New Jersey Department of Transportation
2004
RESEARCH IMPLEMENTATION REPORT

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in cooperation with NJDOT Bureau of Research

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2004 NJDOT RESEARCH IMPLEMENTATION REPORT

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Executive Summary

The New Jersey Department of Transportation (NJDOT), Bureau of Research, typically funds 20 research projects a year. The Bureau is frequently approached by sponsors to justify the value of their work to a much broader audience; therefore, the intent of this implementation study is to identify the quantitative and qualitative benefits of NJDOT research projects that were completed in 2004. Technology transfer benefits were measured on four levels: knowledge transfer, marketing efforts, adoption of policy changes, and demonstration of technology to new audiences. Benefits were defined as enhancements, cost savings and economic impact; improvement of safety, and reduction of labor time for the customers, known as champions.

Principal Investigators from universities were interviewed by email, telephone, or in person on the outcomes of their research projects. It was expected that investigators would report on additional studies and projects that had been generated as a consequence of this initial work. Since the information was not always available, the NJDOT customers were identified by investigators for each project. Interviews were arranged with the customers to establish, not only benefits, but follow up activities that happened as a result of the research.

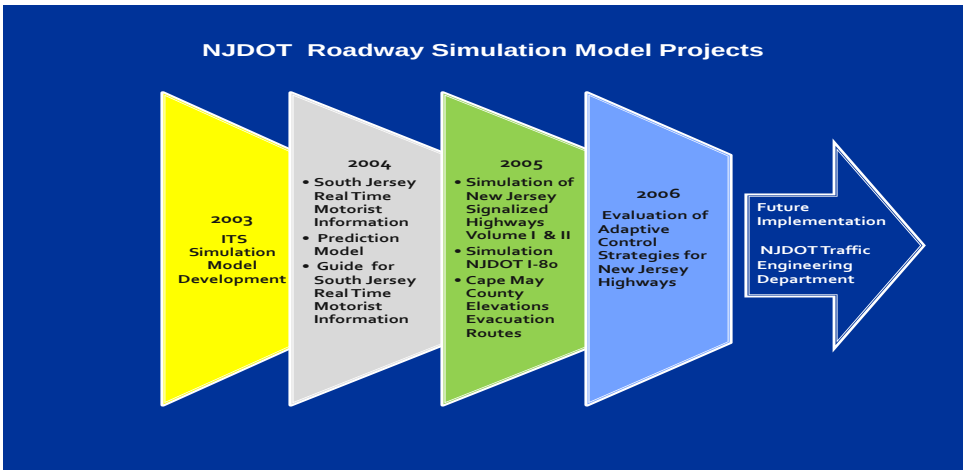
The research investment of $2.1 million resulted in improved time and efficiency on the job, as well as increased customer satisfaction with transportation services, but no quantified cost savings. When examining the trends over time, the studies were critical to the introduction of new technologies and best practices within the NJDOT organization. Several noteworthy trends began in 2004: the introduction of Paramics applications at the NJDOT, development and piloting of roadway simulation model projects, and review of the NCHRP 14- 29 bridge specifications for applicability in New Jersey. A brief summary of the implementation results from the 2004 research projects is presented in the following section.

Paramics Software

The FHWA and many of the State DOTs have been using Paramics software for microsimulation applications. As the product use expands, there is a strong possibility that it may become a standard of the transportation industry in the future. In New Jersey, Kaan Ozbay pioneered the use of Paramics in 2003 to support reduction of congestion in South Jersey. In 2004, Paramics applications were used to conduct four studies on transit and highways issues. Later, this software was used on evacuation and value pricing of toll roads research projects. The evacuation study of Cape May County is currently being featured as a national success story by the Paramics manufacturer.

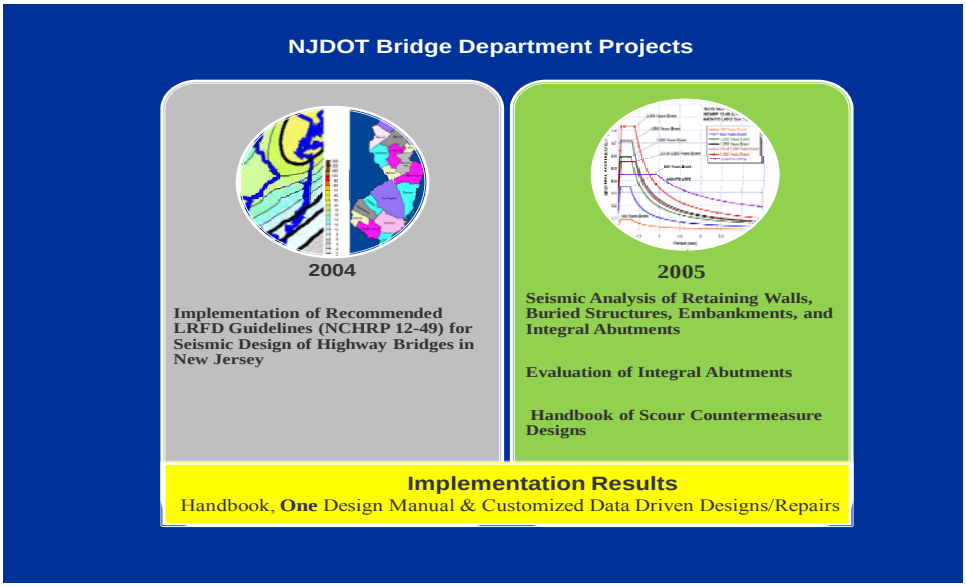
Roadway Simulation Model Projects

The use of simulation and decision-making models began in 2003 with the introduction of Paramics in New Jersey. During the following year, this research base expanded with three studies on the South Jersey Real Time Motorist Information System. A year later, over 90% of all research projects used simulation tools. Today, it is common practice to include simulation models as part of research. Although the models are effective in proving the validity of findings, the role of the champion is critical in gaining the required support and administrative approval to implement new products at the NJDOT.



NCHRP 14-29 Guidelines Evaluation Study

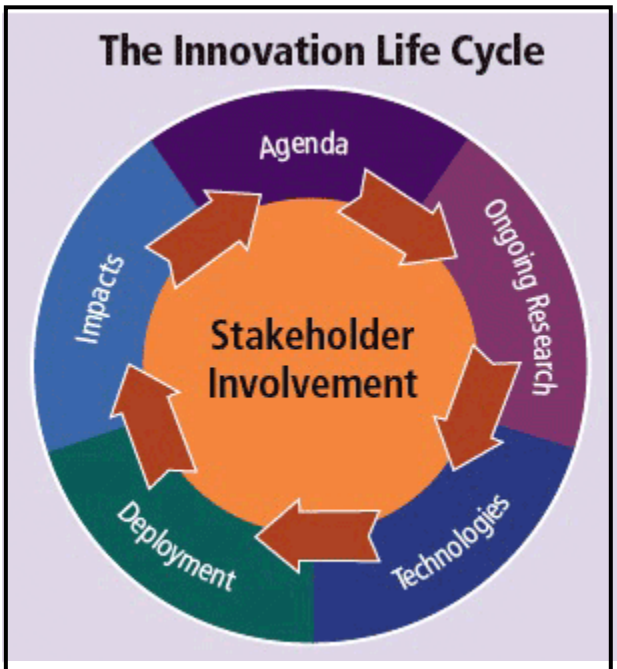
NCHRP 12-49 guidelines were evaluated in 2004 to assess their impact on the seismic design of highway bridges in the State of New Jersey. Although cost savings were unavailable this study recommended that the NJDOT support the new provisions in their present form. Aside from the fact that the new provisions were based on state-of-the-art knowledge and recent scientific developments, it was noted that the new LRFD guidelines did not necessarily result in higher seismic demands. Another important recommendation, supported by the NJDOT was to develop design tools to facilitate and streamline the application of new analysis and design concepts under the NCHRP 12-49.



In 2005, three additional studies were requested by the NJDOT Bridge Department, in order to complete the development of one comprehensive design manual and a decision-making analysis model from their existing boring data base system. When considering seismic analysis of retaining walls, buried structures, embankments, and integral abutments, the research confirmed that the developed guidelines for seismic design of bridges in New Jersey are based on the design criteria from NCHRP 12-49 and are consistent with guidelines from other eastern states: New York and South Carolina. Two examples showed transverse reinforcement requirements for large-diameter columns with heavy reinforcement in plastic hinge zones, which are higher in the new provisions compared to current AASHTO LRFD

design. Also, the previously absent seismic design criteria and guidelines for abutments, retaining walls, embankments, and buried structure in New Jersey had been identified for inclusion in the manual.

The information gained from these studies did provide additional background needed for the successful development of one design manual and the completion of a geotechnical data management system on collective boring data analysis by county and zip code. In the future, this decision-making analysis system will provide accurate customized design and repair criteria on all projects by county and zip code. The technology transfer benefit for these important projects was identified as enhanced efficiency and future cost savings for NJDOT.



FHWA Technology Transfer Model

2004 NJDOT RESEARCH IMPLEMENTATION REPORT

Introduction

The New Jersey Department of Transportation (NJDOT), Bureau of Research, annually funds approximately twenty research projects that support the transportation industry. Requested by industry customers, many of these projects solve important transportation problems, but limited information is known about the long-term effects of the studies. The Bureau is frequently approached by sponsors to justify the value of these projects to a much broader audience; therefore, the intent of this implementation study is to identify the quantitative and qualitative benefits of NJDOT research projects that were completed in 2004.

About the New Jersey Department of Transportation Bureau of Research

The Bureau of Research is responsible for delivering quality research and technology transfer solutions through a customer-focused program. This research is dedicated to identifying new products, improving existing processes, and refining systems that support the transportation infrastructure, enhance public safety, improve mobility, reduce congestion, protect the environment, and introduce innovative technologies to New Jersey based customers. The Bureau serves every unit within the Department of Transportation, Motor Vehicle Commission, and New Jersey Transit (NJDOT, 2007).

Surveys and literature searches, demonstration projects, and research studies are conducted by University partners and consultants. Most research studies are conducted by, but not limited to the following universities:

Academic Research Partners

New Jersey Institute of Technology

Princeton University

Rowan University

Rutgers,The State University of New Jersey

Stevens Institute of Technology

The College of New Jersey

University Transportation Research Center Consortium

Members of the UTRC Consortium

- City University of New York (CUNY)*
- Columbia University (Columbia)
- Cornell University (Cornell)
- New Jersey Institute of Technology
- New York University (NYU)
- Polytechnic University (Polytechnic)
- Rensselaer Polytechnic Institute (RPI)
- Rowan University (Rowan)
- Rutgers University. The State University of New Jersey*
- State University of New York (SUNY)
- Stevens Institute of Technology (Stevens)
- University of Puerto Rico - Mayagüez (UPRM)

**USDOT University Transportation Centers*

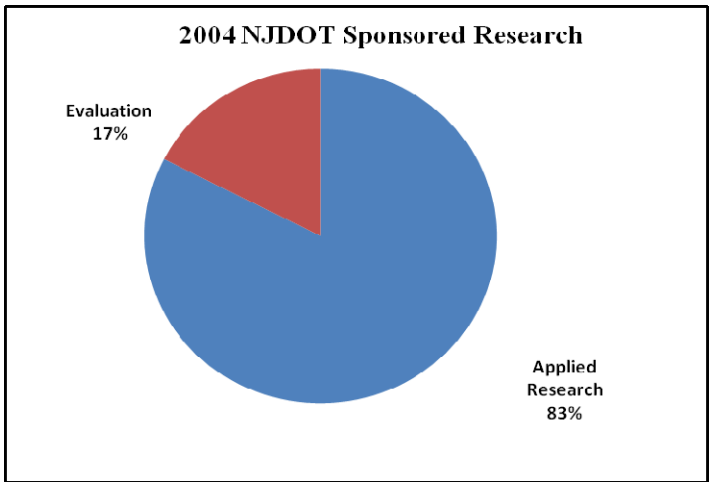
Methodology

The purpose of this follow-up study was to track and quantify the outcomes of funded research that had been completed in 2004. Technology transfer benefits were measured on four levels: knowledge transfer, marketing efforts, adoption of policy changes, and demonstration of technology to new audiences. Benefits were defined as enhancements, cost savings and economic impact; improvement of safety, and reduction of labor time for the customers, known as champions (See implementation study interview form in Appendix A.)

Project Investigators were interviewed by email, telephone, or in person on the outcomes of their research projects. It was expected that investigators would report on additional studies and projects that had been generated as a consequence of this initial work. Since the information was not always available, the NJDOT customers were identified by investigators for each project. Interviews were arranged with the customers to establish, not only benefits, but follow up activities that happened as a result of the research. When required, the NJDOT project managers were also used as technical resources on projects.

2004 NJDOT Research Project Review

Over 80% of the nineteen projects completed in 2004, were applied research and the remainder consisted of evaluation studies (17%) on materials procedures, specifications, customer service, or driver perceptions of railroads and devices. The projects primarily supported NJ Transit, the Port of New York and New Jersey, and the New Jersey Motor Vehicle Commission (40%) or addressed Environmental (5%), Infrastructure (25%), and ITS/Safety (29%) issues for the NJDOT Most of this research included national reviews of best practices that were used to develop survey instruments for use in the State. The targeted audiences ranged from transit riders to motorists, and even motorized scooter users. Background information and implementation reviews on these studies are presented in the following section.



FHWA-NJ-2004-001: Customer Satisfaction with Motor Vehicle Agency Offices in New Jersey – Michael G. Hagen, Eagleton Institute of Politics, Center for Public Interest Polling

Cost: Supported with other sources.

Summary

The Eagleton Institute Center for Public Interest Polling contracted with the NJ Motor Vehicle Commission to study customer satisfaction with motor vehicle services provided by the state. The goals and scope of the project were defined during a series of meetings which included a review of customer satisfaction surveys primarily conducted in Florida, Massachusetts, New York, Pennsylvania, Virginia, and Wisconsin. Two separate telephone surveys were then conducted to elicit customer evaluations of New Jersey's motor vehicle agencies. One survey was for business customers, while the other was for residents of New Jersey. With the exception of initial questions on the business customer questionnaire designed to identify the right person to take the survey and the demographic questions that concluded the resident survey, the questions pertaining to customer satisfaction were nearly identical.

Analysis of survey responses revealed some basic differences between business and individual customers. Overall satisfaction of business customers was higher than that of individuals, but individuals indicated a willingness to tolerate longer wait times than did business customers. Many business customers, such as new and used car dealers, are allowed to drop off transactions in bulk and return later in the day to pick up completed work. This reduces the wait time and could account for the overall higher satisfaction of business customers.

Locations in the southern part of the state received higher overall ratings than those in the middle and northern sections. Business customers were more satisfied in north Jersey than were individual customers who preferred mid-state locations to those in north Jersey. There were many demographic differences among individual customers as well. Older residents were more satisfied than younger customers, Hispanic and Blacks were more satisfied than Whites and others, and satisfaction declined as individual wealth increased.

Overall, how satisfied were you with your last visit to a DMV office?

	Recent individual customers	Business customers
10 Very satisfied	25%	37%
9	9	9
8	18	19
7	13	8
6	7	5
5	10	7
4	5	2
3	3	2
2	2	3
1	2	2
0 Very dissatisfied	6	5
Total	100%	100%
Number of cases	697	502
Average	6.9	7.5

The most influential factors in determining satisfaction were:

- Evaluation of the staff (helpful, courteous, knowledgeable, etc.)
- Length of time spent waiting in line
- Number of times waiting in line
- Completing transactions in a single visit
- Evaluations of the facility (cleanliness, comfort, etc.)

The responses provided valuable information about the levels of satisfaction with various aspects of DMV agency performance, about the relationships between those aspects and overall satisfaction, and on the differences among various groups of customers.

Implementation

The Motor Vehicle Commission requested this study, which included customer interviews and employee focus groups. The 2003 survey provided valuable information about the levels of satisfaction with various aspects of DMV agency performance, about the relationships between those aspects and overall satisfaction, and about differences among various groups of customers. This study helped to guide the allocation of resources by identifying processes and practices particularly in need of improvement

Further Recommendations

By documenting customers' expectations, the study helped to develop targeted areas for improvement by the agency. Most importantly, the results served as a baseline for documenting improvements in customer service. Policymakers were assisted in evaluating initiatives undertaken at DMV agencies, which helped to further improve the performance of individual agencies, as well as the overall organizations.

