Program Progress Performance Report for University Transportation Centers

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Project Title: NEXTRANS - Integrated and Sustainable Transportation Solutions: From Concepts to Deployment

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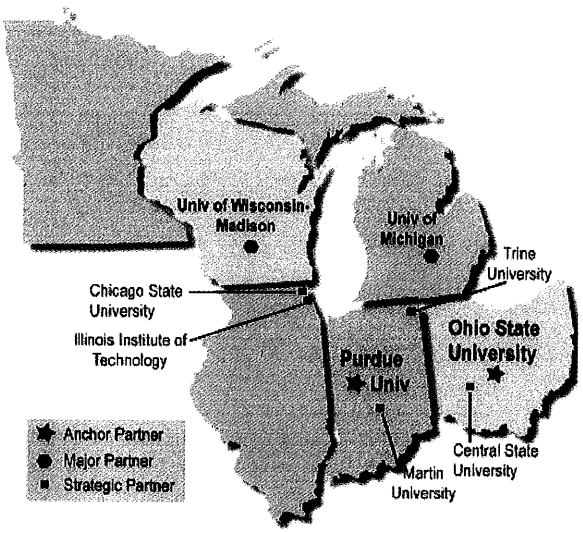

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Reporting Period End Date: December 31, 2012
Report Frequency: Semi-annual

Signed: _____
Rick D. Evans, Managing Director

PURDUE UNIVERSITY
Discovery Park

Major Goals
There have been no changes to program goals.

From July 1, 2012 to December 31, 2012, activities of the NEXTRANS Center focused on projects at Purdue University and The Ohio State University, anchor partners, and the Illinois Institute of Technology, strategic partner.

Purdue University Showcase Project – Driving Simulator Lab: Interactive Experiments and Modeling of Traveler Behavior to Address Mobility and Safety Needs

1: Accomplishments
What Was Accomplished
Major Activities

- Procurement of the driving simulator, high-performance computers, micro-simulation software and hardware for the Driving Simulator Lab.
- Assembly of driving simulator and integration with the hardware components.
- Driving simulator and software (SCANeR) training by the vendor.
- Driving simulator lab set up.
- Network selection for the experiments.
- Survey design for the planned experiments to understand the psychological effects of travelers under real-time information.
- Continued refinement in experiment design and planning.
- Initial network building in SCANeR for the experiments.
- Integration of AIMSUN traffic simulation software and SCANeR driving simulator software.
- Discussions on collaborations with real-time traffic information providers (INRIX, NAVTEQ) in terms of obtaining real-world data for the experiments.

Specific Objectives

- Establish and sustain the Driving Simulator Lab as infrastructure to conduct interactive experiments using travelers to perform research on driver behavior as well as policy and market aspects of Advanced Traveler Information Systems.
- Develop a comprehensive methodology to better assess the potential value of real-time information to travelers.
- Exploit synthetic driver choice behavior data to construct reliable quantitative models for evaluating Advanced Traveler Information Systems using performance measures beyond travel time benefits.
- Use archived interactive experiment data and the analytical models developed as educational materials to help graduate and undergraduate students better understand the present state-of-the-art in human performance modeling and related safety aspects.
- Use the Driving Simulator Lab platform to generate education modules to highlight various dimensions related to driver performance, behavior, and safety for middle and high school students.

Significant Results

- A point-based mechanism was designed with incentives and penalization to generate a realistic driving behavior setting for experiment participants.
- The network that will be replicated in the driving simulator was selected along with various origin-destination (O-D) pairs in the city of Indianapolis. Multiple routes from each O-D pair were finalized for map and terrain development in the driving simulator software.
- Survey design was conducted such that it can be performed on a portable device and is simple, yet sufficient to capture various explanatory variables.
- The finalization of the decision points for route choice information provision during each commute was accomplished during this period.
- In the experiments, different levels of familiarity need to be replicated. Familiarity will be at two levels: familiarity with the network or routes, and familiarity with the driving simulator. The experiments have been designed such that we avoid driving simulator familiarity bias and still create different levels of network familiarity levels for participants. It is important that the driving times for participants represent the realistic commute scenario in a network. Our objective is to make the commute time similar to average time spent by commuters in traffic. According to literature, we have found that 25 minutes is the national average commute time. Based on this, we have planned that the commute time under each experiment run, on average, is around 25 minutes.

Key Outcomes

- Driving Simulator Lab setup.
- Integration of micro-simulation software AIMSUN and the driving simulator software SCANeR.
- Detailed experiment design.
- Survey design.

