimal but quick results. Therefore, there is a great demand for effective heuristic development and model preprocessing. Lastly, we found that the impact of congestion on intermodal networks exhibits system interaction effects between different modes and connecting points (intermodal facilities).

NOTES

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2. FHWA, Freight Operations and Technology. http://ops.fhwa.dot.gov/freight/inter-modal/index.htm.
3. The American Association of State Highway and Transportation Officials. http://www.aashto.org.

POSTER SUMMARY

Safety Synthesis of Oversize–Overweight Commercial Vehicles

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PROJECT DESCRIPTION

State departments of transportation (DOTs) are increasingly concerned about growing trucks weights and infrastructure damage in permitting oversized–overweight (OS-OW) vehicles. As a result, in the summer of 2006 FHWA and AASHTO conducted a European scanning study of commercial motor vehicle size and weight (VSW) enforcement. The objective of this project is to address one of the seven high-priority topics, identified by the tour team. It is hoped that the synthesis will allow the inclusion of safety in the permit issuance process.

During the tour, the team learned that in European countries, safety plays a stronger role in both issuing permits to OS-OW vehicles and in enforcement than in the United States. Research in Belgium identified a safety relationship involving excessive weight of OS-OW vehicles, and the Belgian government adopted aggressive legislation against commercial motor vehicles (CMVs).

OVERVIEW

This project is being conducted under the guidance of a strong advisory panel composed of representatives from the scan team, FHWA, and AASHTO. The research is evaluating previous domestic and international research studies, using the following work steps:

- Evaluate background information. Background information was acquired and is being evaluated as the first stage of the research. This includes examination of the VSW Scan Tour Final Report; other documents acquired during the tour, and pertinent reports from prior scan tours; interviews with VSW Scan Tour representatives; contacts with and interviews of appropriate officials in Belgium; and similar exercises.
- Conduct literature review and interviews. This consists of a traditional web-based literature review, supplemented by telephone interviews with officials involved with large trucks. The phone calls are yielding leads to ongoing research, additional completed research, and literature to incorporate into the study.
- Prepare synthesis report. The report will document existing research into relationships between commercial motor vehicle weight and safety in the United States and internationally. It will indicate what is known, what additional knowledge is desired, and potential ways to acquire the additional knowledge.

GROWING FREIGHT VOLUME AND LARGER LOADS

Significant growth in domestic and international commerce, coupled with ever-increasing traffic congestion and consequent delays on surface transportation networks, challenges the ability of industry to move freight economically without the use of larger and heavier loads. Over the past 20 years (1982–2002), there has been a 42% increase in registered large trucks and the mileage they have driven has almost doubled (*1*). The thought among transportation planners is that over the next 20 years, the mileage will again double. Many Interstates are near capacity. Roadways are not being built or maintained at the same rate as the traffic is growing. If that 20-year prediction holds true, the nation's roadways are in dire straits (*2*).

OVERVIEW OF LARGE TRUCK CRASHES

In 2005, a total of 5,212 people were killed in crashes involving large trucks. This corresponds to approximately 12% to 13% of all traffic fatalities that occurred that year. This value has been relatively consistent for the past 20 years (*1*, *4*, *5*). But this value is high considering that large trucks account for only 3% of all registered vehicles (*5*).

As documented by the U.S. DOT, there are several "reasons why it has been difficult to isolate effects of vehicle weights and dimensions on highway crash rates" [as follows:]

- "Weights and dimensions of vehicles involved in crashes often are not known or recorded on accident reports;
- "Even where data on the number of crashes for certain types of vehicles are known, the [vehicle miles traveled (VMT)] for those vehicles often is not known, so it is difficult to develop crash rates for vehicles larger than the typical vehicles in use; and
- "Crash rates for larger vehicles used in certain regions of the country or on turnpikes may not be transferable to operations in other parts of the country where traffic volumes are higher and the operating environment is less safe" (*3*).