Customer Satisfaction with Motor Vehicle Agency Offices in NJ Results		
T/2 Measures	**Researcher**	**Customer**
Knowledge Transfer (Findings/Dissemination)	✓	✓
Marketing/Media (website)	✓	✓
Policy/Process Change	✓	✓
Demonstrations		
Implementation Benefits		
Enhancement (Efficiency, Environment, Safety)	✓	✓
Cost Savings/Economic Impact		

Cost Benefit/Economic Impact

According to the 2006 MVC Service Assessment Report, this 2003 study was important because it served as the baseline to measure customer satisfaction with MVC services. The Commission employed Eagleton in 2005 to conduct a follow up study, which showed significant improvement in satisfaction with hours of operation, plus a three-minute reduction in the average wait time for customers. Also, overall satisfaction with the MVC improved, along with employee satisfaction that was attributed to the handling of more reasonable workloads than in the past.

This research enabled the public and business partners to transfer knowledge on operating practices. The report also served as a valuable marketing tool to educate the public on the progress of the Commission. Economic impacts were not documented to date, but an opportunity exists to quantify economic gains in the future.

FHWA-NJ-2004-002: Survey of Transit and Rail Freight Interaction – Dr. Rongfang Liu, New Jersey Institute of Technology

Cost: $99,910.

Summary

Highway congestion has stimulated a renewed interest in commuter rail, light rail, and other types of transit in large American cities. Increased comingling of freight and passenger train services has been used as a solution for reducing congestion. The trend toward railroad and transit shared use increased the concern about safety when common tracks are shared. New Jersey Institute of Technology (NJIT) was commissioned by New Jersey Transit to participate in the nationwide Survey of Transit and Rail Freight Interaction to gain information on the interaction between transit and freight agencies. The scope of this study included surveying transit agencies in North America to identify the best practices for passenger and rail freight interaction, as well as determining key factors that contribute to a successful relationship between freight railroads and transit operators.

The response, from 47 transit agencies, was positive regarding their interaction with freight railroads. Transit service providers identified critical issues that included dispatching and scheduling, freight management and employee attitude to service, capacity constraints, communications, insurance and liability, and funding. Communications between transit

and freight railroads was the key factor in successful joint operations. These findings did result in the development of a catalog of best practices for shared passenger and freight operations.

Furthermore, the study confirmed that both the transit and freight railroads maintained differences in characteristics. A commuter rail service with almost total comingling between freight and passenger service maintains good communications and positive attitude among workers from both entities. For example, the Montreal commuter network respondent reported "mutual respect" as the key factor for success of a shared operation.

The Federal Railroad Administration (FRA) crash worthiness regulation had required that there be no physical service interaction between freight and LRT, which has been accomplished by separation during time of use. The danger of physical contact is addressed by the signal system. Recently, these FRA rules were relaxed in the United States for two systems: the San Diego Trolley and the River Line of South Jersey.

Also, history plays an important role in the attitude between both the transit and freight authorities. Commuter services have been in operation since the beginning of the twentieth century and have limited concerns about the interaction between both services. Therefore, new systems require the freight only attitude to be dropped. The size of freight railroad also impacts this interaction with Class I railroads being characterized as having a tolerable coexistence, while the regional railroads having been identified as more positive.

There are differing attitudes between transit and freight interactions throughout regions of the United States. The West Coast appears to be more open than the East Coast, which may be due to the severe crashes that occurred between freight and passenger trains in the Washington DC area. Overall, rail freight crashes were infrequent with approximately 20 percent of all agencies reporting them; along with damages involving passenger and employee injuries or fatalities.

Implementation

Jerry Lutin, Senior Director of Intermodal Planning, and Rich Wisneski, Project Development, New Jersey Transit were identified as the champions of the project. Also, one graduate student was funded on the project that produced a series of Technical Memoranda. Those documents had the potential to serve as a roadmap in surveying transit agencies around North America. The research generated and recorded comprehensive profiles for a few selected transit properties that share transit rail operations with the freight railroads.

Further Recommendations

The overall survey response from transit service providers was positive in terms of interaction with freight railroads. Transit service providers did identify several critical issues that included dispatching and scheduling, freight management and employee attitude to service integration, capacity constraints, communications, insurance and liability, and funding problems. Sufficient communication with freight railroads was generally recognized as the key factor to a successful joint operation. As suggested by the research, it could benefit the country if priority issues of freight versus passenger services can be worked out at a national level.

Survey of Transit and Rail Freight Interaction Results		
T/2 Measures	**Researcher**	**Customer**
Knowledge Transfer (Findings/Dissemination)	✓	✓
Marketing/Media (website)		
Policy/Process Change	✓	✓
Demonstrations		
Implementation Benefits		
Enhancement (Efficiency, Environment, Safety)	✓	✓
Cost Savings/Economic Impact		

Cost Benefit/Economic Impact

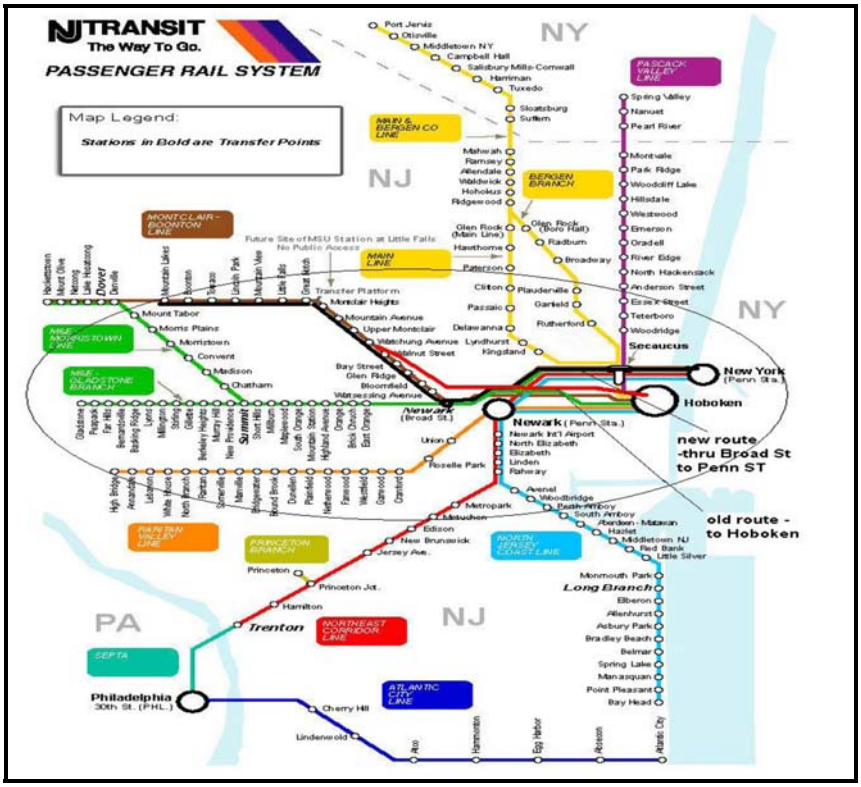
Richard Wisneski, New Jersey Transit, reported that this study resulted in the preparation of a catalog of best practices and other information that could be referenced by NJ Transit staff to develop strategies for rail network expansion and negotiation with freight railroads. The major benefit of this project was having relevant resources in a single location to save on staff time. Since the conclusion of the study, several projects were sponsored involving different types of interactions, which may not be directly attributed to the study findings. Knowledge has been transferred within NJ Transit through the catalog being made available to NJ Transit staff. As a result, possible improvements may have occurred in preparation and handling of negotiations. Improved efficiency in preparing for negotiations may be realized as savings in labor costs.

FHWA – NJ-2004-005: The Impact of Mode and Mode Transfer on Commuter Stress: Montclair Direct – Dr. Richard Wener, UTRC – Polytechnic University

Cost: $176,444.

Summary

Commuter stress was examined; using data collected from groups of commuters before and after improvements were made to the Montclair to New York City train line. A new Montclair Direct service was adopted to improve the commute of passengers through reduced time and providing a one-seat ride. The nature of the commute did have a measureable and important effect on the stress levels of riders. The psychological marker of stress (salivary cortisol) and self-reported measures from the commuters were examined before and after using the new service. Those using the new service showed reduced stress during the post change period, while those with the previous service did not. There were indicators that trip stress also carried over into the work place and showed improvement for those using the new service. Interestingly, women commuters, who had children at home, appeared most stressed during the initial commute and improved after using the new train service. Reduction of commuter stress over time may provide significant benefits to public health.



Implementation

Three graduate students from Polytechnic University worked with Richard Wener on this project. The results of this study were presented twice at NJDOT Showcases and also at several academic conferences. Jerry Lutin confirmed that the presentation of a paper at the American Public Transportation Association Rail Conference has generated nationwide interest. A total of six research articles referenced this study (e.g. APTA "Leave the Driving to Them: Comparing Stress of Car and Train Commuters" and Health Psychology "Rail Commuting Duration and Passenger Stress"). An additional article has recently been submitted by Richard Wener for publication.

Further Recommendations

This study was groundbreaking in that the research method included the biological measurement of salivary cortisol levels. Cortisol present in saliva is a known indicator of stress. The study has been important for transit marketing, particularly to the working mother population, since stress levels are reduced as a result of a more direct commute. The reduction of stress is twice as great for working mothers as compared to the general population.

The Impact of Mode and Mode Transfer on Commuter Stress Results		
T/2 Measures	**Researcher**	**Customer**
Knowledge Transfer (Findings/Dissemination)	✓	✓
Marketing/Media (website)	✓	✓
Policy/Process Change		
Demonstrations		
Implementation Benefits		
Enhancement (Efficiency, Environment, Safety)	✓	✓
Cost Savings/Economic Impact		

Cost Benefit/Economic Impact

Dr. Jerry Lutin, NJ Transit, served as the champion of this research process. The intent of this project was to develop an understanding of the effect that transportation modes and mode transfer had on commuter stress. The difference between this study and others is the focus on the customer. Improved aesthetics and time efficiency were two technology transfer attributes that had occurred, according to the researcher and customer.

The major benefit of this study was the transfer of knowledge through several published papers and presentations on the findings of the biological measurement of salivary cortisol levels. The stress level of the working mother population was significantly reduced, as a result of a more direct commute. The survey results also showed that users of the new system experienced shorter commuting times, less stress during the commute, which also carried over to their jobs.

FHWA-NJ-2004-006: Alternative Performance Measures for Evaluating Congestion – Dr. Lazar Spasovic - New Jersey Institute of Technology

Cost: 100,412.

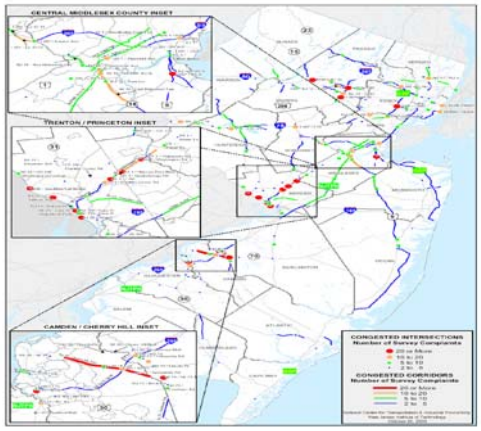
Summary

This study outlined existing approaches to examining congestion and builds upon previous work of evaluating congestion by incorporating the public's perception of congestion through a web-based survey. Public opinion and drivers' perceptions are not frequently used in congestion studies, which characterized this study as being unique. The major findings indicated that New Jersey motorists are more tolerant of congestion than the expected nationally used traffic engineering principles. Also, they experience a significant amount of stress while driving on New Jersey roadways.

Since transportation funding frequently competes for resources, it is important to accurately identify the cost of congestion to allow decision-makers to develop an accurate estimate of potential benefits from the mitigation of congestion. Computer modeling systems allow the integration of congestion cost-benefit analysis for budget planning at the state, county, and municipal levels.

The two major ways of measuring traffic conditions include time-based and density-based categories. Time-based measures include variations on travel time, travel speed, or travel rate; while density based measures include volume, density, or volume to capacity ratio. Traffic engineers usually favor density-based measures because the data is less costly and time-consuming to obtain, calculations are simplified through computer software packages, and comparisons are more easily made between different roadways. However, the traveling public and public officials appreciate time-based measures because they can be directly measured on how long it takes to travel from Point A to Point B, the average speed, and how lon the wait was in a toll plaza.

A web-based traffic congestion survey was developed to gauge the driver's perception of congestion, quantify the stress that drivers experience in New Jersey, and identify the most congested locations in the state. There were 1,393 survey responses between March and the beginning of August 2003. Respondents viewed a series of video clips and rated them according to the type of trip that they would be making (work, shopping, and vacation). This comparison allowed individuals to make a comparison between New Jersey drivers' perceived congestion and the nationwide levels used by engineers.



Although New Jersey drivers tolerated congestion, they seemed to experience high levels of stress. Most respondents (96%) experienced stress while driving with 58% acknowledging that they experienced stress often, very often, or always. Tolerance toward road congestion decreased as the drivers get older. Additionally, the survey requested motorists to identify the most congested locations in the State. They were the Garden State Parkway Union Toll Plaza, I 295 and NJ 42 Interchange, Lincoln Tunnel, Garden State Parkway and I 280 Interchange, and Route 24 and I 78 Interchange. It was recommended that critical congested locations, based on public input, may be used for potential NJDOT "Quick Fix" initiatives.

Implementation

This study presented a detailed overview of existing congestion measures and findings of the web-based congestion survey of New Jersey motorists done by the research team. The extensive literature review of the existing congestion measures confirmed that it is important to understand the limitations of data sources and to identify the conditions of the congestion baseline.

Another aspect of the research was the unique method used for evaluating congestion in New Jersey. Specifically, public opinion was incorporated into the process of defining congestion, evaluating impacts, and identifying congested locations in the State. A database of 1,393 responses was created and referenced in the study. Some important differences between New Jersey drivers and the national average indicated that New Jersey drivers are more tolerant of congested roadways, experience a greater stress while driving to work, and older drivers become less tolerant toward roadway congestion.

Some of findings from this research were used in a Blue Ribbon Commission report. Several data sets (e.g. DELAY) were used to highlight the "impact magnitude" as well as identify locations for new congestion relief projects. There has been no follow-up to date on whether or not the locations, identified in the report, have received any congestion mitigating action. Since the study was completed, NJDOT has continued to work with NJIT to refine the "cost of congestion" aspect of their work. This has been particularly useful to their annual Statewide Capital Investment Strategy work on the economic impact of congestion, which annually amounts to $8.6 billion in costs (NJDOT, 2008).

Further Recommendations

John Allen, Section Chief, NJDOT Bureau of Systems Planning, reported that the study collected good information, but additional funding for congestion relief projects had not been realized. State priorities are focused on infrastructure (bridges). The problem or missing piece to research seems to be selling the results to those at the decision making levels. Further assistance from the NJDOT Bureau of Research would be welcomed in the area of packaging and targeting important information to high level champions. A DOT sponsored study of best ways to communicate study results might be helpful.

Alternative Performance Measures for Evaluating Congestion Results		
T/2 Measures	**Researcher**	**Customer**
Knowledge Transfer (Findings/Dissemination)	✓	✓
Marketing/Media (website)		
Policy/Process Change		
Demonstrations		
Implementation Benefits		
Enhancement (Efficiency, Environment, Safety)	✓	
Cost Savings/Economic Impact	✓	

Cost Benefit/Economic Impact

Research findings were included in the NJDOT Blue Ribbon Commission Report and the Annual Statewide Capital Investment Strategy work. There were no further marketing activities, enhancements, or cost savings that were identified as a result of this study.