Stated Goals Not Met

- Nothing to Report

<u>Training and Professional Development</u>

- Five graduate students are currently working on the project.
- We are hiring at-least four undergraduate interns (two under 10 month internships and two under NEXTRANS summer internship program) for helping in carrying out the experiments.
- Driving Simulator Training was provided to seven graduate students working at the NEXTRANS Center. A recording was made so that it can be used in the future by interns as well.

<u>Disseminating Results</u>

- Presented and published in conferences.
- Communicated the novelty of experiments and possible implications to stakeholders such as the private sector (NAVTEQ, INRIX) and public sector (state DOTs such as INDOT)

<u>Plans for Next Reporting Period</u>

- Network Building: The selected network of the Indianapolis city will be built in SCANeR software during the next reporting period.

- System Integration: The whole system, including the driving simulator, simulator software SCANeR, microscopic traffic simulation software AIMSUM, information provision peripheral equipment, supervision and monitoring devices, data collection and storage devices, will be integrated together.
- Information Provision Design: Multiple information provision mechanisms will be developed and available during the experiments to capture traveler response to different information provision mechanisms, as well as the decision-making process associated with aspects in information complexity, information accuracy, information adequacy, and information favorableness.
- Pilot Test: A key next step of the project is to conduct a pilot experiment on a sample population and to calibrate the experiment design and survey accordingly.
- Survey System Development: We will develop an on-line survey system for a mobile device platform that allows participants to access questionnaire easily and archives their answers automatically.
- Intern Hiring: We plan to hire four undergraduate interns for helping with the experiments, including development of relevant technical modules.
- IRB Approval: In next reporting period we plan to obtain an Institutional Review Board approval for the participation of human subjects in the experiments.
- Participant Selection and Recruitment: The next reporting period will also see participant selection and recruitment for the main experiments.

2: Products

Publications, Conference Papers, Presentations

- Sushant Sharma, Yu-Ting Hsu, Dong Yoon Song and Srinivas Peeta (2012), "Development of realistic behavior models for reliable assessments of benefits from real-time traveler information provision" In Proceedings Travel Behaviour Research: Current Foundations, Future Prospects 13th International Conference on Travel Behaviour Research, Toronto, Canada, July 2012
- Dong Yoon Song, Yu-Ting Hsu, and Srinivas Peeta (2012), "Value of travel information: implications for quality of travel experience" In Proceedings Travel Behaviour Research: Current Foundations, Future Prospects 13th International Conference on Travel Behaviour Research, Toronto, Canada, July 2012
- Dong Yoon Song, Yu-Ting Hsu, and Srinivas Peeta (2012), "Value of Travel Information: Exploring Psychological Effects of Real-Time Travel Information on Traveler Decision-Making Behavior", In Proceedings TRISTAN VIII, San Pedro de Atacama, Chile, June 2013 (submitted in 2012)
- Srinivas Peeta (2013) "Understanding the Psychological Effects of Real-Time Information for the Travel Experience and Related Performance Measures" , Session 160: Impact of Information on Decisions, Choices, and Behaviors of Travelers (Workshop) sponsored by the TRB Use Information Systems committee (AND20) at 92nd Annual TRB Meeting, Washington DC, January, 2013

3: Participants & Collaborating Organizations

- Nothing to Report.

4: Impact

What is the impact on the development of the principal discipline(s) of the program?

- Nothing to Report.

What is the impact on other disciplines?

- Nothing to Report

What is the impact on the development of transportation workforce development?

- Graduate students were provided the opportunity to work in the Driving Simulator Lab that can lead to multiple dimensions of possible research in the area of traveler behavior and safety.
- Internship opportunities are available for undergraduate students to work in the Driving Simulator Lab.

What is the impact on physical, institutional, and information resources at the university or other partner institutions?

- The Driving Simulator Lab setup is a state-of-the-art facility at the NEXTRANS Center, Purdue University. The advanced driving simulator has the unique capability of replicating/mapping a large city network and creating ambient traffic via integration to micro-simulation software (AIMSUN). This is one of the most advanced driving simulator labs for understanding driver response to real-time information provision across many dimensions that have not been previously addressed in a research setting but have key implications for safety and effectiveness of information in the real world. With its advanced features, the driving simulator provides a robust and realistic driving experience for drivers. The driving simulator is connected to three high-performance computers and other hardware components such as webcams, video capturing devices and high definition multi-media displays. The Driving Simulator Lab represents a unique physical and institutional resource.

What is the impact on technology transfer?