Vehicle handling is an important factor in understanding OS-OW CMVs. Vehicle characteristics (i.e., turning radii, sight distance) are the standard by which roadway geometric designs are established. Most often, these designs are based on the critical vehicle using the roadway in question (*5*). Unfortunately, CMVs have been increasing in size and weight. Because of this, off-tracking is a major concern especially in areas where multitrailer combinations are prevalent (*3*). Also, because of their irregular size, OS vehicles can disrupt a perfectly working roadway. For example, these larger vehicles "can block the view of highway signs" that would normally be accessible by all motorists (*6*).

Other factors influencing CMV handling include braking and stability. "A 100,000-pound truck takes 25% longer to stop than a 80,000-pound truck and a 120,000-pound truck can travel as much as 50% further before stopping than an 80,000-pound truck" (*1*). "Antilock brakes are now required by federal regulation for all newly manufactured heavy vehicles. Braking capabilities of trucks have improved to the point that the braking distances of passenger cars and trucks on wet pavements, where braking distance is most critical to safety, are now equal" (*5*). Unfortunately, only the new trucks require antilock brakes. There is no similar legislation applicable to trailers (*7*). Rollover is another big issue. Of all fatal accidents, approximately 60%

of truck trailer deaths are caused by rollovers. OS-OW vehicles are more prone to rollover than all other large trucks because of their height and center of gravity (*3*).

One article in particular focused on the various factors contributing to crashes. The Report to Congress on the Large Truck Crash Causation Study (LTCCS), was written to describe a "nationally representative sample" of statistics involving large trucks. A total of 967 crashes involving at least one large truck and at least one injury or fatality, were studied. The LTCCS found that the truck driver was the "critical reason" for the investigated accident 87.2% of the time. Environmental factors and vehicle quality were both addressed in this article (*8*). This report produced some compelling data, but the collection techniques utilized are under scrutiny by several organizations such the University of Michigan Transportation Research Institute and the Truck Safety Coalition.

ENFORCEMENT FACTORS

Overloading and enforcement visibility have an inverse relationship. When a vehicle is OS-OW and a weigh station is open on the road on which it is traveling, some drivers will purposely lag to the rear of a convoy. The driver knows that the station will become saturated and will have to temporarily stop accepting vehicles. This technique—"plugging"—allows the OS-OW driver to bypass the weigh stations (*2*). To combat the "plugging" practice, weigh-in-motion (WIM) devices could be used to pre-sort CMVs (*9*).

Another enforcement avoidance practice is avoiding the weigh stations all together. According to the article "Heavyweight Safety," if a weigh station was open, up to 14% of truck drivers "would travel up to 160 miles to avoid a weigh station" (*2*). Another method to combat this traffic shift to secondary the roadways would be to utilize portable WIMs (*2*).

Interviews with enforcement officers have identified small firms (typically one to five trucks) as more likely to carry overweight or over-length loads. The term "ma and pa one-truck operation" occurred in interviews frequently, because such operations are operated at a low margin, are overloaded to help make their businesses profitable, and are hard pressed to upgrade their trucks. Officials in both the United States and Europe expressed the same feelings. These same firms are usually loaded away from scales (logs, gravel, agricultural, etc.) and may deliberately operate off the state system of roads or at night to avoid enforcement officers.

PRELIMINARY CONCLUSIONS AND NEXT STEPS

Although the study is ongoing, several preliminary conclusions have been drawn:

1. There are few existing studies on the role of freight loads in crashes. Possible reasons include the following:
    a. In a severe OS-OW crash, the load is normally scattered from the vehicle, making weight and loading patterns difficult to determine.
    b. Gathering the complex data from a severe heavy vehicle crash requires special knowledge and is very time-consuming.

c. It is usually necessary to reconstruct such a crash to determine the specific circumstances associated with the crash, which requires extensive work from highly trained officers.