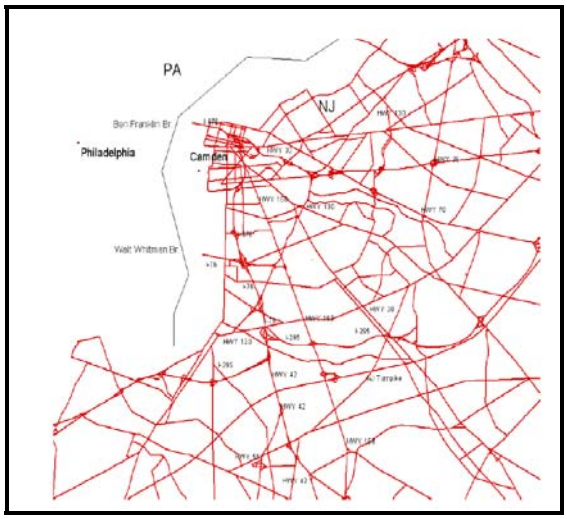
FHWA-NJ-2004-007: South Jersey Real-Time Motorist Information System – Dr. Kaan Ozbay, Rutgers University

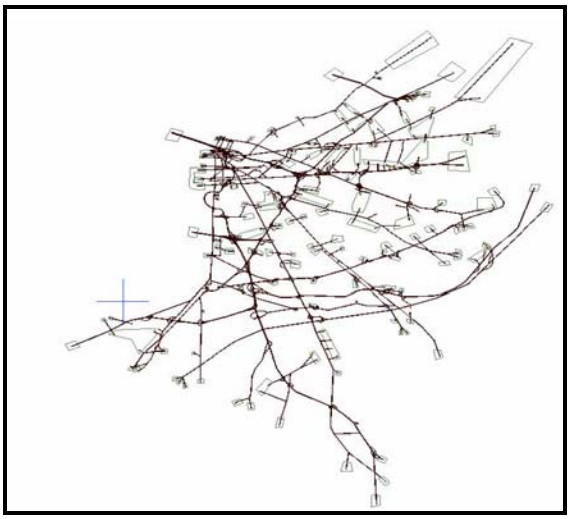
Cost: Funded with other sources.

Summary

Philadelphia is one of the most commercial ports in the nation, located on the Delaware River, and accesses the Atlantic Ocean. The traffic originating from New Jersey to Philadelphia has two main routes to travel: the Walt Whitman or Ben Franklin Bridges. Roadways leading to these bridges become congested, which creates a problem for the motorists. The solution is to provide an effective real-time uncongested alternative, using Variable Message Signs (VMS) or other electronic means of communication to relay the message.

Traffic sensors can be used to measure traffic volumes and the data can be transmitted to the traffic operations center. Traffic operations center computers can receive high volume alerts from the sensors and automatically transmit a congestion alert to VMS structures or pagers. A preliminary project was initiated that developed an integrated and mobile surveillance system in the form of a self-sufficient box that contains a traffic sensor and computer system, powered by batteries and solar panels. These devices were installed along I-76 and I-676, routes that connect southern New Jersey to Philadelphia. Next, the system was deployed and tested for acquiring and processing information, and validating traffic sensor data. The traffic information was then sent to pagers using commuter surveys, and system performance was tested using the micro simulation network developed in PARAMICS simulation software. Also, algorithms were developed to predict real-time travel patterns.





In collaboration with L-3 Communications, Inc, five surveillance systems were designed, developed, and tested in the laboratory. The best locations for installing these systems were then selected by NJDOT. The systems were installed for continuous communication with the server, located at the NJDOT Traffic Operations Center. Rutgers researchers collected ground truth data, using camcorders at sensor locations. The information was processed at Rutgers Intelligent Transportation Systems (RITS) laboratory. Data obtained from counts and sensors were then compared to the camcorder results to determine if significant differences were detected. Commuters also received pagers that were tested for reliability.

The Southern New Jersey highway network was developed in PARAMICS simulation software that included link information entered by using NJDOT Straight Line Diagrams. Origin-Destination demand matrix, provided by the Delaware Valley Regional Planning Commission, was aggregated into 137 zones for the study network. This simulation tool evaluated the efficiency of this deployed system under various scenarios where certain links in the network are affected by incidents. It was found that locating sensors at critical areas increases accuracy of reporting. Also, a method for estimating and predicting short-term travel time was developed. Kalman filtering algorithm was then applied for improving prediction accuracy.

Since the project dealt only with disseminating the location of congestion, not the alternative routes to be taken; the next step would be to disseminate the information collected by these mobile sensors through VMS. Travel time on each possible alternative route should be predicted and the one with the minimum travel time be used to advise the motorists. The Kalman filter, based travel time estimation algorithm, developed in the first phase of this project can be used for this purpose.

Implementation

The New Jersey Department of Transportation (NJDOT) Traffic Operations South Jersey Division sponsors a project entitled "South Jersey Real-Time Motorist Information System" aimed at rapid deployment of available ITS surveillance and communication technologies to monitor traffic on the basis of need at different locations in the South Jersey network. The proposed system is a highly mobile traffic surveillance system that is made of mobile self-sufficient systems called Sensor Processor and Communication Units (SPCU) and accompanying communication and data collection capabilities for sensor units to exchange information with the traffic control center.

The pilot project demonstrated that there was potential to use the system on a larger scale. In this specific version of the system, congestion alerts are disseminated to selected motorists through pagers. The proposed system includes portable sensor units that can be installed easily at any location on the transportation network without any delays in establishing power and communication connections to the infrastructure. This rapid deployment capability of the system is in

accordance with new efforts to develop easy to deploy traffic surveillance systems and better manage the transportation system during a disaster.

Further Recommendations

The project was aimed at evaluating effectiveness and accuracy of the implemented motorist information system. The developed system is rather limited in the number of mobile units, 5 in total; but it is significant as proof of a concept that helps understand the system characteristics and possible problems that might occur in the future. Now that the system had been deployed and tested, and potential technical problems were known, additional units can be built to cover major alternative routes to divert motorists during emergencies and non-recurrent congestion.

South Jersey Real-Time Motorist Information System Results		
T/2 Measures	**Researcher**	**Customer**
Knowledge Transfer (Findings/Dissemination)	✓	✓
Marketing/Media (website)		
Policy/Process Change		
Demonstrations	✓	
Implementation Benefits		
Enhancement (Efficiency, Environment, Safety)	✓	
Cost Savings/Economic Impact		

Cost Benefit/Economic Impact

The South Jersey Real-Time Motorist Information System was successfully demonstrated as having the potential to better manage the transportation system through ITS technology. The researchers conducted presentations and submitted publications for the 82nd and 83rd TRB sessions. Also, they presented their findings at the 2005 IEE Conference on ITS Systems in Vienna, Austria. In 2007, the article entitled "Alternative Methods for Estimating Full Marginal Costs of Highway Transportation" was published in Science Digest.

Several studies, conducted by NJIT, have successfully used the Paramics simulation model to address congestion, evacuation plans, and other traffic conditions. One important example is the project, "Analysis and Modeling of Cape May County Roadway Elevations and Evacuation Routes", that required simulation of scenarios to determine the effectiveness of an evacuation plan. .

FHWA-NJ-2004-008: The Development of Dynamic Travel Time Prediction Models for South Jersey Real-Time Motorist Information System – Dr. Steven I-Jy Chien, New Jersey Institute of Technology

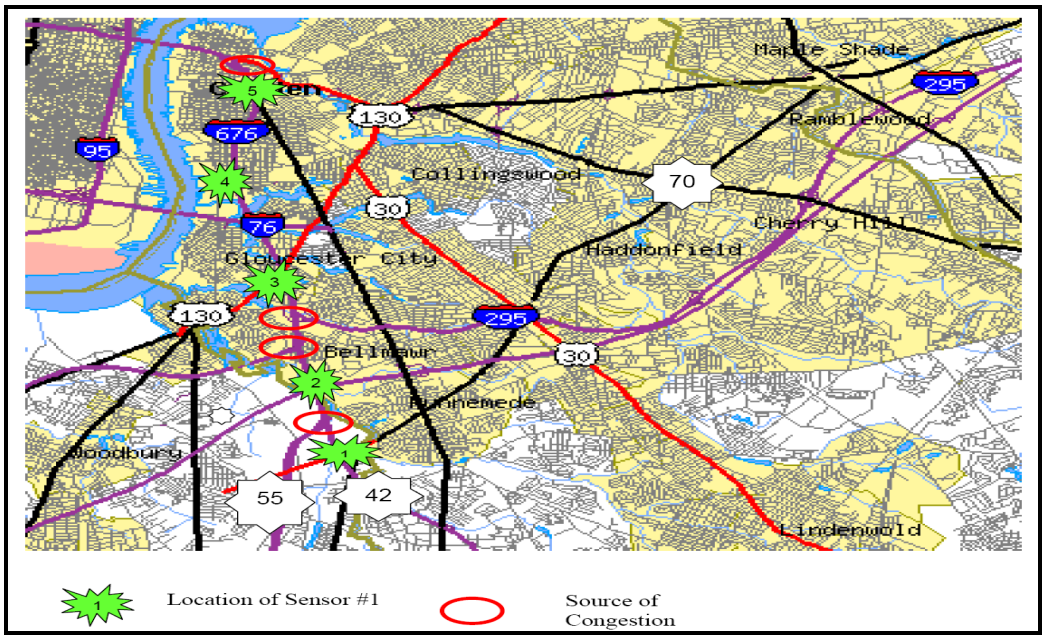
Cost: Funded with other sources.

Summary

The Walt Whitman and Ben Franklin Bridges connect Camden County, New Jersey, and Philadelphia, Pennsylvania. The traffic from southern New Jersey uses Routes 55, 42, 76, and 676 that contain congestion points throughout these roadway networks during different times of day. An effective and real-time traffic advisory system is needed to alert motorists of potential congestion and advise them to use less congested routes. The focus of this study was to develop a dynamic model to estimate and predict path travel times for use in conjunction with the South Jersey Real-time Motorist Information System project.

Traffic congestion continues to be one of the major problems in various transportation systems that may be alleviated by providing timely and accurate traffic information to motorists. Alternate routes and changes in departure times can be planned to reduce some of the traffic. The Advanced Travel Information Systems (ATIS) includes an integrated surveillance and communication system to monitor traffic conditions, which was successfully deployed in the United States. This sound dynamic estimation/prediction system has been used to accurately forecast travel time, congestion over space and time, and effectiveness as well as reliability of the estimation/prediction system.

The objective of this project was to develop real-time traveler information generation algorithms, dissemination of traveler information, and establish a model for estimating travel time and delays. After conducting a literature review of several data collection, estimation models, prediction models, and simulation models; the Kalman filter model was selected to be used since travel times were available and being collected for both a real world and simulation model.



A series of sensors were installed in the network to collect real time data with certain priorities to make the detected data consistent for calibration of the simulation model. Also, the data used for developing a simulation model included geometric and traffic data that was available from several agencies. The geometric data was collected from construction plans, straight line diagrams, and geographical information systems data. Most geometric data was provided by using the construction plans of the study and Straight Line Diagrams from the NJDOT. Also, the New Jersey Institute of Technology (NJIT) had sponsored the GIS database supplied information on the study area that was used for this project.

Traffic volumes and speeds were obtained by the sensors used in this project, and traffic counts were collected by data stations for the NJDOT Bureau of Transportation Data Development (BTDD). Only Annual Average Daily Traffic data had been recorded for the study. Since only the speed limits can be found in the straight-line diagram, the free-flow speed in the simulation model was assumed at 5-10 mph over the speed limit.

While travel times in highway transportation networks had been highly dependent on traffic conditions and occurrence of random incidents, the estimated travel time focused on the potential congested area with the real time traffic data from the sensors that provided the spot speeds of each passing vehicle. Various techniques have been used to predict travel time; however, the Kalman filtering method was chosen to enable the prediction of State variables that were continually updated when a new observation had become available. This technique was used to perform travel time prediction based on real-time information provided from the sensors.

Implementation

In order to test the performance of this model, both simulation data and real-world data were collected and applied. A case study of a four hour traffic operation (6:00 am – 10:00 am) was simulated based on time varying travel volumes. Two different input datasets were prepared for estimating travel times. Acoustic sensors were applied in this network, while performance and accuracy of the proposed prediction model were tested by linking travel times during the peak period that was generated by CORSIM. Three scenarios with three different types of historic data were proposed for analyzing the accuracy of predicting travel times with the Kalman Filter algorithm. The first scenario used previous time interval data to predict the next time interval travel times. The second scenario took travel time recorded in the same time period on the same day one week before as the input, while the third one used the 5-weekday average travel time collected from the same link as a week ago. The outputs equated to predicted travel times. When applied into the predictive mode, the first scenario provided the best results.

The five-minute measurement from the field data was based on a 30-second estimate in every 5 minutes, which had been compared to 5-minute traffic measures (e.g. speed/travel time) generated by CORSIM. This experiment was designed based on the calibration of acoustic sensors that reported 30-second data in every 5-minute interval. The Kalman filter algorithm updated the variable of time/travel. The real-time information and previous time interval information was used to predict the travel time in the next time interval. The prediction accuracy with 5-minute data had been superior to the 30-second data. The model did generate satisfactory results with the use of simulated output.

A method for estimating and predicting travel time to generate short-term future travel was developed, while the Kalman filter algorithm was applied for improving prediction accuracy. For collecting traffic data, five acoustic sensors were installed at potentially congested places in the study area to monitor the real-time traffic information. The evaluation results show that the developed model could generate satisfactory results with the use of simulated output (e.g. 30-second and five-minute travel times).

Further Recommendations

It was found that the prediction error was comparatively high when the coefficient of the variation value had been large, and errors decrease when the coefficient of variation decreased. This action helped to improve predictive performance of the developed model and needs to be further studied. Also, four additional factors should be examined in order to develop more robust prediction algorithms, which include the following:

- relationship between the covariance of measurement and process variability should be investigated from the real-world information,
- relationship between the coefficient of variation and prediction performance, and
- algorithm tested and calibrated for different traffic conditions, as well as according to different characteristics of real time traffic conditions.

The Development of Dynamic Travel Time Prediction Models for South Jersey Real –Time Motorist Information System Results		
T/2 Measures	**Researcher**	**Customer**
Knowledge Transfer (Findings/Dissemination)	✓	✓
Marketing/Media (website)		
Policy/Process Change		
Demonstrations	✓	
Implementation Benefits		
Enhancement (Efficiency, Environment, Safety)	✓	
Cost Savings/Economic Impact		

Cost Benefit/Economic Impact

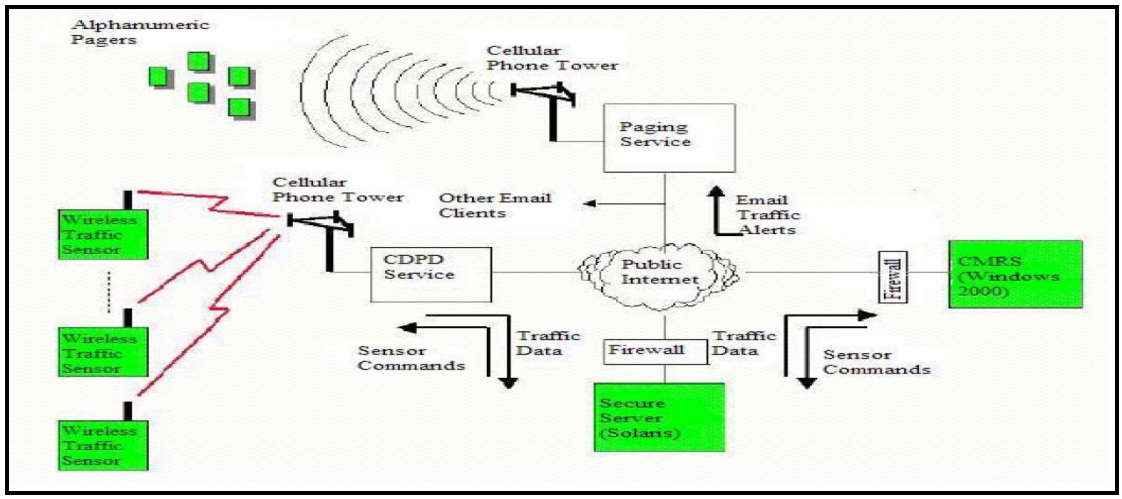
The Dynamic Travel Time Prediction Model was successfully demonstrated as having the potential to better manage the transportation system through ITS technology. The researcher had conducted a presentation and submitted a publication for the 82nd TRB session. Also, this study has been quoted in several other research publications.

FHWA-NJ-2004-009: System Description and Operator's Guide for South Jersey Real-Time Motorist Information System – L-3 Communication Systems – East

Cost: Funded with other sources.

Summary

This project described the architecture and operation of the Southern New Jersey Real Time Motorist Information System and provided instructions on installation and operation of the major system components. The design included many features that enabled the system to provide a highly portable roadway sensor that was able to operate using solar or AC power. An operator interface enabled the system to maintain secure wireless communications. The main components of the Motorist Information System were wireless traffic sensors, a secure data server, a Central Monitoring and Reporting Station (CMRS) and alphaneumeric pagers.