- The results from this study will provide government and public sector transportation agencies an assurance that they are targeting their limited funds toward technologies that are most likely to improve the nation's highway system and deliver maximum benefit to travelers. This study will help traffic information service providers and investment decision-makers in understanding the value of real-time information and traveler behavioral response to it. Also, it will help in deciding the content and amount of information necessary for travelers to make informed and effective routing decisions.
- The ability to explicitly quantify the human behavior dimension provides a broader set of performance measures to public/private sector stakeholders relative to the evolution of the traveler information services market.

What is the impact on society beyond science and technology?

- The study will help in developing a comprehensive understanding of the mechanism in which more benefits can be derived from real-time traffic information systems. This study can lead to direct benefits to the individual travelers, as it facilitates the design of personalized traffic information that can help commuters choose their routes based on their psychological benefits (which link to the quality of travel experience) in addition to travel time savings.

5: Changes/Problems

Changes in approach and reasons for change

- Nothing to Report.

Actual or anticipated problems or delays and actions or plans to resolve them

- Nothing to Report.

Changes that have a significant impact on expenditures

- Nothing to Report.

Significant changes in use or care of human subjects, vertebrate animals, and/or biohazards

- Nothing to Report.

Change of primary performance site location from that originally proposed

- Nothing to Report.

6: Special Reporting Requirements

- Nothing to Report.

The Ohio State University Showcase Project - Campus Transit Laboratory: Infrastructure for Research, Education, and Outreach

1: Accomplishments

What Was Accomplished

Major Activities

- Continued collecting directly observed passenger origin-destination (OD) flows
- Summarized directly observed OD flows for stakeholders and research efforts
- Continued processing automatic vehicle location (AVL) data to determine bus cycle times, stop-to-stop travel times, dwell times, and headways
- Summarized bus cycle times, stop-to-stop travel times, dwell times, and headways for stakeholders and research efforts
- Investigated bus cycle times, stop-to-stop travel times, dwell times, and headways to evaluate impacts of infrastructure changes
- Continued processing automatic passenger counter (APC) data
- Summarized APC data for stakeholders and research efforts
- Used software previously developed to capture real-time predictions of bus arrival times at stops and to match them with actual arrivals
- Evaluated the quality of real-time predictions of bus arrival times
- Continued investigating responses to web-based surveys of community perceptions and travel patterns related to a technology-enhanced bus transit service
- Continued developing a website that describes Campus Transit Lab (CTL) related activities
- Developed and implemented CTL-based education modules in two courses

Specific Objectives

- Sustain, develop, and showcase the CTL as a living lab infrastructure supporting research, education, and outreach
- Archive and process data on passenger flows, vehicle locations, and community perceptions and travel patterns related to a technology-enhanced transit service
- Exploit CTL to develop seed research investigations, modules for coursework, training of students in data collection, and focused studies of immediate interest to service operators

- Develop collaborations with transit agencies and other investigators based on CTL-related activities

Significant Results

- Observed OD flow data were collected and summarized. Summaries were presented to service operator for planning purposes. Results were also provided to researchers evaluating the performance of OD estimation models.
- AVL data were transformed into summaries of bus operations. Summaries were presented to service operator for planning purposes. Results were also used to begin assessing the impact of infrastructure changes on bus operations.
- Data on predicted bus arrival times were captured and matched to actual arrival times. Results were used to begin investigating quality of arrival time predictions as a function of time-of-day and bus route.
- Web-based survey results were used to document significant positive impacts of the provision of real-time passenger information systems on both users and non-users.
- Implementing CTL-based education modules appeared to have a positive impact on the quality of the two courses, one large undergraduate introduction to transportation course and another advanced graduate course. These course modules have attracted undergraduate students to engage in CTL related activities and introduced CTL-related activities to non-transit focused graduate students.

Key Outcomes

- Dissemination of CTL-related research results further established CTL as a platform that supports the development of new research ideas.
- The scope of a multi-agency research project motivated by CTL activities was developed.
- CTL was highlighted during a site visit by a Federal Transit Administration representative.
- A CTL graduate research associate was selected to participate in the 2013 International Road Federation Scholar Program.

Stated Goals Not Met

- Nothing to Report

<u>Training and Professional Development</u>

- Seven graduate and four undergraduate students regularly collected transit onboard surveys.
- Ten graduate students regularly processed and analyzed automatically collected data.
- Eighty-six undergraduate students learned about state-of-the art transit automated data collection and uses of processed data through CTL examples in a classroom setting. Six graduate students developed skills for analyzing and interpreting transit automatically collected data in a classroom setting.
- Seven graduate students attended two international transit webinars using CTL facilities.