2. In general, we know much less about heavy commercial vehicle crashes than car crashes.

3. Interviews with enforcement officials in both the United States and Europe indicate that the smaller firms (one to five vehicles) are most likely to exceed size or weight limits, and that their vehicles are typically older and less maintained that those of larger firms. U.S. officials indicated that vehicles that operate entirely within a state are more likely to exceed limitations and dodge enforcement officers by operating on "off system" roadways or at night.

4. The Federal Motor Carrier Safety Administration has traditionally focused on the safety of vehicles (tires, brakes, etc.) and drivers (fatigue, falsifying records, risk taking, etc.) FHWA has traditionally focused on the road and its role in crashes. The research agendas of the two agencies point toward common ground, and collaboration between them to develop an understanding of types, rates, and causes of heavy commercial vehicle crashes would be beneficial. Such knowledge is needed to develop optimum, cost-effective countermeasures.

5. Intuitively, there has to be an increased safety risk when OS-OW vehicles exceed the posted speed limit or their permitted weight (tendency to rollover, exceeding braking system capacity, high kinetic energy expended during the crash, etc.), but there is little information in existing safety studies to conclusively support this concept. That does not mean that the relationship does not exist, just that it has not been proven through crash research.

6. There is no reliable data for longer vehicles, bigger combination vehicles and especially triples allowed by nine western states and five eastern states (turnpikes only for eastern states).

7. An intensive effort is warranted to gather significant, high-quality data to analyze OS-OW commercial vehicle crashes. Such an effort would be expensive, require high levels of training, and would have to be a highly-organized federal agency effort.

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POSTER SUMMARY

The Effect of Auxiliary Power Units on Long-Term Idling
A Case Study

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PROJECT DESCRIPTION

The Nebraska Transportation Center (NTC) conducted research on the idling activity of long-haul truckers. The research was sponsored by the U.S. Environmental Protection Agency. The goal was to see if the installation of auxiliary power units (APUs) reduced the long-term idling of truck drivers.

BACKGROUND

The nature of the trucking industry requires long-haul truck drivers to spend much of their time away from their homes. In addition, current rules of operation dictate that drivers have a 10-h break for every 14 h of operation. Taken together this means that drivers spend much of their 10-h break in their cabs. Comforts such as television and climate control require power, and, particularly for extreme weather conditions (both hot and cold), the drivers will often run their trucks to maintain a reasonable level of comfort. There are two problems associated with this. The first is that engine idling is highly inefficient in terms of energy use. The second is that many jurisdictions limit the amount of idling time by trucks (e.g., less than 10 min) in order to limit emissions. These problems adversely affect the drivers' ability to maintain even basic comforts.

PROCESS

In partnership with a local small (e.g., less than 50 trucks) trucking company, NTC has tracked the idling times of 26 long-haul trucks—11 of which have been equipped with APUs and 15 of which have not—with the disaggregate idling times, the geospatial coordinates, distance traveled, fuel used, active time, and date of observation were also logged. Using the geospatial data, it was possible to overlay the observations on such factors as average monthly temperature, pressure, and humidity. It is important to note that the location at which the idling occurred is not known. Therefore, the values recovered for a single day were aggregated via an arithmetic mean. An example of an overlay on the National Climatic Data Center (NCDC) Climate Atlas of the United States v2.0 is shown in Figure 1.

Calling those vehicles that were eventually equipped with APUs the test group and those that were not the control group, the means and quartiles of each of the observed variables weighted by vehicle were plotted over their respective groups and over month, season,