Traffic sensors periodically sampled traffic volumes and speeds, in order to report this information when significant changes in speed occurred. Real-time traffic data was transmitted using wireless cellular links to a secure data server. Data was periodically pulled from the server and processed by the CMRS which distributed it to pagers and email addresses. Each roadside wireless traffic sensor station consisted of a traffic sensor, a Sensor Process and Communications Unit (SPCU), an optional Solar Power Panel, and a set of interconnecting cables. Additional information was provided on the installation and set up of the sensor equipment, secure server, and the procedures used to control and monitor the data.

Implementation

Numerous design features were incorporated into the system to establish a highly portable roadway sensor that was capable of operating from solar or AC power. Communications had been extensively optimized to reduce wireless service expenses, while this modular system was expandable and ready to meet future needs for growth.

Further Recommendations

This system demonstrated the proof-of-concept with minimal engineering development effort. Also, the system had the potential to handle immediate expansion to support larger scale demonstration programs. However, additional development was recommended prior to full-scale deployment, specifically features to further reduce operating and maintenance costs.

Operator's Guide for South Jersey Real-Time Motorist Information Systems Results		
T/2 Measures	**Researcher**	**Customer**
Knowledge Transfer (Findings/Dissemination)	✓	✓
Marketing/Media (website)		
Policy/Process Change		
Demonstrations	✓	
Implementation Benefits		
Enhancement (Efficiency, Environment, Safety)	✓	
Cost Savings/Economic Impact		

Cost Benefit/Economic Impact

The study was successfully completed and had demonstrated the potential for implementation. Several presentations and publications were developed on the results of this project.

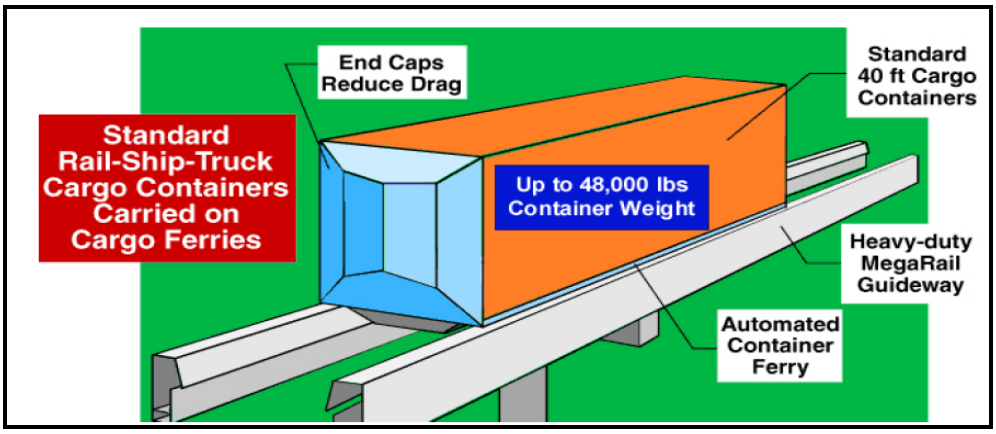
FHWA-NJ-2004-011: Study to Determine the Need for Innovative Technologies for Container Transportation Systems – Dr. Lazar N. Spasovic, New Jersey Institute of Technology

Cost: $100,084.

Summary

During the past century, New Jersey ports experienced tremendous growth in container volumes. The Port Authority of New York and New Jersey had initiated projects to increase the port capacity by improving access and expanding terminal operations. A serious issue arose regarding the ability of existing regional highways and rail networks to handle the anticipated increase in goods movement. Therefore, the NJDOT, PANYNJ, and the port terminal operators sought ways to improve transportation access in the region of New Jersey's principal port terminals.

This research examined "unconventional" transportation options for moving containers in New Jersey. Innovative transportation technologies for moving freight and intermodal containers (e.g. technologies using fixed guideways, automated guided vehicles, and fast freight ferry technologies) were studied in order to develop a framework for evaluating appropriate technologies. Once this framework was identified, several cases were used to test the effectiveness of this model.



A comparison was made between technologies and standard rail and truck service. The study was based on weighted values of cost, safety, travel time, reliability, intermodal compatibility and expandability of the system as well as environmental, ecological, and socio-economic impacts. Four cases were developed representing different geographic areas adjacent to Port Newark/Elizabeth. Particular attention was paid to the geo-technical and ecological properties of the underlying terrain to determine its impacts on construction of the infrastructure of innovative technologies.

Implementation

Innovative technologies appeared to have the greatest potential for success, especially the Cargo Rail system. All of the movement options became viable solutions as the container volume increased due to the slow economy. Further studies were recommended to examine potential interactions between innovative technologies and the current system.

Further Recommendations

Innovative technologies were also able to provide efficient access from currently undeveloped properties to port terminals. The most important outcome was the successful development of a framework that enabled planners to analyze the financial gains of implementing new technologies for transportation of containers. The process included collecting geological, geotechnical, and environmental data that was then digitized and converted into a GIS format for the purpose of producing an engineering study of the region.

Study to Determine the Need for Innovative Technologies for Container Transportation Systems Results

T/2 Measures	Researcher	Customer
Knowledge Transfer (Findings/Dissemination)	✓	✓
Marketing/Media (website)		
Policy/Process Change		
Demonstrations		
Implementation Benefits		
Enhancement (Efficiency, Environment, Safety)	✓	✓
Cost Savings/Economic Impact	✓	✓

Cost Benefit/Economic Impact

When new technologies are implemented, the potential cost savings can be measured in tens of millions of dollars annually due to the reduction of congestion and air pollution, as well as fuel costs. The cost benefit of this study included providing efficient alternatives for moving marine containers in the region.

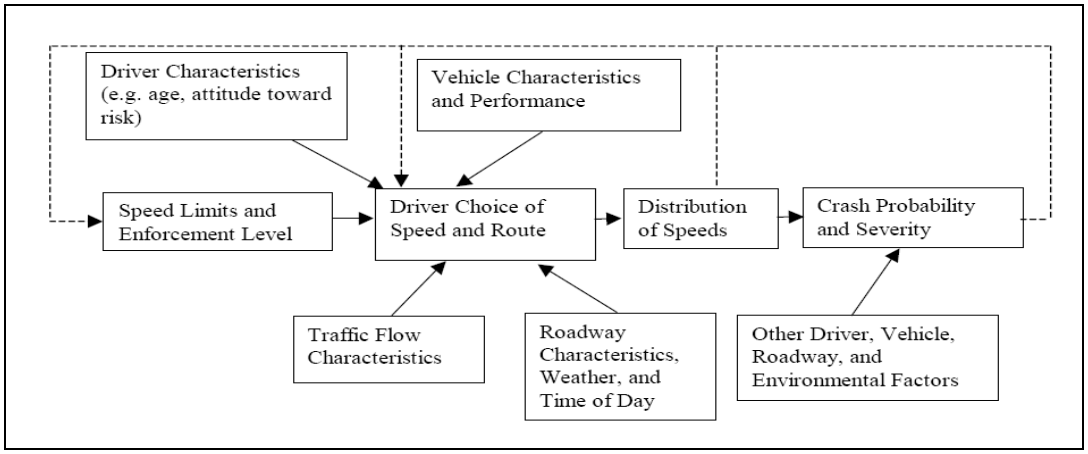
According to Talvin Davis and Paul Truban, NJDOT Freight Planning, three technologies were reviewed to determine the most promising application for relieving traffic density. In addition to the NJDOT, the Port Authority of New York and New Jersey was also involved in this study. Rail was more promising than truck transportation due to the longer distances required for movement of containers. The customers were satisfied with the knowledge transfer that was obtained from the study, which had the potential to lead to more research, improved efficiency, and the reduction of congestion. To determine cost savings, it is important to examine the overall benefits of the study. If trucks have to queue up and wait at the Port, then it may be better to use rail transportation instead. Finally, the NJDOT Research Bureau has provided NJDOT customers with the opportunity to connect with the university and solve issues that affect transportation in New Jersey and other States.

FHWA-NJ-2004-012: Study of Optimal Travel Speed Limits for Shared Traffic – Jian Yang –New Jersey Institute of Technology

Cost: $136,688.

Summary

This project determined safe operating speeds on residential and commercial roadways by identifying proper speed limits for shared roadways that accommodate motor vehicles, pedestrians, and bicyclists. The research team examined current criteria and procedures used for setting speed limits, in order to develop an approach to confirm appropriate speed limits for shared use of public right of ways by motor vehicle, bicycle, and pedestrian traffic. A logistical model was developed that related to the severity of crashes with roadway speed limits and other conditions (e.g. geometric, traffic, and weather/light). The model was used to compute speed limits for given injury severities and roadway conditions. The computed speed limits would then serve as guidelines for setting actual speed limits.



In the past, limited research was done to confirm if the low statutory speed limit of 25 mph in residential and business districts was appropriate where pedestrians and bicycles share the roadway with motor vehicles. This study examined current procedures for setting speed limits and developed an approach to identify appropriate speed limits for shared use of public right of ways. A statistical model was developed that related pedestrian/bicyclist injury severities to speed limits and other roadway factors. NJDOT crash data, collected between 1997 and 2000, was used for the analysis that included an ordinal logistic regression application to detect the relationship between injury severities and other roadway characteristics. Afterward, CORSIM, the microscopic simulation tool, was used to study impacts of various speed limits on roadway operational performances (e.g. travel times, average vehicle delays, percent stops, fuel consumptions, and vehicle emissions).

Implementation

Relationships were established between pedestrian/bicyclist injury severity levels and speed limits along with other roadway characteristics. A safe speed limit was able to be computed for all roadway and injury severity conditions. County and state roadways were analyzed based on geometric and traffic conditions.

Further Recommendations

This study confirmed that different safety standards needed to be used for urban and rural roadways. Frequently, geometric and traffic conditions greatly affected the safety conditions of a roadway, so safety needed to be used in concert with other operational impacts. Further, consideration on optimal travel speed limits for shared traffic had to include a cost model.

Study of Optimal Travel Speed Limits for Shared Traffic Results		
T/2 Measures	**Researcher**	**Customer**
Knowledge Transfer (Findings/Dissemination)	✓	
Marketing/Media (website)		
Policy/Process Change		
Demonstrations		
Implementation Benefits		
Enhancement (Efficiency, Environment, Safety)	✓	
Cost Savings/Economic Impact	✓	

Cost Benefit/Economic Impact

Since the study was completed, there had been no adoption of proposed speed limits. This conclusion was reached based on the review of proposed travel speeds for four county roads, two state roadways, and one municipal location. Interestingly, the proposed speed limit was five to fifteen mph lower than the existing speed limit. If recommendations had been implemented, there may have been a reduction in crashes and enhancement of safety factors. Also, cost savings would have resulted from the reduction of property damage, injuries and fatalities.

FHWA-NJ-2004-013: Assess Impacts and Benefits of Traffic Signal Priority for Buses – Dr. Janice Daniel, New Jersey Institute of Technology

Cost: $138,109.

Summary

Bus transportation has been the major support of public transportation, but delays at traffic signals and roadway congestion impacts operating costs and reliability of service. Implementation of a traffic signal priority for buses, establishing a green phase when approaching intersections, was one method that had been considered in New Jersey. This study assessed implementation issues associated with the use of a bus signal priority in the state, developed operational test plans for implementing signal priority at promising locations, and assessed the benefits of signal priority.

The research methodology included a review of signal priority studies in the US and abroad, in order to obtain information on the impact of transit signal priority delay to transit vehicles, schedule adherence, cross street traffic, pedestrians, overall delay, and crashes. Promising locations were then identified, and an operational test plan for implementing signal priority at these locations was developed. A simulation study of Newark's Broad Street was conducted to delineate procedures for implementing and assessing the effects of a transit signal priority system in New Jersey, as well as an operational test to assess the benefits and costs of application.

The research demonstrated that bus signal priority can be effective in New Jersey relative to schedule integrity and cost savings associated with enabling fewer buses to service the route, but it may not be appropriate at heavily congested locations and areas serviced by local buses with frequent stops.

Implementation

Traffic simulation was used to effectively quantify travel time impacts and transit operational benefits due to transit priority. Transit priority often reduced both transit and auto travel times on the route with varied results. Transit priority had compensated for signal plans slipping out of date, which sometimes occurred due to limited resources or competing priorities. The benefits of transit priority were generally greater at higher traffic volumes. The potential of transit priority to influence the number of buses needed to service a route had to be analyzed in the context of other operational factors (e.g. layover times at termini). Achieving a reduction in the number of buses did have significant operating cost benefits.

Although signal priority had proven to be an effective tool for reducing delays to buses, this technique was sometimes not beneficial to the overall traffic network. The objectives of the research described in this report is to assess the impacts of and the implementation issues associated with the use of bus signal priority in New Jersey and to assess the benefit and costs of signal priority.

To assess the benefits and costs associated with implementing signal priority, a simulation study was performed on Broad Street in Newark, New Jersey. Broad Street was selected based on the recognized transit corridor on the roadway, the roadway and bus passenger volumes that suggested that priority may be warranted, and the availability of data. The study area included 15 signalized intersections and 2 un-signalized intersections on the primary arterial, and 8 signalized intersections on two of the major cross-streets.

From the research, recommended guidelines were developed for identifying locations where bus signal priority would have the greatest impact. Bus signal priority needed to be considered at locations where a significant portion of the bus delay was at signalized intersections; where bus stops were located at the far-side of the intersection; where bus volumes were between 10 and 20 buses during the peak hour; for express bus service routes, where all vehicles queuing at signalized intersections discharged in one cycle; where the level-of-service for the cross-streets was average or better; where bunching of buses at bus stops did not occur, where pedestrian volumes were low to moderate; and where AVL technology existed or was planned.

Further Recommendations

Recommendations were made for new locations to be carefully studied for potential transit and vehicular impacts. Good candidates for effective bus signal priority were to be considered if they were located at signalized intersections that often caused significant bus delays, bus stops located at the far side of the intersection, locations with bus volumes of between 10 and 20 buses during a peak hour, low pedestrian volumes, and express versus local bus routes.

Assess Impacts and Benefits of Traffic Signal Priority for Buses Results		
T/2 Measures	**Researcher**	**Customer**
Knowledge Transfer (Findings/Dissemination)	✓	
Marketing/Media (website)		
Policy/Process Change		
Demonstrations		
Implementation Benefits		
Enhancement (Efficiency, Environment, Safety)	✓	
Cost Savings/Economic Impact	✓	

Cost Benefit/Economic Impact

Although additional knowledge was gained on the impacts and benefits of traffic signal priority for buses, no customer was identified for this project. It was confirmed by the NJDOT Traffic Engineering Department that no traffic signal priority for buses application was adopted in New Jersey. However, there would be a realized enhancement of safety, efficiency, the environment, and cost savings if traffic signal priority for buses was adopted under appropriate conditions.

FHWA-NJ-2004-014: Fatigue Management, Rail Operations Personnel – Dr. Lazar Spasovic, New Jersey Institute of Technology

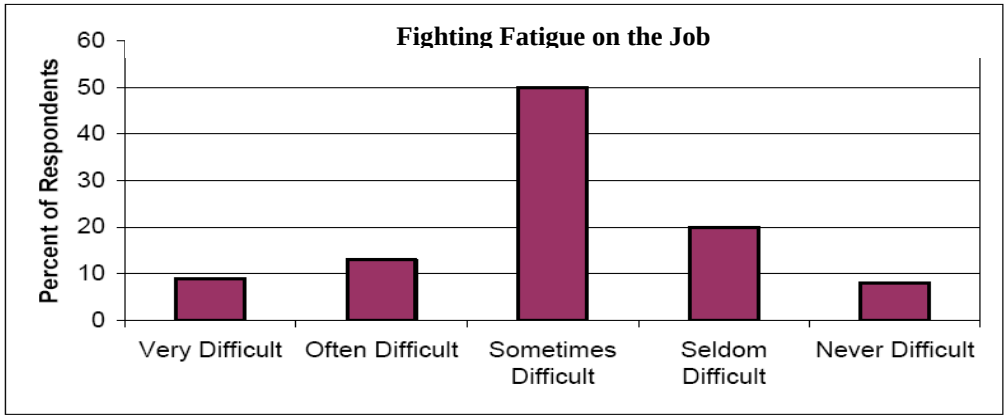
Cost: $185,598.