<u>Disseminating Results</u>

- Wrote, submitted, and published journal and conference proceedings papers
- Prepared and presented technical results at meetings and conferences
- Communicated pertinent results to transit stakeholders through reports and meetings
- Communicated overall activities and results to university donor and university development personnel
- Communicated overall activities to Federal Transit Administration representative

<u>Plans for Next Reporting Period</u>

- Data collection: Automatic vehicle location (AVL), automatic passenger counter (APC), predicted and actual bus arrival times, OD flows, additional community perceptions and travel patterns if desirable
- Research: Manual, web-based, and automatic data-driven investigations to generate research hypotheses
- Education: Ongoing and new uses under new semester-based curriculum
- Outreach and communication: With transit agencies, general website based dissemination, and articles and presentations

2: Products

Publications, Conference Papers, Presentations

- McCord, M.R., Mishalani, R.G., and Hu, X., 2012. Grouping of Bus Stops for Aggregation of Route-Level Passenger Origin-Destination Flow Matrices. Transportation Research Record: Journal of the Transportation Research Board, No. 2277, pp. 38-48, 2013. Status of publication (published), acknowledgment of federal support (yes).
- Ji, Y., Mishalani, R.G., McCord, M.R., 2012. Transit Route-level Passenger Origin Destination Flow Estimation: Empirical Evaluation of a Heuristic Expectation Maximization Methodology. Proceedings of the 12th Conference on Advanced Systems for Public Transport, Santiago, Chile. Status of publication (published), acknowledgment of federal support (yes).
- McCord, M.R., and Mishalani, R.G., The OSU Campus Transit Lab (CTL) and Transit-related Activities at The Ohio State University. Presentation to Federal Transit Administration representative, The Ohio State University, Columbus, OH, August 27, 2012.
- Ettefagh, M., Effect of Passenger Information System (TRIP) on OSU Travelers' Attitudes and Perceptions. Presentation to OSU donor and development personnel, The Ohio State University, Columbus, OH, September 24, 2012.
- Hertler, G., Factors Affecting Intra-Campus Origin Destination Passenger Flows. Presentation to OSU donor and development personnel. The Ohio State University, Columbus, OH, September 24, 2012.
- McCord, M.R., and Mishalani, R.G., Campus Transit Lab (CTL): Introduction to Select Activities and Institutional Updates. Presentation to OSU donor and development personnel, The Ohio State University, Columbus, OH, September 24, 2012.
- Reinhold, H., Combining Route-specific OD Flows into an Integrated OD Flow Matrix. Presentation to OSU donor and development personnel, The Ohio State University, Columbus, OH, September 24, 2012.
- Ji, Y., Mishalani, R.G., McCord, M.R., 2012. Transit Route-level Passenger Origin Destination Flow Estimation: Empirical Evaluation of a Heuristic Expectation Maximization Methodology. Presentation at the 12th Conference on Advanced Systems for Public Transport, Santiago, Chile, July 2012.

Websites

- A website is under development. It includes, among other things, activities and results from this project.

Technologies or Techniques

- Commercial-grade state-of-the practice automatic vehicle location technologies, passenger information systems, and automatic passenger counter technologies implemented on an operational bus service provide data that are regularly downloaded and stored.

Data, Databases

- Databases that include bus location, position, and speed data, predicted and actual bus arrival data, bus passenger boarding and alighting data, estimated and observed bus passenger origin-destination flows, and community transit-related perceptions, attitudes, and mobility patterns are developed.

Physical collections

- Bus passenger origin-destination flows are manually collected.

Software, NetWare

- Various software for archiving, processing, and analyzing the rich and large datasets collected through the Campus Transit Lab are developed.

Models

- Models to estimate bus passenger origin-destination (OD) flows from passenger boarding and alighting data and related components needed to use summary OD flow information appropriately are developed, refined, and tested.

Educational aids or curricula

- Data obtained from the CTL, as well as the physical infrastructure, continues to be used in a variety of transportation and civil engineering courses. Hands-on experience in transit data collection is provided to graduate and undergraduate students associated with the project. Experience with practical transit planning and operations issues is provided to our graduate students through the outreach activities.

Instruments or Equipment.

- Work with bus service operators continues to maintain the sensing equipment on the bus fleet, the storage of data on the buses, the communication of the data to the server, the accompanying software to manage these processes, and the real-time passenger information system.