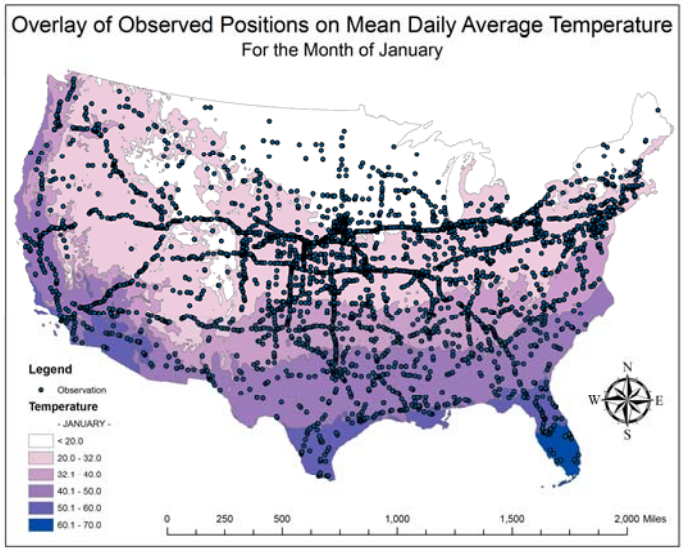

FIGURE 1 Overlay of truck locations on map of January's mean daily average temperature

temperature, etc. Reductions in the sample used for direct comparisons were made as differences were observed between such categories as owner-operated and fleet vehicles. The idling times of the test group and control group were subjected to two-sample *t*-tests for control before to control after; test before and test after; control before and test before; and control after and test after.

For many of the vehicles in the test group, the vehicle entered the study equipped with its APU as opposed to being upgraded. Bear this in mind as the aggregate analysis assumes these vehicles to have behaved in the same manner as those that appeared prior to being equipped. Individual test vehicles with sufficient number of observations prior to being equipped with the APU were examined alongside a comparable control for a before–after statistical analysis.

FINDINGS AND CONCLUSIONS

Long-term idling times were not found to be correlated with average daily temperature for each month when taken in aggregate across drivers and grouped by test group and control group. While expected to take a convex parabolic shape, it did not, as shown in Figure 2. This is likely due to the bias previously noted in the description of the overlay process along with such other factors as relevant ordinances.

Without a strong temperature relationship, the means of the long-term idling times for the aggregate groups were plotted over the months of the year in Figure 3. The related statistical tests show that the mean of the test group was already less than that of the control group, so the study is not in control. Thus, the reduction, or lack thereof, cannot be stated without including additional assumptions.

Comparisons of pairs of individual vehicles both present during the same time of the dataset yield promising but inconclusive results. An example of such a pair is shown in Figure 4, but the following map of the locations observed for the pair's idling behavior shows that their assignments vary greatly.

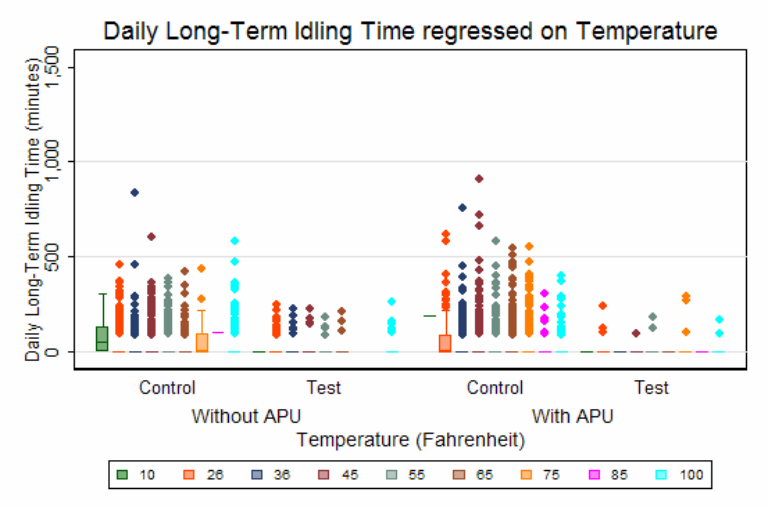

FIGURE 2 Daily long-term idling time regressed on temperature.