Summary

New Jersey Transit Corporation employed over 1,500 rail operations personnel including: locomotive engineers, conductors, and yard masters who were responsible for 300,000 customers annually. This agency depended on its personnel to effectively manage operator fatigue. A study was conducted to develop a set of practical recommendations for reducing fatigue among operators that met employment rules and regulations, addressed management and operations personnel concerns, and accommodated the demands of rail passenger customers.

Operator fatigue had led to impaired service as well as serious injury. It was identified as the probable cause of major crashes and incidents within the transportation industry and received national attention. Under provisions of the Federal Railroad Safety Enhancement Act of 1999, Fatigue Management Plans were included to amend the existing hours of service laws to reduce on-the-job fatigue and fatigue based accidents. While fatigue management was an important safety concern for NJ Transit, there had been no acceptable method of effectively measuring and testing operators for fatigue. However, the agency did maintain an “hours of service” (HOS) database for rail operations personnel and crew assignments. Their intent was to use this database for comparison to HOS determinations. NJIT partnered with Circadian Technologies Incorporated (CTI) to develop a model and procedures for evaluating fatigue that was to be used in conjunction with the NJ Transit HOS database to develop strategies for minimizing the fatigue of rail operations personnel.

According to the literature review, the proper assessment of fatigue was identified as one of the most important elements of an effective model. A computer model was used to assign a fatigue score for crew assignments. The model was developed by CTI and was compatible with the HOS database. Fatigue indices were determined for personnel having regular assignments (four to five days on and two to three days off between work periods) and Extra Board assignments. The CTI fatigue estimator was used for testing "what if" scenarios such as examining the impact of changing schedules. This model was based on research of rail operations personnel and the medical research on circadian rhythm patterns. Schedule attributes, such as start and end times, days on and off, were entered into the model to produce fatigue scores from 1 to 100 with the lower score indicating little fatigue. Most operator schedules produced scores between 20 and 60.



The model was geared toward long haul freight rail clients, so it was important to consider factors that related to fatigue. Therefore, a survey of 136 multiple choice questions and four open ended questions was distributed to 200 randomly selected participants of 100 conductors and assistants, and 100 locomotive engineers and assistants. The return rate was 17% of the distributed surveys. The majority of these respondents (61%) indicated difficulty in obtaining an adequate amount of sleep. Over half of this group noted that they had some difficulty in maintaining alertness on the job. The majority (84%) reported that they required 7 to 8 hours of sleep to be alert, but less than half reported getting 7 or more hours of sleep. Over half of the respondents did not use the resting rooms provided by NJ Transit because they were in poor condition. Other personnel conditions impacted the sleep pattern of these employees; which included lack of job security, more consistent work shifts, longer break times, and better working relationships between the crews and management.

Implementation

Alex Baker and Jerome Lutin of NJ Transit were the champions of this research project including CTI's fatigue assessment of selected operator schedules, the impact of schedule modifications on operator fatigue and a comprehensive survey of NJ TRANSIT's rail operations personnel. The results provided the basis for several interesting conclusions. Overall, schedules of NJ TRANSIT rail operations personnel were not found to be significantly fatigue inducing for regularly scheduled assignments as compared to fatigue indices for other rail operations personnel.

Further Recommendations

Survey responses showed the need for administration to decrease the number of consecutive days working and to eliminate split shifts when a night shift is followed by a day assignment. It was important to modify schedules so that personnel, working night shifts, can be placed on day shifts every other week. Also, NJ Transit should reduce the number of hours worked at night. The administration should continue to engage in active discussions on revamping the Extra Board concept.

The literature review results, CTI's evaluation of the NJ Transit schedule, and survey questionnaire responses produced the following recommendations:

- Eliminate split shifts where a night shift is followed by a day assignment.
- Reduce the number of hours worked at night.
- Engage in active discussions to examine revamping the Extra Board concept.

Ongoing discussion needed to continue between NJ Transit officials and union leaders to further balance economic benefits and potential safety risks that had been due to operator fatigue.

Fatigue Management, Rail Operations Personnel Results		
T/2 Measures	**Researcher**	**Customer**
Knowledge Transfer (Findings/Dissemination)	✓	✓
Marketing/Media (website)		
Policy/Process Change	✓	✓
Demonstrations		
Implementation Benefits		
Enhancement (Efficiency, Environment, Safety)	✓	✓
Cost Savings/Economic Impact		✓

Cost Benefit/Economic Impact

An interview with Alex Baker, NJ Transit, confirmed that the recommendations of the study team had been incorporated in the new work cycles, which are updated twice a year. This action resulted in fewer union complaints and no grievances related to scheduling. Acceptance of the recommendations was smoother because the study team met with union trainmen and engineers regarding their concerns and adhered to the New Jersey Transit requirement that the proposed solution be revenue neutral. There were no measurable improvements in safety, since the NJ Transit safety record was already very good.

The study helped to improve communications between personnel responsible for updating the work schedule procedures. Enhancements were realized with fewer union complaints and grievances. A possible improvement in safety was considered to be due to the decreased fatigue of railroad workers, which needed to be measured over time by tracking the reduction of crashes. Also, a slight reduction of administrative costs occurred as a result of fewer complaints and grievances filed by employees.

FHWA-NJ-2004-016: Computer Modeling and Simulation of NJ Transit Penn Station Newark – Dr. Lazar N. Spasovic, New Jersey Institute of Technology

Cost: $170,260.

Summary

In order to promote the movement of buses and increase security, New Jersey Transit had temporarily blocked non-authorized vehicle access to Raymond Plaza East in downtown Newark. This project was initiated to model the impact of these and proposed traffic improvements to the Newark Penn Station pick-up/drop off facilities and surrounding roadway infrastructure. A simulation model was built and calibrated to existing conditions, using bus data collected from NJ Transit, consultants, NJDOT, the City of Newark, and site visits.

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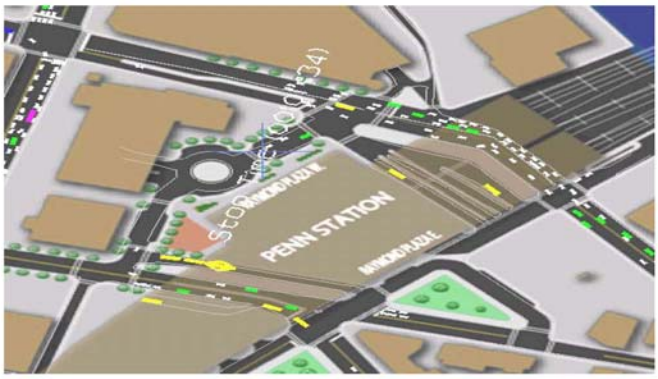
Using seven scenarios simulating evening peak hour traffic, research was conducted on potential conditions in the immediate vicinity of Penn Station. Findings from the simulations revealed that the City of Newark's proposals resulted in increased delays, while the NJ Transit's combined recommendations had a positive impact on vehicular flow in the Penn Station area.

Implementation

In consultation with NJ Transit and the City of Newark, it was concluded that the improvements be introduced in phases. The phases were determined by examining the benefits to be gained versus the anticipated costs. The proposed phases were as follows:

- Phase 1: Continue left turn prohibition from Raymond Boulevard WB to Route 21 SB.
- Phase 2: Add Left-most bus priority lane on Raymond Boulevard WB from Raymond Plaza East to Route 21 without signal pre-emption or synchronization.
- Phase 3: Implement additional pick-up/drop-off on Raymond Plaza East at Market Street and Commerce Street.
- Phase 4: Reconstruct Raymond Plaza West (RPW) two-way flow with rotary; add bus signal phasing (queue jump) on Raymond Boulevard WB at Route 21 and signal synchronization on Raymond Boulevard from Raymond Plaza East through Route 21.



Further Recommendation

In order for future development and redevelopment to be viable in the downtown Newark area surrounding Penn Station, it was critical to increase the transit mode share. This research also revealed that the existing roadway infrastructure and new improvements would not accommodate the traffic generated by facilities that were proposed to be built in the downtown area. It was important to maintain appropriate circulation levels so the transit mode share had to increase from 35 percent to at least 50 percent.

Computer Modeling and Simulation of NJ Transit Penn Station Newark Results

T/2 Measures	Researcher	Customer
Knowledge Transfer (Findings/Dissemination)	✓	✓
Marketing/Media (website)		
Policy/Process Change	✓	✓
Demonstrations		
Implementation Benefits		
Enhancement (Efficiency, Environment, Safety)	✓	✓
Cost Savings/Economic Impact	✓	✓

Cost Benefit/Economic Impact

NJ Transit representative, Roz Diamond, confirmed that the recommendations for improvements surrounding Newark Penn Station were to be made in four phases. The first two phases have been implemented with very positive results. Phase 1 recommended that the left turn prohibition from Raymond Boulevard Westbound to Route 21 Southbound be retained. The simulation conducted as part of the study proved that allowing a left turn at this location would have a

negative impact and increase delay for all vehicles and trips on Raymond Blvd. and for autos and trucks on Market Street. This simulation was instrumental in persuading NJDOT and the City of Newark not to proceed with the plan to allow a left turn there.

The Phase 2 recommendation to add a left-most bus priority lane on Raymond Boulevard Westbound from Raymond Plaza East to Route 21 was implemented with signal pre-emption. Although we are not aware of any studies having been made to measure the effect of these improvements compared to the percentage of change predicted by the simulation, it is readily apparent through observation that the bus delays have been significantly reduced while the expected nominal delays for other vehicles are as predicted by the simulation. Phase 3 and 4 had not been implemented due to lack of funding. The expectation is that implementation for these phases would also be beneficial based on the accuracy of the simulation for Phases 1 and 2 and the professional opinion of engineers and planners.

The simulation model provided knowledge transfer by proving which planning options had the most potential for reducing traffic delay. Marketing occurred through the new signage at intersections, and the NJDOT and Newark officials were influenced to change traffic pattern plans in the area. There was a reduction in the delay of buses that had the potential to generate cost savings.

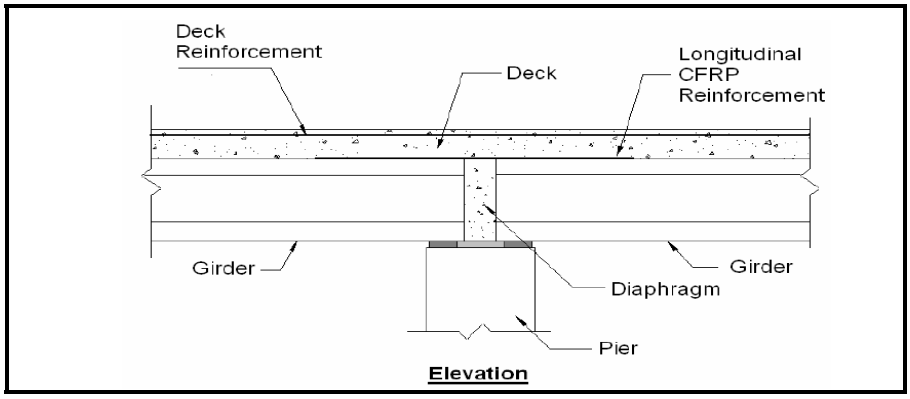
FHWA-NJ-2004-017: Improvement of Continuity Connections over Fixed Piers – M. Ala Saadeghvaziri, New Jersey Institute of Technology

Cost: $226,319.

Summary

The purpose of this research study was to improve structural efficiency of multi-span simply supported bridges, partial and/or full continuity that is provided through cast- in-place concrete diaphragms and decks. These bridges, known as *Simple-Span Precast Prestressed Bridge Girders Made Continuous*, are continuous for live loads. This continuity connection is also beneficial from a maintenance perspective due to the elimination of open joints.

However, continuity connections had structural, construction, and maintenance issues which included the development of positive moments and diaphragm cracking at the internal pier. This condition was due to time-dependent effects of prestressing that was a major structural problem and also affected bridge durability and aesthetics. Another issue had been construction time and expense, while the degree of continuity varied depending on structural and construction conditions. These problems were common to various design details used by many other states.



This study collected design data from other states and transportation agencies, monitored field performance of bridges and compared results to detailed analytical studies (including finite element analysis) to better understand the behavior and load transfer mechanism of continuity connections. Using these results, recommendations for changes to existing design and detailing practice were made. Also, an effective analysis program (CONTINUITY) was developed for use by engineers to check the restraint moments caused by the time dependent effects while examining the degree of continuity of simple span girders made continuous.

Implementation

A doctoral student participated in this project on the development and testing of an innovative continuity connection using Carbon Fiber Reinforced Polymer (CFRP). To provide continuity, CFRP reinforcement was attached to the top of the girders over the cast in place diaphragm. The negative moment over the supports caused by the deck weight balances and the positive restraint moment caused by creep in the prestressed girders eliminated positive moment cracking. Structural efficiency also increased since the girders were continuous under the deck dead load. It was shown that the new continuity connection was a viable option and that it addressed the problems and shortcomings associated with the existing design while further enhancing structural integrity and design effectiveness.

Further Recommendations

Standard design plates and construction sequences were provided and areas for further research were identified by the researchers. They also proposed that FHWA apply for approvals and provide them to customers interested in the new materials.

Improvement of Continuity Connections over Fixed Piers Results		
T/2 Measures	**Researcher**	**Customer**
Knowledge Transfer (Findings/Dissemination)	✓	
Marketing/Media (website)		
Policy/Process Change		
Demonstrations	✓	
Implementation Benefits		
Enhancement (Efficiency, Environment, Safety)	✓	
Cost Savings/Economic Impact		

Cost Benefit/Economic Impact

Knowledge transfer occurred with the researcher presenting the following papers

- Development of High Performance Continuity using CFRP Composites," Proc., 2006 Structures Congress, ASCE, New York City, St. Louise, May, 2006 (with Libin and Spillers)
- "Transverse Cracking of Concrete Bridge Decks: Effects of Design Factors," *Journal of Bridge Engineering,* ASCE, Vol. 10, No.5, 2005 (with Hadidi).
- "Transverse Cracking of Concrete Bridge Decks: the State-of-the-Art," *Journal of Bridge Engineering,* ASCE, Vol. 10, No.5, 2005 (with Hadidi).
- "Qualitative Assessment of Seismic Response of Internal Components of Power Transformers," Proc., 13th World Conf. on Earthquake Engrg., IAEE, August 1-6, 2004, Vancouver, B.C., Canada (with Allaverdi).
- "Seismic Response of Transformer-Bushing Systems," IEEE Transactions on Power Delivery, Power Engineering Society, IEEE, No. 1, Vol. 19, Jan., 2004, pp. 131-137 (with Ersoy).

- "A Practical Tool to Accurately Estimate Tensile Stresses in Concrete Bridge Decks to Control Transverse Cracking," Practice Periodical on Structural Design and Construction, ASCE, Vol. 8 (2), May 2003 (with Hadidi).

The knowledge transfer from this study was expected to enhance design efficiency and produce cost savings. However, no benefits were reported at this time.

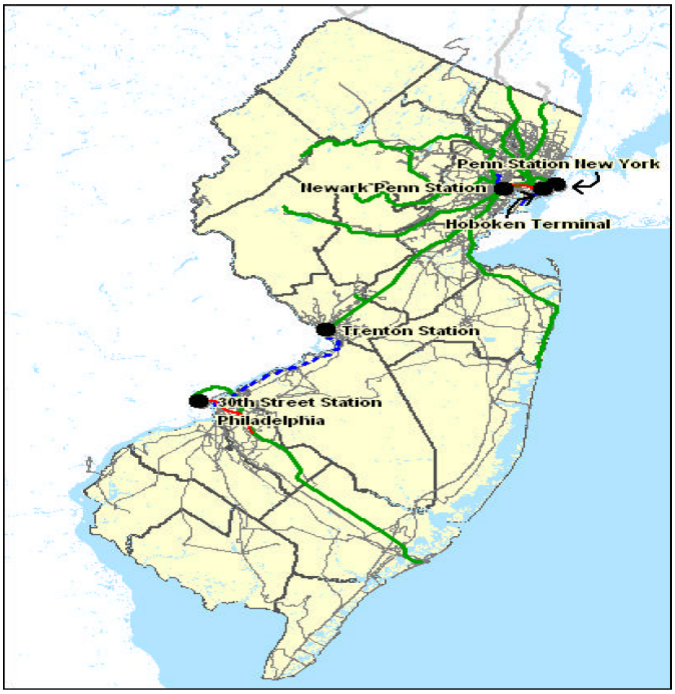
FHWA-NJ-2004-018: Mobility Information Needs of Limited English Proficiency (LEP) Travelers in New Jersey – Dr. Rongfang (Rachel) Liu, NJ Institute of Technology

Cost: $230,393.