3: Participants and Collaborating Organizations

The Ohio State University Department of Transportation and Traffic Management
Columbus, Ohio
Partner's contribution to the project:

- Financial support
- In-kind support
- Facilities
- Collaborative research

Clever Devices
Woodbury, New York
Partner's contribution to the project:

- In-kind support

Other Collaborators

- Nothing to Report

4: Impact

What is the impact on the development of the principal discipline(s) of the program?

- Nothing to Report

What is the impact on other disciplines?

- Nothing to Report

What is the impact on the development of transportation workforce development?

- Graduate and undergraduate students participating in the project were provided with the opportunity to conduct transit-related research.
- Three female graduate students and two female undergraduate students participated in the project.
- CTL material was used in an 86-student course in transportation engineering and analysis and a 6-student course in dynamic transportation management.

What is the impact on physical, institutional, and information resources at the university or other partner institutions?

- The Ohio State University Campus Transit Lab is a unique living laboratory that has been and will continue to be used for research, education, and outreach. This project makes a major contribution toward providing the physical and human resource infrastructure required to develop, sustain, and take advantage of the laboratory.
- CTL results in the amassing of large datasets relating to transit passenger flows, transit vehicle operations, passenger information systems, and transit user and non-user perceptions and attitudes towards transit services.

What is the impact on technology transfer?

- Amassed data are already leading to results of research and practical value that are communicated via presentations and publications. Ways to possibly broaden this communication will be explored.
- Among other things, this project seeks to make methods to estimate bus passenger origin-destination flows from boarding and alighting data and other derived uses of automatic passenger counter and automatic vehicle location data available to transit agencies and planning organizations.

What is the impact on society beyond science and technology?

- Nothing to Report

5: Changes/Problems

Changes in approach and reasons for change

- Nothing to Report

Actual or anticipated problems or delays and actions or plans to resolve them

- Nothing to Report

Changes that have a significant impact on expenditures

- Nothing to Report

Significant changes in use or care of human subjects, vertebrate animals, and/or biohazards

- Nothing to Report

Change of primary performance site location from that originally proposed

- Nothing to Report

6: Special Reporting Requirements

- Nothing to Report

Illinois Institute of Technology Project – Signal Timing Optimization for Large-Scale Urban Networks under Dynamic Traffic

1: Accomplishments

What Was Accomplished

Major Activities

- Literature review of the current models for traffic signal timing optimization was completed

Specific Objectives

- As above

Significant Results

- Nothing to Report

Key Outcomes

- Details of the limitations of the current models for traffic signal timing optimization were identified and summaries in the literature review report

Stated Goals Not Met

- Nothing to Report

Training and Professional Development

- The graduate research assistant appointed to this research study gained experience on traffic timing plan design models and field deployments.

Disseminating Results

- The literature review findings were circulated within the 50+ transportation engineering graduate students at IIT.

Plans for Next Reporting Period

- Collection of traffic signal timing designs deployed in the field from city of Chicago Department of Transportation.

2: Products

- Nothing to Report

3: Participating and Collaborating Organizations

City of Chicago, Department of Transportation

Chicago, Illinois

Partner's contribution to the project:

- In-kind support of city of Chicago's traffic signal timing design procedure, field deployed signal plans, and traffic counts

Other Collaborators

- Nothing to Report

4: Impact

What is the impact on the development of the principal discipline(s) of the program?

- The current models for traffic signal timing optimization were well understood, their limitations were explicitly identified.

What is the impact on other disciplines?

- No product of the proposed work has been developed so far.

What is the impact on the development of transportation workforce development?

- Sharing the literature findings of the current models for traffic signal timing optimization within the 50+ graduate students in the transportation engineering program at IIT has added to their new body of knowledge in traffic operations management.

What is the impact on physical, institutional, and information resources at the university or other partner institutions?

- Information resource

What is the impact on technology transfer?

- Nothing to Report

What is the impact on society beyond science and technology?

- Nothing to Report

5: Changes/Problems

Changes in approach and reasons for change

- Nothing to Report

Actual or anticipated problems or delays and actions or plans to resolve them

- Nothing to Report

Changes that have a significant impact on expenditures

- Nothing to Report

Significant changes in use or care of human subjects, vertebrate animals, and/or biohazards

- Nothing to Report

Change of primary performance site location from that originally proposed

- Nothing to Report

6: Special Reporting Requirements

Respond to any special reporting requirements specified in the award terms and conditions, as well as any award specific reporting requirements.

- Nothing to Report