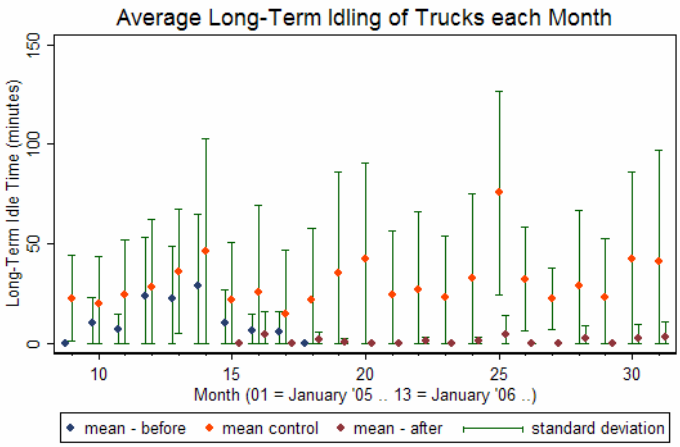

FIGURE 3 Average long-term idling of trucks each month.

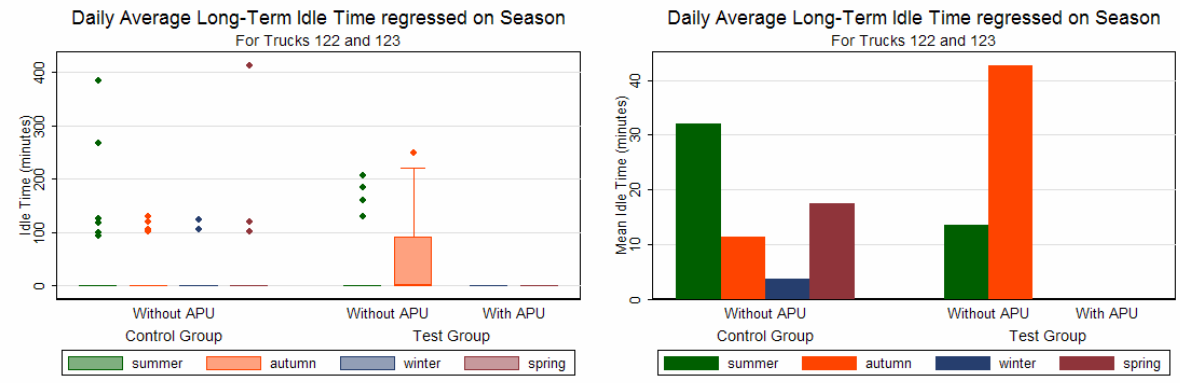

FIGURE 4 Average long-term idle time for a pair of trucks 122 (control) and 123 (test).

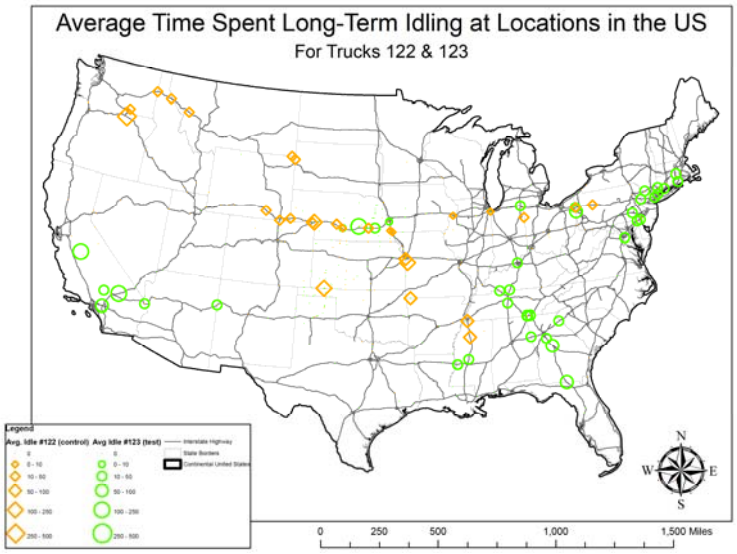

FIGURE 5 Average time spent long-term idling at locations in the United States for a pair of trucks.

This study shows that there are many other factors affecting long-term idling. For example, nonzero means exist on the after side of the test group in Figure 5. Why those APU equipped vehicles responsible would need to idle cannot be known without a more in-depth study. But anecdotal evidence has included such explanations as "can't sleep without the engine running."

FURTHER ACTION

A larger, controlled, and more-detailed study on the effect of APUs on idling would be beneficial. Ideally, this would be a controlled experiment whether the drivers, vehicles, and routes are randomly assigned to test and control groups. The study could include a survey of drivers' preferences, the actual location of idling, the climate factors inside and outside the cab, the APU usage time, a survey of relevant legislation, etc. In particular, the effect on driver attentiveness as a function of cab comfort level needs to be ascertained. The APUs may pay for themselves not only through fuel savings but also through improved driver performance and value to the drivers themselves; thus the key issue of financing would also be beneficial to study.

POSTER SUMMARY

Bridge Weigh-in-Motion Application in Alabama

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PROJECT DESCRIPTION

The continued advancement and acceptance in Europe of the bridge weigh-in-motion (B-WIM) technology as a tool for highway maintenance, safety and enforcement has established an interest for field demonstrations of the technology and potential applications in the United States. In this project, researchers at three University of Alabama (UA) campuses are collaborating to apply B-WIM technology developed in Europe to Alabama bridges.

A portable B-WIM system has several advantages over traditional systems including the following.

1. Can be employed to monitor truck weight and size without interfering with traffic flow.
2. Portable installations are not visible to truck traffic as it crosses the instrumented bridge.
3. Can be installed without damaging the pavement or interfering with the traffic.
4. Can be moved from one location to another without influencing accuracy of the results.

At this stage of development many of the potential benefits of B-WIM in terms of traffic safety and maintenance are largely anecdotal. This project aims at filling in the knowledge gaps by answering the following questions:

- Is the European B-WIM system a practical and effective tool for vehicle weight enforcement in Alabama (and hence other U.S. states)?
- How difficult is it to install and calibrate the system?
- Can the system identify overweight vehicles traveling at highway speeds?
- Can the B-WIM system be used effectively on typical Alabama bridges such as concrete girder and steel stringer bridges?

More specifically, the project has three primary objectives:

1. Identify the potential benefits of using B-WIM technology in Alabama;
2. Perform a pilot B-WIM system field test program in Alabama to evaluate the potential for deployment; and
3. Use the results of the technical research and field testing as both an educational tool and a foundation for further discussion on a national level.

To assist in this effort, the Alabama Department of Transportation (DOT) has purchased a B-WIM system developed by the Slovenian National Building and Civil Engineering Institute (Zavod Za gradbenisto Slovenije, ZAG) and a Slovenian private firm, Cestel, and made it available to the University of Alabama research team. The system developed by ZAG and Cestel is trademarked SiWIM. Representatives from Cestel visited the UA at Birmingham October 18 through 25, 2007 to help install the B-WIM system on an Alabama bridge for experimentation.

BACKGROUND

The expansion in freight shipments on the nation's highways has led to a substantial increase in road traffic congestion. Of particular concern is the increase in the number, size and weight of heavy commercial vehicles. Because of the limited resources available to enforcement agencies, an effective program of highway maintenance and safety could benefit substantially from an affordable traffic sampling and enforcement program that is not man power intensive. A reliable, accurate and portable dynamic sampling system capable of delivering measurements of moving vehicle type, size, and weight would be very attractive. B-WIM is such a system.

In the late 1970s B-WIM research was performed in the United States by Fred Moses and his team, however, European researchers have advanced the technology considerably over the last 15 years. In the summer of 2006 a 10-member team of experts composed of AASHTO, FHWA, law enforcement, and academia representatives participated in a Commercial Motor Vehicle Size and Weight Enforcement Scan Tour in Europe. Team members observed that a B-WIM system was being used successfully in Slovenia and other countries for pre-selection for mobile weight enforcement and to monitor alternate routes used by truckers to bypass scales. The AASHTO Technology Implementation Group has identified WIM as a focus technology for vehicle size and weight enforcement.

In response, a collaborative research partnership was developed between researchers from UAB that serves as the lead institution on this project, the UA Tuscaloosa, and UA Huntsville. The 18-month research project was supported by the University Transportation Center for Alabama and began in May 2007.

PROCESS

Task 1: Appraisal of Applicability of B-WIM Technology

Detailed literature and state-of-practice review is being performed and recommendations will be developed to the potential beneficial use of B-WIM system technology in Alabama.

Task 2: Alabama Suitability for Potential B-WIM Systems Deployment

This task evaluates the database of bridges in Alabama and sorts the inventory of bridges to identify good candidates for equipment installation.

Task 3: Purchase and Delivery of a Portable B-WIM System

Based on the collaboration with key stakeholders, Alabama DOT purchased a B-WIM system and made it available for testing.

Task 4: Field Testing and Data Analysis

Initial laboratory testing and analysis will verify the recommended installation procedure and calibration methodology and will confirm the suitability of the site recommended for initial field testing. The field testing program will provide the data for the full range of capabilities of the purchased B-WIM system. The field demonstrations will be documented carefully (written and video) so that the knowledge gained will be available for technology exchange and educational applications. This task will include the following steps:

- Controlled laboratory-scale demonstrations of the B-WIM system components and software before the field installation. A crucial requirement of this task is the establishment of a reliable system calibration methodology.
- A detailed physical equipment installation methodology will be confirmed and the data collection and transmission equipment setup tested and finalized.
- A detailed field testing plan for the selected field test demonstration will be developed and coordinated with Alabama DOT and other stakeholders.
- Field system demonstration testing and calibration will be accomplished using the selected preliminary field test bridges. A minimum of two trucks will be utilized in the testing. The trucks will first be weighed on a static scale and then driven multiple times over the test bridge instrumented with the B-WIM system. The software calibration algorithms built into the B-WIM system by the equipment vendor will be evaluated.
- Advanced WIM calibration technologies, such as calibration by axle rank will also be investigated.
- The B-WIM system will be demonstrated to Alabama DOT engineers by measuring the axle weights of several “unknown” trucks which will then be weighed on static truck scales.
- Analysis of results for the bridge structural configuration tested and recommendations for future application to different types of bridges.

Task 5: National B-WIM Symposium

A national symposium was organized in April 2008 in Birmingham, Alabama, on the topic of B-WIM. The purpose of the symposium was to bring together potential users and researchers to share information and ideas concerning B-WIM systems, and to discuss research needs for effective deployment of B-WIM in the United States.

FINDINGS AND CONCLUSIONS

Results from the testing and evaluation of the SiWIM system in Alabama were not available at the time at the time this document was written. Review of relevant research and practice indicates B-WIM has great potential as a tool to help agencies control the loads on their bridges

and highways. If successfully mated with license plate recognition technology, for example, highway agencies could identify owners of frequently overweight vehicles.

B-WIM issues under active investigation in Europe include:

- Development of influence surfaces to identify multiple vehicles on the bridge simultaneously,
- Calculating the truck static weight based on the measured dynamic response of the bridge to a moving truck, and
- Determining axle spacings and truck speeds using under-bridge sensors only.

POSTER SUMMARY

Rail Relocation Projects in the United States
Case Studies and Lessons for Rail Planning

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PROJECT DESCRIPTION

This project, performed for the Texas Department of Transportation (DOT), examines rail relocation projects in the United States to determine best practices, document project costs and expected benefits, and develop recommended policies for rail planner use in assessing potential urban rail relocation projects. Case studies deliver information on a broad variety of issues to be considered in railroad relocation projects including example project costs, impacts upon urban and outlying communities, potential funding mechanisms, and how potential rail relocation projects may be integrated with planning for other transportation improvements.

BACKGROUND

The increase in the volume of truck and rail freight in recent years has been dramatic. This trend is expected to continue as international trade levels grow both in North America and via seaborne trade with the rest of the world. In no place are the effects of this increase felt more than in metropolitan areas, where freight movement is often choked by local traffic. Traffic conflicts in urban areas are especially acute in areas surrounding urban rail facilities and at the many at-grade highway–rail grade crossings. Rail operations are also hindered in the urban environment where urban rail yards have become constrained by neighboring land uses and city ordinances that seek to restrict certain railroad operations. One approach to addressing urban vehicular–train conflict and urban rail operational issues is to consider the relocation of train operations to new rail corridors and facilities located outside urban boundaries or to depressed, grade-separated corridors.

PROCESS

Texas Transportation Institute (TTI) researchers analyzed a range of critical issues related to rail relocations, identified known major rail relocation projects around the country (both past and planned projects), and thoroughly analyzed five of those projects as case studies. The critical information gathered from the literature review and case studies assisted the research team in

creating a list of best practices related to implementing this type of project and identified significant factors for Texas DOT and other rail planners to consider.

FINDINGS AND CONCLUSIONS

The research team developed a table listing information on 30 rail relocation projects around the United States that had been planned, studied, or implemented since 1973 when the Federal Aid to Highways Act implemented a demonstration program for funding rail relocation projects. Several of those projects were later canceled in the mid-1980s due to the lack of progress, yet other rail relocation projects were advanced using alternative funding sources. Many of the original projects have only recently been completed—more than 30 years after their inception.

By examining the national relocation projects and the potential Texas rail relocation projects listed in the Texas Rail System Plan, TTI determined that the projects can be classified into three broad classifications.

1. Small urban area bypass. Relocation would move the rail line out of a small or mid-sized urban area to minimize traffic or safety conflicts.
2. Large urban area consolidation–relocation. Consolidation or relocation of routes within a large urbanized area.
3. Extra-urban consolidation–bypass. Consolidation or relocation of rail lines to an area outside urbanized boundaries meant to bypass completely the urban area.

Five of the rail relocation projects, selected jointly by TTI and Texas DOT project advisors, were advanced as detailed case studies. The case study projects were chosen based upon similarity to projects being considered in Texas and are located in: Marysville, Kansas; Lafayette, Indiana; Reno, Nevada; Salt Lake City, Utah; and the state of Colorado (Front Range Project). The in-depth examination of these projects provided critical information related to project motivation, costs and benefits, and lessons learned.

The lessons compiled from the case studies identified several issues important for the state of Texas as it begins to consider rail relocation projects as part of its long-term strategy to address urban highway–rail conflicts. Issue areas include:

- Project prioritization–selection characteristics,
- Potential funding sources and methods,
- Partnering principles for railroad companies and other private sector partners,
- Public information–involvement recommendations, and
- Corridor relocation and subsequent development recommendations.

FURTHER ACTION

Based on the in-depth evaluation of rail relocation projects in the United States there are several areas that could be considered for further investigation:

- Examination of relocating rail operations as compared to other possible solutions, such as grade separating, rail infrastructure improvements, or operational changes.
- Incorporation of rail relocation projects into the planning process and how to compare rail relocation projects against other important transportation projects.
- In depth evaluation of public and private sector direct and indirect costs and benefits associated with relocating freight rail operations or other projects involving public investment in private infrastructure.
- Examination into the roles passenger rail, transit, and economic development play in the development of rail relocation projects.
- Evaluation of the ability of the public sector to develop restrictions on development along newly relocated rail corridors that call for compatible land uses and restrict residential encroachment along the corridor.
- Investigation of existing federal, state, and local funding and financing options available for rail relocation projects, along with the investigation of potential creative funding and financing solutions.

APPENDIX

Workshop Attendees

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NOTE: Number indicates breakout group.

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