Summary

The 2000 Census Data indicated that twenty-five percent (25%) of New Jersey residents do not speak English at home. Nearly half of these people have limited English Proficiency (LEP) and they may not be able to obtain services and information on transportation services and programs that affect their economic and social opportunities. As part of an overall effort to improve transit services and comply with Title VI non-discrimination mandates, NJDOT and NJ Transit requested research on best practices to satisfy mobility information needs of Limited English Proficiency (LEP) residents in New Jersey.

Three distinct surveys were conducted during this study. The first survey was to obtain LEP community input on mobility information issues. The project identified the geographical location and linguistic background of approximately 400,000 LEP New Jersey residents. The highest concentrations occurred mostly in the state's six urban northeast counties and there was a high correlation between transit use and LEP population distribution. Verbal transit announcements were found to present problems for LEP individuals, and some expressed negative feelings about the transit system, including a lack of appropriate transit routes and perceived discriminatory treatment from transit employees.



Other research was conducted on peer transit agencies within the metropolitan areas that serve bi- or multilingual populations in the United States. Best practices of these agencies mostly included multilingual websites. A third survey was conducted on transportation providers, outside the United States, responsible for various airports, tourism centers, and other locales catering to multilingual clientele. Best practices in use across the globe included multilingual web pages, publications and announcements, telephone lines, pictograms, visual aids, and personal assistance.

Recommendations were made on both strategic and operational levels. Strategies needed to include a long range transit plan that took into account evolving community demographics and included a voice for LEP community members in planning routes. The plan needed to address cultural and linguistic sensitivity training for all employees maintaining traveler contacts and leveraging of resources with other organizations such as social service agencies to maximize personal assistance. On the operational level, the study team recommended increased use of pictograms, creation of a multilingual website, and improved public announcement techniques.

Implementation

Jerry Lutin, Senior Director of Intermodal Planning, New Jersey Transit, served as the champion for this research project. As documented in our survey, a number of agencies advertised their transit services in community newspapers, local radios, and resident mailings. A focus group discussion confirmed that comprehension was an issue for some people in accessing transit when residing in new immigrant communities. Participant comments showed that language-based service-delivery problems existed for Polish, Arabic, Portuguese and Spanish speakers.

Having received a large number of responses from LEP travelers in New Jersey and information regarding techniques used by various entities around world, the most efficient and cost-effective practices were selected for NJ Transit. Given the large number of foreign languages spoken in New Jersey, it is impossible to provide written or oral directions for most transit information in multiple languages. As documented in the literature search, scholars also proved that the processing of multilingual messages may burden the travelers with tension and stress. The survey of LEP groups showed that their second highest information exchange preference was to have timetables, schedules and other related information presented in their native languages. This solution may be effective as indicated by the generally positive reaction of Spanish-speaking travelers who already had some timetables and other transit information translated in Spanish. Also, Public Announcements (PA) had been frequently cited as encountered by LEP travelers.

Further Recommendations

As a result of the research findings, NJ Transit did subscribe to a toll-free number to provide transit information, which was used to reach certain interpreters if the user was not capable of navigating the first group of questions in English alone.

Information Needs of Limited English Proficiency (LEP) Travelers in New Jersey Results

T/2 Measures	Researcher	Customer
Knowledge Transfer (Findings/Dissemination)	✓	✓
Marketing/Media (website)		✓
Policy/Process Change	✓	✓
Demonstrations		
Implementation Benefits		
Enhancement (Efficiency, Environment, Safety)	✓	✓
Cost Savings/Economic Impact		

Cost Benefit/Economic Impact

Marianne Stock of NJ Transit reported that her agency had implemented several of the study recommendations and had been continually aware of the needs of the LEP community. For example, bus operator workshops incorporated cultural and linguistic sensitivity training into the existing program. Drivers were now required to make announcements at all stops. This practice was especially helpful for visually impaired passengers. Every effort was made to improve communications between employees and the public being served.

In addition to changes in training practices, pictograms were incorporated wherever possible and all new buses feature a new technology system for announcements. Communications improved and better customer service was realized, but there were no measureable cost savings attributed to the implemented enhancements. Also, the following articles were published on this research:

- Leone, Kelly and Rongfang (Rachel) Liu. "An Analysis of Security System Designs for Ferry Transportation" Transportation Research Record, Journal of Transportation Research Board. 2006. Forthcoming.

- Schachter, H. and Rongfang (Rachel) Liu. "Policy Development and New Immigrant Communities: A Case Study in Citizen's Input in Defining Transit Problems." ASPA: Public Administration Review: The Premier Journal of Public Administration, Vol. 65, Issue 5, pp 614-623. September/October 2005.

FHWA-NJ-2004-019: Implementation of Recommended LRFD Guidelines (NCHRP 12-49) for Seismic Design of Highway Bridges in New Jersey – M. Ala Saadeghvaziri, New Jersey Institute of Technology

Cost: $47,194.

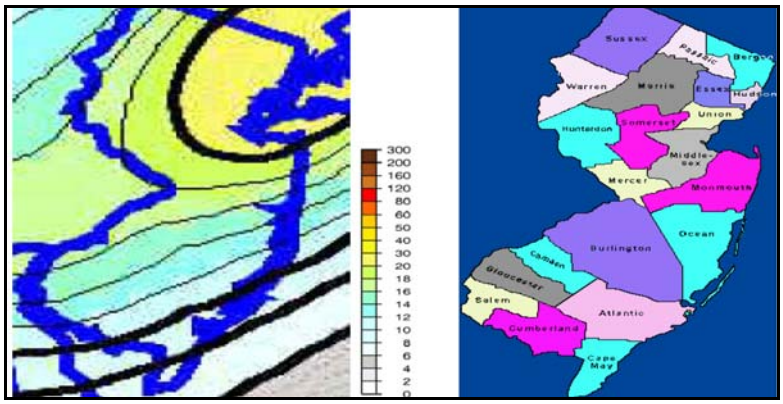
Summary

The objective of this study was to evaluate the NCHRP 12-49 guidelines and assess their impact on the seismic design of highway bridges in the State of New Jersey. The 2001 guidelines were proposed by the National Cooperative Highway Research Program (NCHRP), based on lessons learned from the San Fernando earthquake of 1971 and other earthquakes, which occurred in the following decades. The document addressed state-of-the-art aspects of highway bridge seismic design, including the latest approaches for representing the seismic hazard, design and performance criteria, improved analysis methods, steel and concrete superstructure and substructure design and detailing, and foundation design.

Five bridges were selected for study that met the criteria of having more than three spans and were built after 1997. The following bridges were studied:

- Union Avenue over Passaic River (Bergen County),
- NJ Rt. 15 over NYS Western Rail (Sussex County),
- NJ Rt. 35 over Navesink River (Monmouth County),
- US Rt. 206 over Raritan River (Somerset County),
- Ocean Drive over Middle Thorofare (Cape May County).

Newark (Essex County) was also used as a location for additional seismic design spectrum and force determination.



Observations were made at the study sites, which confirmed that the locations were not unique to the State. Any move to lower the seismic hazard by reducing the return period may have had serious implications regarding future events. Conclusions and recommendations are as follows:

- Adopt NCHRP 12-49 in its present form and encourage AASHTO to do the same.
- Most designs already exceed the seismic design forces in the proposed NCHRP 12-49 code.
- NCHRP provisions provided simplified analysis and design procedures that will increase cost minimally, if at all, and will result in more accuracy.
- Proposed provisions were nationally applicable.
- Comparative designs based on NCHRP 12-49 needed to be considered as part of bridge project scope in New Jersey.
- Changes in hazard definition resulted in a lower return period (less than 1,500 years) and needed to be opposed.
- Encourage seismic provisions that take advantage of advances in analytical procedures and rewards designs based on state-of-the-art knowledge.
- Collect dynamic soil properties as part of future bridge construction.
- Encourage relaxing site-specific analysis limits to promote further collaboration among geology, seismology, geotechnical engineering, and structural engineering to better define seismic hazards and model soil-structure interaction.

Implementation

The objective of this study had been to evaluate the NCHRP 12-49 guidelines and to assess their impact on the seismic design of highway bridges in the State of New Jersey. This study did attempt to qualitatively assess the impacts of the proposed NCHRP 12-49 provisions on the seismic design of bridges in New Jersey. The findings were summarized as having strongly supported new provisions in their present form. Aside from the fact that the new provisions were based on state-of-the-art knowledge and recent scientific developments, it was determined that contrary to some misperceptions, the proposed new LRFD guidelines did not necessarily result in higher seismic demands.

Further Recommendations

Future recommendations for research and development include the following:

- Consider the response of highway bridges to vertical motion and blast load, the development of protective systems for both sub and superstructure, and impacts of upward motions on pre-tensioned and post-tensioned bridges.
- Perform a sensitivity study on interdependency of bridge dynamic characteristics and site conditions to more exactly quantify the impact on seismic demands for various bridges.
- Develop design tools to facilitate and streamline the application of new analysis and design concepts under NCHRP 12-49.

Implementation of Recommended LRFD Guidelines (NCHRP 12-49) for Seismic Designs of Highway Bridges in New Jersey Results		
T/2 Measures	**Researcher**	**Customer**
Knowledge Transfer (Findings/Dissemination)	✓	✓
Marketing/Media (website)		
Policy/Process Change	✓	✓
Demonstrations	✓	
Implementation Benefits		
Enhancement (Efficiency, Environment, Safety)	✓	✓
Cost Savings/Economic Impact		✓

Cost Benefit/Economic Impact

Although the customers have retired from the Bridge Department, Richard Dunne maintains that a very strong relationship continues to exist with the Bureau of Research. This project was important because the NCHRP 12-49 and other research had been reviewed for application in New Jersey. Now, only one document is used as a design manual and guidance for work being done on New Jersey bridges.

Projected Cost Benefit/Economic Impact

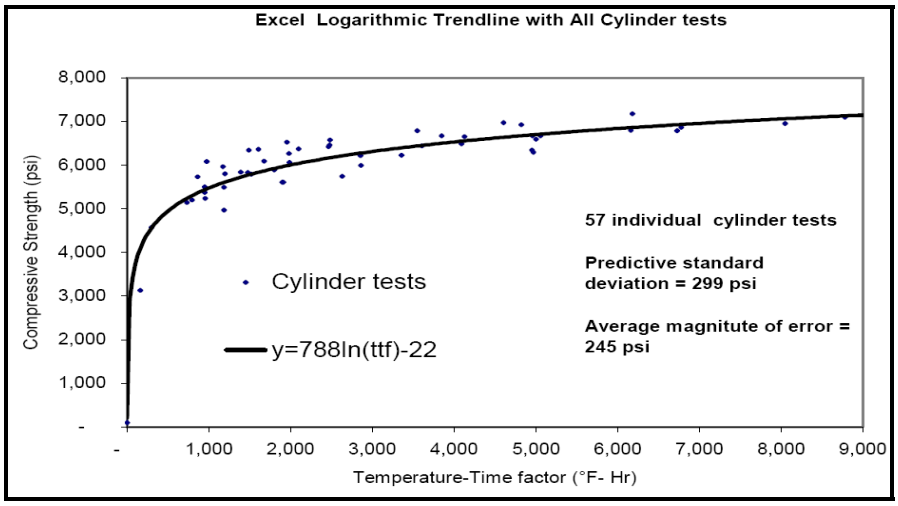
This project was also the precursor for the geotech data management system of collective boring data and will be analyzed by county and zip code. This decision-making tool will be used to establish customized design criteria on all projects. The expected outcome will be improved efficiency and cost savings for both retrofitted and new projects. Although not available at the present time, the cost benefits of enhanced efficiency and cost savings will be better able to be identified over time.

FHWA-NJ-2004-022: The Maturity Method in Prestressed Concrete Applications – Allyn Luke, New Jersey Institute of Technology

Cost: $74,148.

Summary

This study was undertaken as a follow up to the 2003 research project, Implementation of Maturity Meters, which recommended further research was needed to provide guidance for using the maturity method for precast/prestressed steam cured specimens. The maturity method had been used to make excellent predictions on the prestress transfer strength for precast/prestressed box beams. Temperature measurements were located at the bottom end of the beam, where the prestressing strands left the forms for the anchorages, to be the critical area for strength measurement. Maturity measurements in this area allowed evaluation of the strength in parts of the prestressed section where strength measurements could not be made before. It was also found that companion test cylinders predicted the strength in this area as well. Verification procedures, recommended in previous work, were validated.



The results of this study confirmed the following:

- A datum temperature of 50° F is assigned for use in steam accelerated applications.
- Maturity measurements are to be made in the critical areas of the beams adjacent to the anchorages at both ends of the prestressing bed. The maturity measurements in the section cast last are expected to be lower and will probably control the release strength. However, the lowest strength prediction will always control.
- The strength-maturity relation must be validated by predicting accurately the strength of companion cylinders cured with the structure. After the required curing time the maturity method is used to predict adequate strength for the prestressing release. A strength test of companion cylinders is simultaneously conducted to check that the strength-maturity relationship is able to predict this concrete's strength. If the strength of the companion cylinder is predicted within the standard deviation, from at least 30 previous tests, then the prediction can be applied to the structure.
- If the strength maturity relationship is not validated it will be necessary to determine the release strength by conventional means. This would constitute a reversion to the acceptance of the release strength in companion cylinders as indicative of that strength in the structure. If the validation has failed the causes must be investigated. It might be necessary to recompute the strength-maturity relationship.
- The iterative refinement process shall continue until at least 30 tests are included in the strength-maturity data base for that concrete.
- A verification test shall be conducted for each particular mix at least once each week of production. The verified strength maturity relationship may be used for all production using this concrete at this plant.

Implementation

Several NJDOT employees supported this research effort; while Eileen Connelly served as the champion for the project. Findings were presented at ACI in 2006. The study verified that what is currently taking place at NJDOT is acceptable. Energy savings may be realized with the pre stressed concrete application, which was of interest to the Maryland DOT.

Further Recommendations

Eileen Sheehy from the NJDOT Bureau of Materials, hoped that the maturity method could be used to decrease the need for cylinder testing as a process to evaluate concrete strength. Although the investigators concluded that the maturity method can be used for determining adequate concrete strength in an element to allow release of the prestressing force, the maturity method was found to be more complicated than anticipated. The Department shared information from the study with fabricators and gave them the option of using this method, but none of the fabricators wanted to use it because of the complexity and presumably, the additional cost.

The Maturity Method in Prestressed Concrete Applications Results		
T/2 Measures	**Researcher**	**Customer**
Knowledge Transfer (Findings/Dissemination)	✓	✓
Marketing/Media (website)		
Policy/Process Change	✓	
Demonstrations		
Implementation Benefits		
Enhancement (Efficiency, Environment, Safety)	✓	
Cost Savings/Economic Impact		

Cost Benefit/Economic Impact

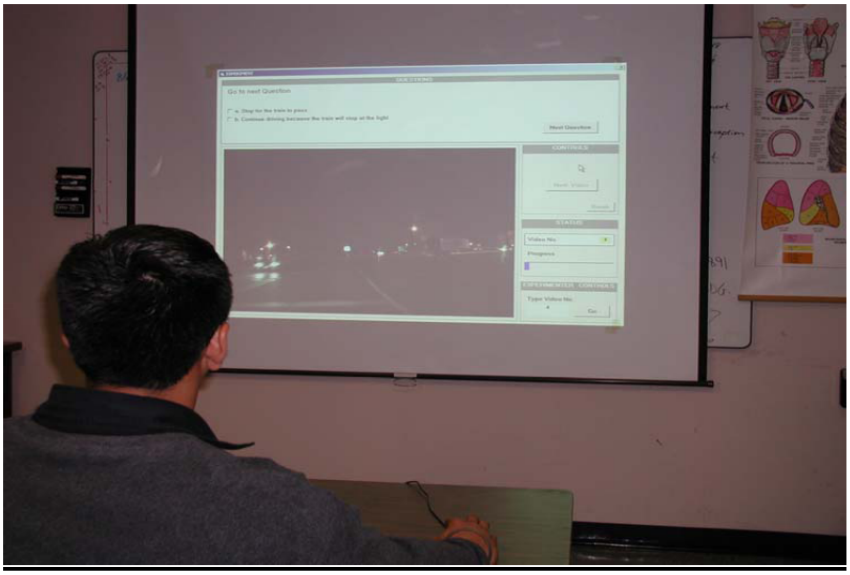
Knowledge transfer occurred informally with the Department sharing information with the fabricators. The research included conducting demonstrations for the fabricators, but no implementation occurred since the maturity method was more complicated and less efficient than the current system. No cost savings were realized from this research effort, except that the current method used at NJDOT was acceptable.

FHWA-NJ-2004-025: Survey of Driver Perceptions of Railroad and Light Rail Warning Devices/Grade Crossings - Dr. One-Jang Jeng, New Jersey Institute of Technology

Cost: $207,454.

Summary

This project used human factors research approaches to study driver perceptions and driving decision making for all safety issues pertaining to railroad grade crossings. The research team began by conducting a laboratory experiment to study driver perception and driving decision making by using video clips taken from moving vehicles traveling through various railroad grade crossings. Next, a draft railroad section of the driver's manual was developed and evaluated. The effectiveness of this section on the understanding of railroad crossing safety issues was reviewed.



The study identified drivers as having different driving behaviors while approaching unique types of crossings (typical active crossings with gates and/or red flashing lights and passive crossings). When encountering unusual traffic control devices that were located in the vicinity of railroad grade crossings, they experienced confusion. Many drivers were not familiar with traffic control devices or roadway layouts at light rail crossings.

The second phase of the study evaluated the effects of the draft railroad section of the driver's manual. It was found that specific and comprehensive instructions on driving at light rail crossings should be provided in the driver's manuals. The results showed positive performance gained from having such a dedicated railroad section in the manual. Also, human factors research methodology proved to be an effective approach for studying driver perception and driving behaviors. The potential existed for studying the relationship between driver's perception and the decision-making process.

Implementation

John Vogler, NJ TRANSIT, Paul Schnieder and Todd Hirt, Utility and Railroad Engineering, NJDOT had championed this research effort. Also, Tirthankar Sengupta, Piyush Chapla, Anand Tharanathan, and Bo Li, graduate students in the NJIT Department of Industrial and Manufacturing Engineering participated in the study. The results showed positive gains from having a dedicated railroad section in the driver's manual. Human factors research methodology proved to be an effective approach for studying driver perception and driving behaviors at railroad crossings.

Further Recommendations

According to Todd Hirt, Diagnostic Team Leader, NJDOT Railroad Engineering & Safety, the Department wanted to better understand how the people of New Jersey perceived and responded to railroad warning devices. The results were shocking, since 70% of the survey respondents did not realize that the cross-buck, a passive warning device, meant "yield". Most knew that they must stop at gates, but 30% believed that warning lights meant that it was safe to cross while they were still flashing, before turning solid. (Railroad crossing lights never turn solid!)

The findings of this study correlated with other studies across the country and will be reflected in changes to the MUTCD for 2009. Within New Jersey, six or more passive railroad crossings have been upgraded to active crossings each year since 2005. The feedback has been very positive. Many towns have expressed their appreciation and requested additional upgrades to other crossings. School bus drivers are especially appreciative. The consensus is that changing to active crossings has made driving decisions easier.

Recommendations to revise the New Jersey Driver's Manual were partially implemented, resulting in education of new drivers. The old manual referred to railroad crossings in three places. It now refers to railroad crossings in two places, but has added additional information on flashing lights, cross-bucks, and advanced warning signs. The recommendation to create a dedicated railroad section was not implemented.

Survey of Driver Perceptions of Railroad and Light Rail Warning Devices/Grade Crossings Results

T/2 Measures	Researcher	Customer
Knowledge Transfer (Findings/Dissemination)	✓	✓
Marketing/Media (website)		
Policy/Process Change	✓	✓
Demonstrations		
Implementation Benefits		
Enhancement (Efficiency, Environment, Safety)	✓	✓
Cost Savings/Economic Impact		

Cost Benefit/Economic Impact

There is additional cost involved in upgrading the crossings, and it is not known how many lives have been saved by these improvements, but the Department believes that safety has improved at many railroad crossings throughout the State and the public has been well served. The study itself included a good cross section of the population and provided the desired information.

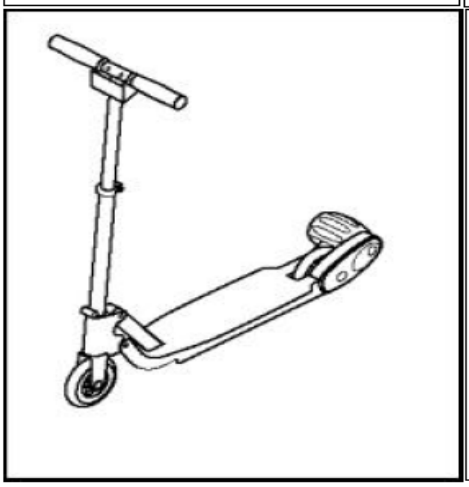
Knowledge transfer was accomplished when the New Jersey Driver's Manual was upgraded on Railroad Warning Signs. NJDOT procedures changed when passive warnings were upgraded to active warnings at over six crossing in 2005. The upgrades resulted in more effective transfer of information to the motoring public, which should result in improved safety at these locations in the future. Although additional costs were incurred from the warning sign upgrades, it is balanced against the potential saving of lives.

FHWA-NJ-2004-026: Motorized Scooters/Go-Peds - Dr. Janice Daniel, New Jersey Institute of Technology

Cost: $48,404.

Summary

In 2000, there was a significant increase in scooter related injuries that required emergency room treatment. As a result, many State and local governing agencies enacted laws and regulations governing the use of motorized scooters. The focus of this research was to survey laws, and regulations to determine best practices for the use of motorized scooters. Legislation from New Jersey and other States was then compared with the proposed Senate Bill 1510.

Motorized Scooter	Motorized Skateboard	Miniature Motorcycle
		

Fifteen of the surveyed states defined motorized scooters in various ways. This survey results recommended that the following features be included in New Jersey's definition of a motorized scooter: have a maximum piston displacement of 50 cc, include no more than three wheels, the maximum speed limit was 25 mph, contained no seat or saddle, and included a handlebar. Also, the review of legislation focused on the use on public roadways/sidewalks; municipal regulations; registration; age of operator; helmet use; and fines for violations.

Several recommendations were made based on the review of best practices found in other states. They included implementing a proven approach for local use, legislative considerations, and safety considerations, which appear below:

- Prohibit use of motorized scooters on public roadways and sidewalks or at least restrict their use to roadways with a designated speed limit or access control.
- Allow municipalities to regulate the use of motorized scooters in designated areas other than streets, highways, and sidewalks.
- Modify the proposed Bill to raise the minimum age from 12 to the current minimum age for motorized bicycles.
- Consider requiring helmet use by age rather than the proposed legislation which would require helmet use for all operators.
- Requiring registration of motorized scooters would not necessarily promote safety.
- The proposed fine structure appeared to have stiffer penalties than other low-speed motor vehicle law violations. These penalties included confiscation of the vehicle and mandatory community service as well as a fine.

Some states adopted motorized bicycle regulations for use with motorized scooters. However there were several advantages and disadvantages that needed to be considered. The advantages included the following: the operator fee structure was fair, there was compulsory liability coverage, under the influence penalties were available, the violation was already included in the crash report, and safety education programs were already available for users. The disadvantages of adopting motorized bicycle regulations: the owner was required to operate on public highways, increased liability coverage, motorized scooters were not included on existing crash reports, a registration and license plate was required, helmets were required for operation, and education programs were not frequently available for safe operation of this vehicle.

Implementation

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Six recommendations were made regarding the features that should be included in the definition of motorized scooters. A review of the signed legislation and Title-39 revealed that only one of the recommendations was incorporated, and that was not to include brake horsepower as a defining feature. Also, the study recommended using a maximum piston displacement of 50cc in the definition. This was not found in the legislation or Title-39 definition, but was used in the press releases regarding the legislation.

Further Recommendations

An additional six recommendations were made regarding the provisions of the bill. Three of these were incorporated: prohibition of use on highways, streets, and sidewalks; allowing municipalities to regulate motorized scooter use on municipal property; and allowing municipalities to establish a minimum age higher than the minimum age of 12 as put forth in the legislation. It is not know conclusively that the report influenced the final wording of the legislation. Peter Manoogian from the Office of Legislative Services reviewed the file of Transportation Committee discussions and could find no reference to the study.

Motorized Scooters/Go-Peds Results		
T/2 Measures	**Researcher**	**Customer**
Knowledge Transfer (Findings/Dissemination)	✓	✓
Marketing/Media (website)	✓	
Policy/Process Change	✓	✓
Demonstrations		
Implementation Benefits		
Enhancement (Efficiency, Environment, Safety)	✓	✓
Cost Savings/Economic Impact		

Cost Benefit/Economic Impact

It was not possible to determine if registrations of motorized scooters had increased after passing the legislation since these vehicle registrations were not distinguished from motorcycles. According to Bill Beans, NJDOT Traffic Bureau, there are no crash statistics available since they would be classified under "other."

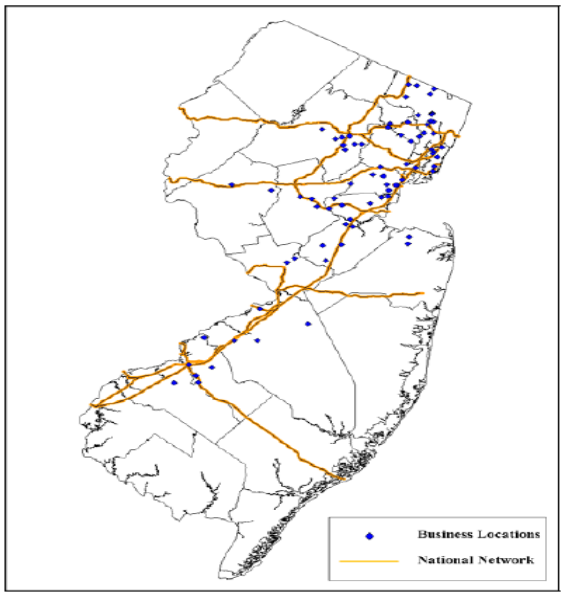
Although the level of knowledge transfer is officially unknown, there was some indication that the study results were part of the legislation. Furthermore, there was a press release to the public once the bill was signed into law. The policy on motorized scooters was changed to give more discretion to municipalities on regulating usage. Potential safety benefits, based on the law, may be documented in the future.

FHWA-NJ-2004-027: Estimation of Truck Volumes and Flows – Dr. Maria Boilé, Rutgers, Rutgers CAIT

Cost: $198,566.

Summary

The use of trucks in the movement of freight accounts for 75% of the transported goods in New Jersey. As truck volumes dramatically increased during the past several years, so did the need for better methods to estimate truck volumes, percentages and flow on interstates and principal arterials, as well as on minor arterials with lower truck volume. According to the Quick Response Freight Manual (QRFM) current freight modeling approaches were unable to make many assumptions or were inconsistent concerning the sequential processes. A statistical approach for estimating truck volumes was examined as a solution to the inconsistencies found in sequential models. Profiles of truck traffic were developed and models were created to predict truck volumes and percentages at any given location in the state truck route network within a GIS environment.



The prototype was not intended to "replace" or "compete" with other methods and was not to be used as a freight-forecasting tool. This model was to be used for facility planning, corridor planning, and strategic planning of transportation systems including pavement and bridge design and management, reconditioning and reconstruction of highway pavement, planning for freight movements, environmental impact analysis, and investment policy applications. This statistical tool had the potential to help planners in obtaining truck volume, flow and percentage estimates on state

roadways without having to use complex, time consuming and data demanding freight forecasting tools. In the past, this type of analysis was typically outsourced to consultants by state DOTs. Having the proposed tool available and directly linked to the state DOT's database, facilitated the quick, in-house estimate of truck volumes.

Implementation

This study presented a statistical approach for estimating truck volumes, based primarily on classification counts and information on roadway functionality, employment, sales volume and number of establishments within the State. Models were created that predicted truck volumes at any given location on the major highway network. Profiles of truck traffic were developed for selected roadways, indicating the AADT, truck and passenger car volumes and percentages. The procedure was modeled into a GIS framework that facilitated data analysis, and produced an effective presentation of the results.

Further Recommendations

Although preliminary results of this study were promising in terms of the proposed methodology and results, it was recognized that a much larger set of counts needed to be considered in order to obtain more sound statistical models and more accurate results. Additional data collection and surveys (example: cordon counts or license plate surveys) were required, in order to provide accurate estimates of the 'through traffic' on the various major highways. Through traffic did not depend on local activity so obtaining a good estimate was needed to further improve the models.

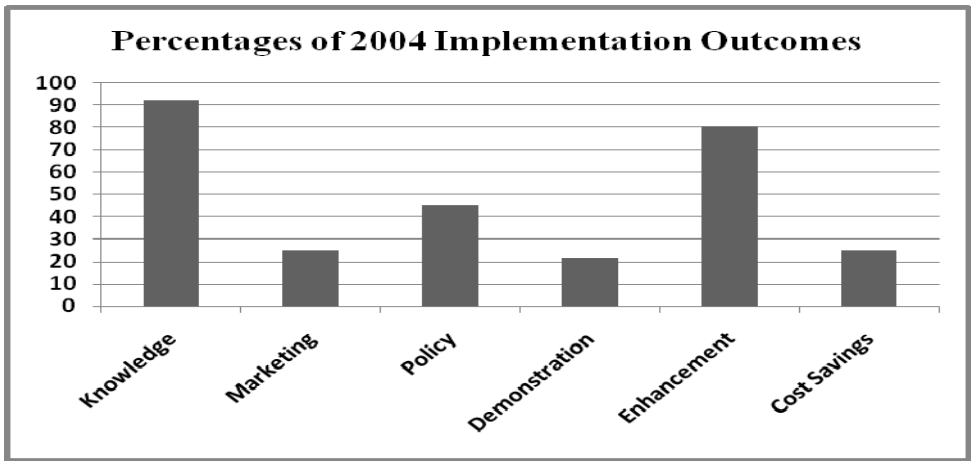
Estimation of Truck Volumes and Flows Results		
T/2 Measures	**Researcher**	**Customer**
Knowledge Transfer (Findings/Dissemination)	✓	✓
Marketing/Media (website)		
Policy/Process Change		
Demonstrations	✓	
Implementation Benefits		
Enhancement (Efficiency, Environment, Safety)	✓	
Cost Savings/Economic Impact		

Cost Benefit/Economic Impact

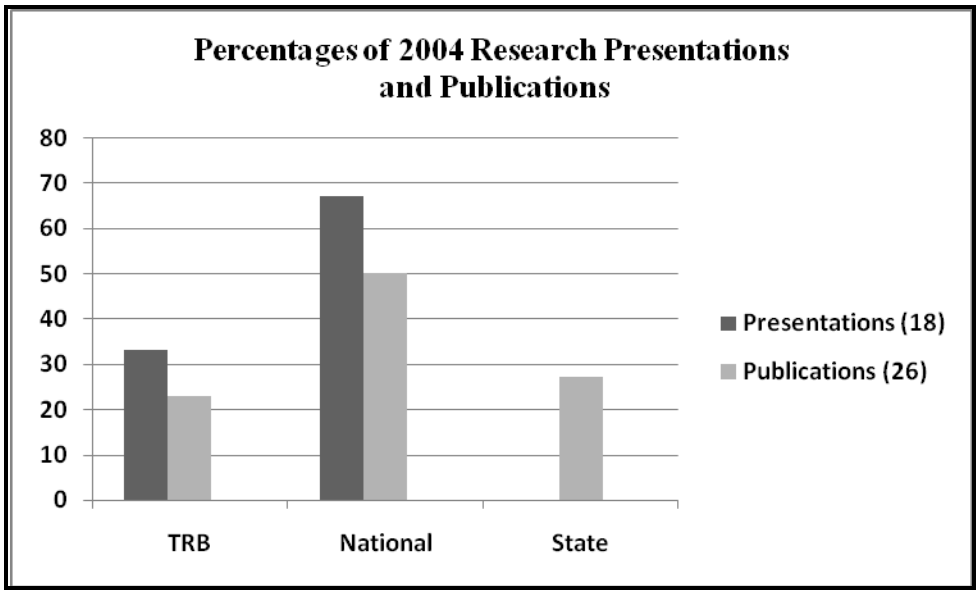
The goal of the project was to provide a means for the Planning Division at NJDOT to quickly and accurately estimate truck volumes, flows, and percentages. The product was developed and demonstrated for the NJDOT Planning Division staff. As noted in the final report, the implementation plan was developed; however, there was no indication that the system had been implemented at the Department.

Summary

The purpose of this implementation follow-up study was to identify technology transfer measures that contributed to the enhancement and cost benefits of transportation research. According to TRB (1999), the four stages of the technology transfer process include awareness (knowledge transfer), attitude formation, persuasion (marketing), trial and decision making (policy/procedure/process change), and confirmation (demonstration). These technology transfer measures and implementation benefits were described by both the researchers and customers. A majority of the respondents reported that knowledge transfer and time savings enhancement were the two most important outcomes realized from research during this period.



Knowledge Transfer: After the projects were completed and accepted by NJDOT, it was reported that 18 presentations were conducted and 26 articles were published for a national audience. The 2003 Motor Vehicle Commission evaluation findings had been incorporated into the agency's 2006 Service Assessment Report, while a transit catalog continues to serve as a valuable negotiation tool for New Jersey Transit employees. Publications on human factors were also included in the Sage Journal and Investing Today. The NJDOT Blue Ribbon Report and Annual Statewide Capital Plan quoted Spasovic's congestion report findings. In addition to TRB, there were also many presentations conducted at the following national conferences: American Society of Civil Engineers, International Association for Engineering Economics (AEE), American Society for Public Administration (ASPA), American Concrete Institute (ACI), Institute of Electrical and Electronics Engineers (IEEE), Transportation Research Forum (TRF) and ESRI Conferences.



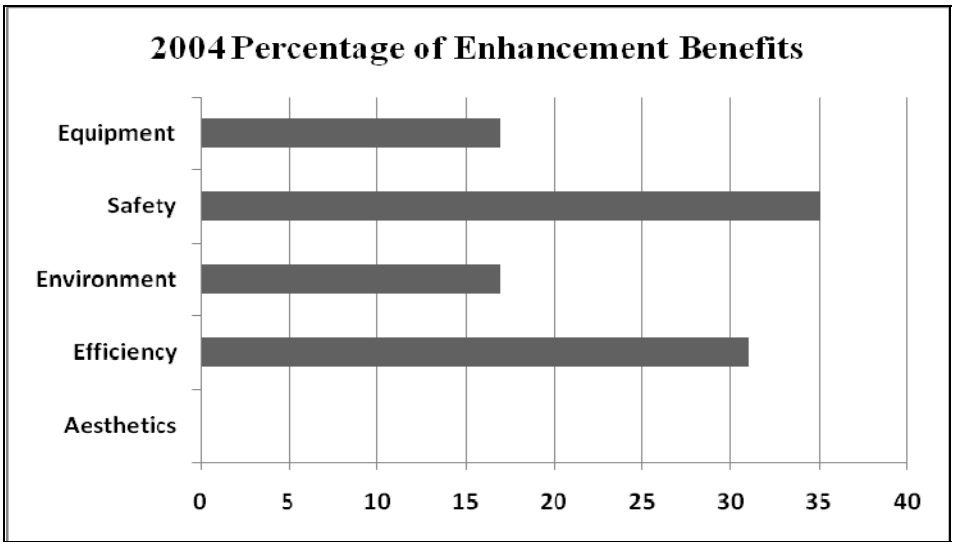
Marketing/Media: The MVC had used the results of their study as a marketing tool for helping to rebuild customer confidence in their operation. The Polytechnic website featured an article on the commuter stress study that was conducted by Richard Wener. NJ Transit followed the recommendations, presented on limited English proficiency travelers, and adapted their informational publications to meet the needs of this targeted group. Only one press release was identified as an important outcome of the 2004 research studies. The Star Ledger, a statewide newspaper, published information on the adoption of the motorized scooter legislation

Policy and Procedures: Several procedural changes were implemented by NJ Transit and the MVC, based on the research findings for this period. Operating procedures were improved at the MVC and the 2003 report findings also

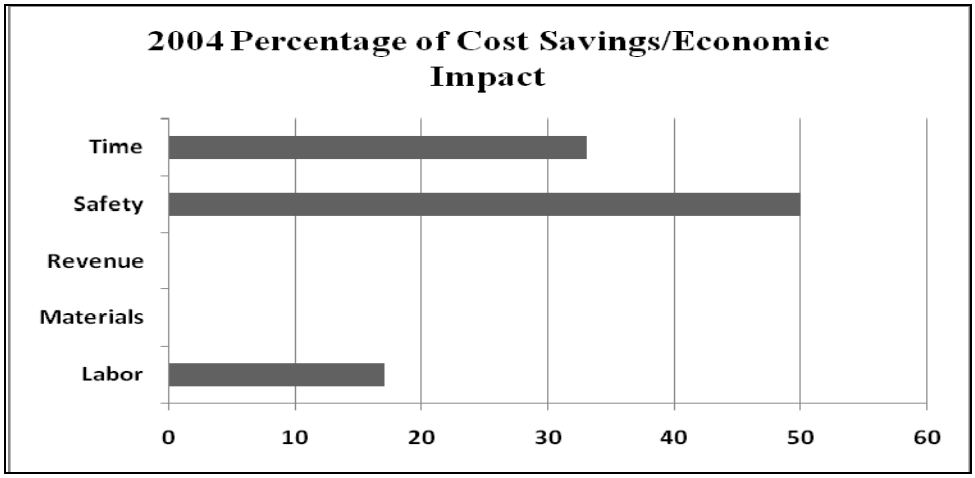
served as a baseline measure on the success of implemented changes. Recommendations, found in the Fatigue Management of Rail Operations Personnel, were adopted with work schedules having been adjusted to reduce fatigue among personnel. A catalog of resources was developed by the researchers and continues to be used by NJ Transit to support the negotiating skills of NJ Transit employees when addressing rail issues. Bus operator workshops incorporated cultural and linguistic sensitivity training into their existing program. As a result of the research findings, the NJDOT Bridge Department has been able to update their references and now only one document is used as a design manual and guidance for bridge work. Also, NJDOT Railroad Engineering and Safety Department upgraded many railroad crossings throughout the State based on results from the driver perception survey.

Enhancement Benefits

All respondents identified enhancement as a benefit of the research studies. (See the table below) Several enhancements were realized as increased efficiency, improved safety benefits, and upgraded materials for the customers. For example, the reduction of congestion improved roadway safety conditions. There were no reported benefits that related to aesthetics during this period. Simulation applications were introduced as a new technology that later became very popular in the following research cycles.



Cost Savings/Economic Impact Benefits: It was reported that less than 10% of all projects realized benefits from improved safety or time savings. Impacts on safety were attributed to the reduction of congestion and safety, and labor savings were based on increased knowledge and improvement of operational functions. None of the sponsoring agencies or research customers had been able to identify dollars saved based on the outcomes of these studies.



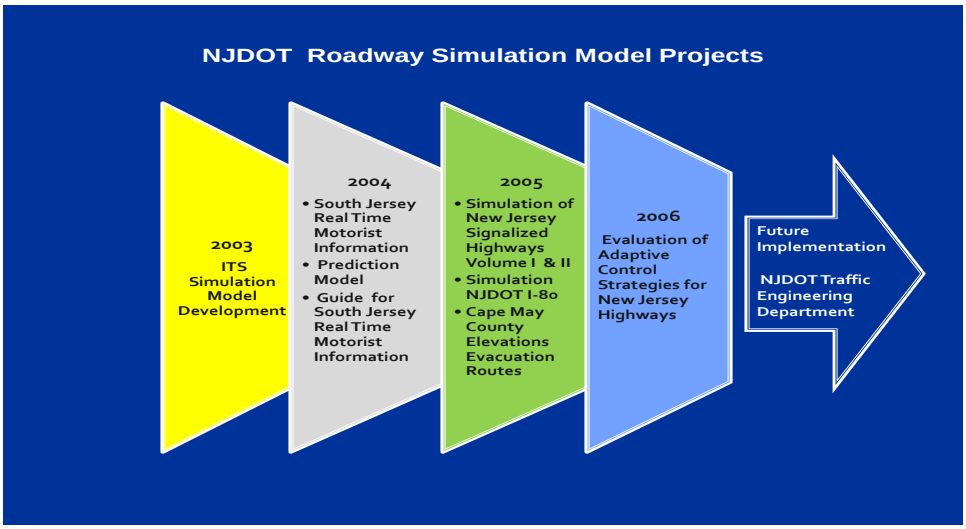
The research investment of $2.1 million resulted in improved time and efficiency on the job, as well as increased customer satisfaction with transportation services, but no identified cost savings. When examining the trends over time, these studies were critical due to the introduction of new technologies and best practices within the NJDOT organization. Several noteworthy events began in 2004: the introduction of Paramics applications at the NJDOT, development and piloting of roadway simulation model projects, and a review of the NCHRP 14-29 bridge specifications for applicability in New Jersey. A brief summary of the implementation results from the 2004 research projects is presented in the following section.

Paramics Software

The FHWA and many of the State DOTs have been using Paramics software for microsimulation applications. As the product use expands, there is a strong possibility that it may become a standard of the transportation industry in the future. In New Jersey, Kaan Ozbay pioneered the use of Paramics in 2003 to support reduction of congestion in South Jersey. In 2004, Paramics applications were used to conduct four studies on transit and highways issues. Later, this software was used in research studies on evacuation and value pricing of toll roads. The evacuation study of Cape May County is currently being featured as a national success story by the manufacturer.

Roadway Simulation Model Projects

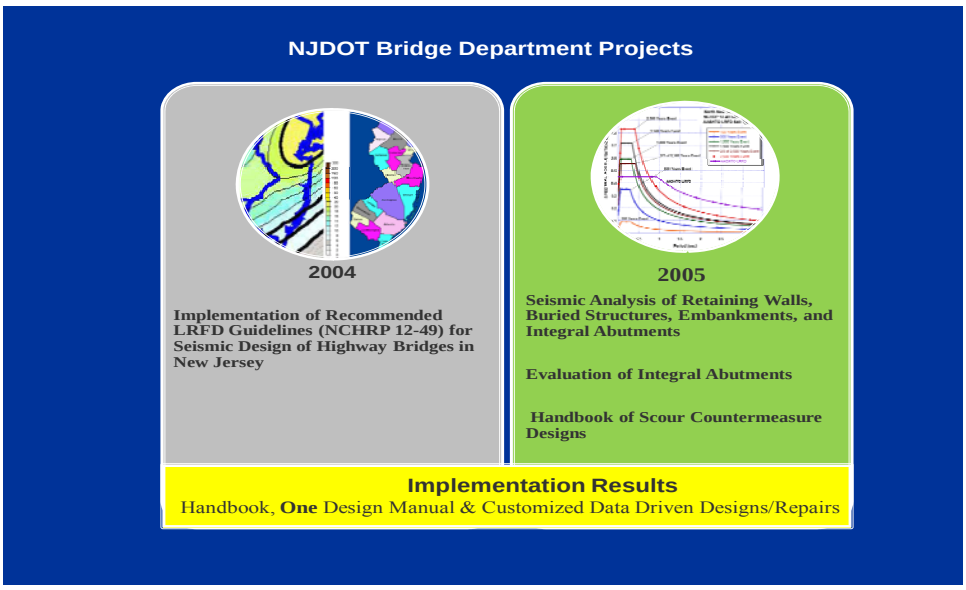
As mentioned, the trend of utilizing simulation and decision-making models for addressing the needs of NJDOT customers began in 2003 with the introduction of Paramics in New Jersey. During the following year, this research base expanded to include the use of other software programs, as well as three related studies on the South Jersey Real Time Motorist Information System. One year later, over 90% of all research projects included simulation and decision-making modeling as a research tool. Today, it is common practice to include a simulation models in most studies. Although the models are effective in proving the validity of research findings, the role of the champion is critical in gaining the required funding and administrative approval to implement the new product at the NJDOT, which is a long term effort that takes years to actualize.



NCHRP 14-29 Guidelines Evaluation Study

The NCHRP 12-49 guidelines were evaluated in 2004 to assess their impact on the seismic design of highway bridges in the State of New Jersey. Although cost savings were unable to be identified, the 2004 study recommended that the NJDOT support the new provisions in their present form. Aside from the fact that the new provisions were based on state-of-the-art knowledge and recent scientific developments, it was confirmed that the proposed new LRFD guidelines

did not necessarily result in higher seismic demands. Another important recommendation that was followed by the NJDOT was to develop design tools to facilitate and streamline the application of new analysis and design concepts under the NCHRP 12-49.



In 2005, three additional studies were requested by the NJDOT Bridge Department, in order to complete the development of one comprehensive design manual and a decision-making analysis model from their existing boring data base system. When considering seismic analysis of retaining walls, buried structures, embankments, and integral abutments, the research confirmed that the developed guidelines for seismic design of bridges in New Jersey are based on the design criteria from NCHRP 12-49 and are consistent with guidelines from other eastern states: New York and South Carolina. Two examples were showed transverse reinforcement requirements for large-diameter columns with heavy reinforcement in plastic hinge zones, which are higher in the new provisions compared to current AASHTO LRFD design. Also, the previously absent seismic design criteria and guidelines for abutments, retaining walls, embankments, and buried structure in New Jersey had been identified for inclusion in the manual.

The information gained from these projects did provide additional background needed for the successful development of one design manual and the completion of a geotechnical data management system on collective boring data analysis, which operates by county and zip code. In the future, this decision-making analysis system will provide accurate customized design and repair criteria on all projects by county and zip code. The technology transfer benefit for these important projects has been identified as enhanced efficiency and future cost savings for NJDOT.

Conclusion

The 2004 research results confirmed that savings were realized through changes in operating procedures and the introduction of new technologies to support several transportation agencies in the delivery of efficient services to the residents of New Jersey. The studies on congestion, motorized scooters, and human factors assisted policy makers and administrators in making educated decisions to enhance transportation practices. New and proven technologies were introduced to NJDOT customers to improve efficiency in maintaining the State's transportation infrastructure. Although this implementation study is based on a descriptive review of responses from the participating researchers and customers, further research needs to be done in order to quantify the full economic gains realized from such variables as knowledge transfer, reduction of labor and equipment costs, safety improvements, and reduction of congestion,

References

MVC (2006). Toward a Self-Service Model of Efficiency: New Jersey Motor Vehicle Commission Service Assessment, March 30, 2006.

NJDOT (2008). News Release: Governor Corzine Announces Congestion Relief on Route 17.

Saadeghvazin, A. (2004). Implementation of Recommended LRFD Guidelines (NCHRP 12-49) for Seismic Design of Highway Bridges in New Jersey.

ATTACHMENT A

Project Title:_____

FHWA Project Number_____ Start Date:_____ Completion Date:_____

Principal Investigator: _____ University/Consultant:_____

Bureau of Research Project Manager:_____ Customer/Unit:___ _____

Implementation Follow Up: 1 year ___ 2 year___ 3 year ___

Implementation/T2 Measure			**Est. Cost**	**Champion**	**Completion Date**
Knowledge Transfer	Findings/Report Dissemination	☐			
	Seminar	☐			
	Training	☐			
Marketing/Media	Brochure/Publication/article	☐			
	Electronic Media/Website	☐			
Policy/Procedure/Process Change	Admin/Process/Procedure Change	☐			
	Policy Change	☐			
	Specification/Standard Change	☐			
Demonstration	Pilot Project	☐			
Implementation Benefits					
Enhancement	Aesthetic	☐			
	Efficiency/Effectiveness	☐			
	Environmental	☐			
	Safety	☐			
Cost Savings/Economic Impact	Equipment	☐			
	Labor	☐			
	Materials	☐			
	Revenue Increase	☐			
	Safety	☐			
	Time	☐			
TOTAL					

How useful were the research findings/products/outcome? The research study resulted in:

☐implementable **changes** with **quantifiable benefits. Please Specify:**_____

☐implementable **changes** with **no quantifiable benefits. Please Specify:**_____

☐**knowledge** transfer with **no quantifiable benefits. Please Specify:**_____

☐no implementation. Explanation:_____

Can the Bureau of Research or NJ LTAP provide further assistance in implementing the findings of the study?
Yes ☐ No ☐ Comments: