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This publication is a report of transportation research, education, and technology transfer activities of the NEXTRANS Center from October 1, 2009 through September 30, 2010.

Written and Designed by Andrea McIntyre, Current NEXTRANS Center Communications Coordinator
Excerpts from Jessica Mehr, Former NEXTRANS Center Communications Coordinator
In recent years, the strategic nature of the role of transportation to addressing key emerging national challenges is becoming increasingly apparent. In addition to efficient mobility, enhanced safety, and security in moving people and goods, solutions provided in the transportation domain have fundamental implications for fostering energy security and mitigating the adverse impacts related to climate change. The NEXTRANS Center has sought to explore these issues through holistic solutions that seek multimodal, intermodal, and multi-jurisdictional and/or regional strategies that, further, leverage existing transportation resources. This philosophy is reflected in the Center's ongoing activities related to research, education, and technology transfer, which I am pleased to present as part of the 2010 NEXTRANS Center Annual Report.

In research, the Center recently funded 17 new projects after an external peer review process (see pages 34-37). They address the Center's mission of seeking integrated solutions using intermodal, multimodal, and regional perspectives, span a range of modes (air, public transit, rail, road, and trucks), leverage technology to develop innovative solutions, and foster international collaborations. Following along the lines of previously funded projects with a regional outlook, ranging from the transportation economics of ethanol-based biofuels to on-demand air service, the newly funded projects include studying the regional economic impacts of bypasses, and analyzing the viability of high speed rail in a regional multimodal transportation planning context. Other projects focus on improving infrastructure in the pavement and rail domains.

The need for a well-prepared workforce that can respond to the complex and multidimensional challenges associated with transportation in the 21st century has taken the centerstage in the national discourse among various stakeholders. By imparting a formal holistic perspective to problems addressed through the research projects, the Center is preparing students to respond to current and future transportation challenges by ensuring that they receive the appropriate skillsets.

Over the past year, our Center funded a number of graduate students; expanded the role of the Illinois Institute of Technology (see page 46); added an undergraduate internship in transportation communications (see page 45); and continued our successful Undergraduate Summer Internship in Transportation and Indiana High School Essay Competition programs.

As part of our technology transfer activities, the NEXTRANS Center hosted transportation experts through our seminar series, conducted an international conference, and participated in several transportation-related conferences and events. In November 2009, the Center held an international conference titled, "In Step, In Line, On
As we embark on our fourth year of operation, we will strive to further address national and regional goals related to safety, economic recovery, reduced congestion, global connectivity, and the environment. I would like to thank NEXTRANS students, faculty, staff and our partners from government, academia, and the private sector, for their dedication to the Center activities. The Center is always seeking new ideas and collaborative partners; we welcome your thoughts and participation as we begin another exciting year.

Srinivas Peeta, Ph.D.
NEXTRANS Center Director
Professor of Civil Engineering, Purdue University
The NEXTRANS Center is one of ten Regional University Transportation Centers selected competitively by the U.S. Department of Transportation to serve as leaders in meeting the nation's need for safe, efficient, and environmentally-responsible transportation systems. Headquartered at Purdue University in West Lafayette, Indiana, the Center represents Region V, which includes the states of Indiana, Illinois, Ohio, Michigan, Wisconsin and Minnesota. NEXTRANS was established in 2007 based on an award from USDOT’s Research and Innovative Technology Administration (RITA), in order to implement a multidisciplinary program of transportation research, education, and technology transfer.

The NEXTRANS Center is led by Purdue University, and administered by Purdue University’s Discovery Park. Its major university partners are University of Illinois at Urbana-Champaign (UIUC) and The Ohio State University (OSU). The Center’s strategic partners are Illinois Institute of Technology (IIT), Wayne State University (WSU), and the University of Wisconsin - Platteville (UWP). Indiana University Purdue University at Indianapolis (IUPUI) is NEXTRANS’ institutional resource partner. Programmatic partners include the Mid-American Transportation Center (Region VII Regional University Transportation Center), National Cheng Kung University’s Department of Transportation and Communication Management Science (Taiwan), Koc-IBM Supply Chain Research Center at Koc University (Turkey), and National Dong Hwa University’s Graduate Institute of Global Operations Strategy and Logistics Management (Taiwan).

Non-university partners of the Center include the Indiana DOT (INDOT), Illinois DOT (IDOT), Illinois State Toll Highway Authority, Chicago DOT, Ports of Indiana, Consulate General of Canada-Detroit, and Crawfordsville High School. Navteq, Ferrovial Group, Delphi, Sem-Materials, Conexus Indiana, the Great Lakes Manufacturing Council, the Association of American Railroads, Transportation Technology Center Inc., Clever Devices, Inc., and Central Indiana Corporate Partnership (CICP) are among the NEXTRANS Center’s current private sector partners.
The theme of the NEXTRANS Center is to develop integrated and innovative solutions to transportation challenges, with some emphasis on intermodal freight transportation, to address regional needs and economic opportunities. In working towards these solutions, NEXTRANS recognizes that transportation goals such as mobility, safety, and infrastructure renewal are not disconnected from one another; they are fundamental elements of a seamless, sustainable, and efficient transportation system.

Because our nation’s transportation problems consist of interdependent components, NEXTRANS believes in integrated solutions. These solutions can be integrated across modes (auto, transit, freight, air, rail, and marine), sectors (public and private), or geography (within the Midwest and for the entire nation). They are innovative in that they seek to leverage technology, disparate data sources, limited resources, public-private partnerships, and novel financing strategies. Most importantly, NEXTRANS works towards these solutions by explicitly capturing the interactions between vehicle, traveler, and infrastructure. By implementing this holistic approach, NEXTRANS aims not only to develop integrated solutions, but to foster a new generation of paradigms and a highly qualified transportation workforce.
MEETING NATIONAL & REGIONAL CHALLENGES

MOBILITY
Poor mobility has long-term environmental consequences, creates transportation choke points in the national economy, and reduces U.S. global competitiveness. Because congestion is fast outpacing the rate of infrastructure investment, the NEXTRANS Center strives to leverage technology and existing infrastructure to improve traffic management and provide congestion relief. Recent NEXTRANS projects have aimed to improve traffic flow in congested intersections; utilize information technologies to improve traffic management; apply innovative technologies to measure travel-time reliability; study the feasibility of dynamic congestion pricing; expand the idea of a commercial on-demand air service; and quantify the value of real-time traffic information for travelers.

SAFETY
In early September 2010, the United States Department of Transportation released promising new figures; highway deaths fell to 33,808 in 2009, the lowest number in 60 years. This decline in fatalities occurred even as vehicle miles traveled continues to increase. NEXTRANS aims to be a leader in continuing this trend of improving safety in our nation’s transportation systems. Since research can directly link safety to congestion and poor infrastructure, NEXTRANS seeks an integrated approach to safety concerns while keeping in mind the interaction between vehicle and driver. Recent projects have aimed to integrate safety with mobility and infrastructure goals; improve work zone safety; and further the exploration of the relationship between safety and technology, which can cause driver distractions as well as prevent collisions through active safety paradigms.
INFRASCTURE RENEWAL
The American Recovery and Reinvestment Act of 2009 highlighted the critical need for infrastructure renewal and maintenance in the U.S. By upgrading our highway, rail, air, and sea transportation systems, we can reduce congestion and improve safety, while at the same time lowering freight transportation and energy costs. Recent NEXTRANS projects have aimed to promote sustainability by evaluating pavement properties, damage, and failure mechanisms; utilize advanced visual sensing technology to improve railroad track inspection; help agencies make efficient investment decisions; study the impacts of bypasses on communities; develop new models for public-private partnerships; and improve infrastructure longevity.

REGION V
NEXTRANS has identified an efficient intermodal freight transportation system as a major regional need. Recent NEXTRANS projects with particular regional significance have aimed to efficiently monitor, assess, and manage multimodal freight transportation systems; as well as develop models for collaboration between small- to medium-sized trucking firms. In addition to outreach programs already in place, NEXTRANS’ expanded relationship with the Illinois Institute of Technology will help women and underrepresented students attain the education needed to join the highly-skilled transportation workforce in the Midwest. Also, the economic vitality of Region V was an important focus when NEXTRANS hosted an international conference related to the U.S.-Canada border.
INNOVATIVE PARTNERSHIPS

The holistic solutions proposed by NEXTRANS require not only a new generation of paradigms and research, but a new generation of partnerships that leverage the resources of different transportation stakeholders through a more integrated approach. In the delivery of its research, education, and outreach programs, NEXTRANS relies on innovative partnerships that optimize the utilization of available resources and maximize outcome value.

Rather than relying on one partnership model, NEXTRANS uses an open architecture that is based on commonality of goals, comparative advantages, and emerging opportunities. These partnerships can be at the local, regional, national, and global level; with other universities, UTCs, or research centers; with the private sector, public sector or non-profit organizations; in the areas of research, education or outreach (see Figure 3 on page 9).

In research, NEXTRANS uses a variety of project types in forming partnerships with state departments of transportation. Depending upon the project components and fund distribution, these projects are categorized as joint, interlocking or supplemental. The resources being shared are also varied and can include items such as actual cash, in-kind, data, and equipment. Finally, these partnerships are not static or limited to some timeframe of a project’s lifetime; they are ongoing, dynamic and interactive.

By fostering these innovative partnerships, NEXTRANS is able to collaborate on research to meet shared goals, maximize its resources, utilize innovative technologies and practices, and create a higher value for research results through efficient technology transfer.
• Research  
  (Univ. of Illinois at Urbana-Champaign)
• Education  
  (Univ. of Wisconsin-Platteville)
• Technology Transfer  
  (Illinois LTAP)
• Outreach  
  (Transportation and Highway Engineering (THE) Conference)

• Actual Cash  
  (Canadian Government)
• In-Kind  
  (Wayne State University)
• Equipment  
  (The Ohio State University)
• Data & Information  
  (Clever Devices, Inc.)

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Figure 3: Innovative Partnerships
The Center Director is responsible for overall Center operation. He directs programs and activities, implements the Center's Strategic Plan, manages funds, ensures compliance with UTC Program requirements, and oversees Center Staff and Research Associates. The Director reports to the Executive Director of Purdue's Discovery Park, which provides administrative and fiduciary oversight on behalf of Purdue University. The Director also chairs the Center's Executive Committee, and administers the Center with the guidance of the NEXTRANS Advisory Council.

**Figure 4: Management Structure**
EXECUTIVE COMMITTEE

The seven-member Executive Committee sets strategy, approves budgets and makes final decisions on Center project funding. It is chaired by the NEXTRANS Director and includes Co-Directors from OSU and UIUC.

Srinivas Peeta  
NEXTRANS Director  
Professor of Civil Engineering, Purdue University

Ray Benekohal  
NEXTRANS Co-Director  
Professor of Civil and Environmental Engineering, University of Illinois at Urbana-Champaign

Rabi Mishalani  
NEXTRANS Co-Director  
Associate Professor of Civil and Environmental Engineering, The Ohio State University

Mark McCord  
Professor of Civil Engineering / City and Regional Planning, The Ohio State University

Erol Tutumluer  
Professor of Civil and Environmental Engineering (CEE) and the Paul F. Kent Endowed Faculty Scholar, University of Illinois at Urbana-Champaign

John Schneider  
Assistant Vice President for Industry Research, Purdue University

Darcy Bullock  
Professor of Civil Engineering, Purdue University  
Director, Joint Transportation Research Program
ADVISORY COUNCIL

The Advisory Council provides strategic and programmatic guidance for the NEXTRANS Center. It fosters vital links between the Center and the transportation community at large, and ensures that activities and goals are synergistic with regional and national needs and of value to the stakeholders.

James P. Stark, Deputy Commissioner, Indiana Department of Transportation - Chair
Ruben L. Anthony, Jr., Deputy Secretary, Wisconsin Department of Transportation
Randall S. Blankenhorn, Executive Director, Chicago Metropolitan Agency for Planning
Rich Cooper, Chief Executive Officer, Ports of Indiana
Bruce Cox, Vice President and Chief Technology Officer, TransWorks
John C. Friend, Engineer, Bureau of Highway Delivery, Michigan Department of Transportation
Thea Graham, Ph.D., Manager, Strategy, Operations Planning Services, Federal Aviation Administration (FAA)
Howard Hayes, Senior Vice President, NAVTEQ Traffic
Richard Kowalewski, Senior Policy Advisor, Pipeline and Hazardous Materials Safety Administration (PHMSA)
Walter Kulyk, Director, Office of Mobility Innovation, Federal Transit Administration (FTA)
David L. Lippert, Engineer, Materials and Physical Research, Illinois Department of Transportation
Brian Majeska, Partner, Majeska and Associates
Fidel Saenz de Ormijana, Ph.D., Technical Director, Ferrovial Agroman US Corp
Robert F. Tally, Jr., Division Administrator, FHWA Indiana Division

CENTER STAFF

From left:
Sushant Sharma, Ph.D., Research Associate
Rick Evans, Managing Director
Nija Phelps, Secretary
Andrea McIntyre, Communications Coordinator
Lili Du, Ph.D., Research Associate
Srinivas Peeta, Ph.D., Director
As the new Chairman of the NEXTRANS Center's Advisory Council, I look forward to partnering with a prestigious group of transportation leaders as we further the region's role as a national leader in freight mobility.

It is incumbent upon us, as transportation leaders, to recognize that the growth of our economy is largely driven by the efficient movement of goods and services. Technical knowledge and resources will need to be shared in an effort to address the challenging issues that face our region and the nation.

As the next highway reauthorization act is debated at the national level, we recognize the importance of renewing the NEXTRANS Center's charter as one of ten Regional University Transportation Centers. To help further this goal, communication, collaboration, and coordination on research needs and funding opportunities will need to strengthen between academia, government, and the private sector.

In our current state of economic rebuilding, opportunities to enhance transportation services and efficiencies for taxpayers abound. I believe that together we can make a difference.

James P. Stark
Deputy Commissioner, Indiana Dept. of Transportation
Chair, NEXTRANS Advisory Council
FINANCIAL REPORT

Expenditures by Partners 2009-2010

- Purdue University 74%
- Federal 33%
- State 42%
- Institution & Others 25%
- Programs & Outreach 15%
- Research & Education 73%
- Center Administration 12%
- Major Partners (OUS & UIUC) 25%
- Minor Partner (WSU) 1%

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NEXTRANS HOSTS CONFERENCE ON U.S. - CANADA BORDER CHALLENGES

On November 16, 2009, the NEXTRANS Center, with the assistance of the Government of Canada/avec l'appui du gouvernement du Canada and Access Technology Across Indiana, hosted a conference at Purdue University titled, "In Step, In Line, On Time: Regional Strategies for Trade, Security, and Mobility Challenges at the U.S. - Canada Border."

The conference provided a unique opportunity for guests from the U.S. and Canadian diplomatic missions, Transport Canada, and U.S. Department of Transportation to engage in dialogue with private-sector stakeholders and researchers. Focusing on the Great Lakes Region, the event helped NEXTRANS meet its charge as a Regional University Transportation Center by addressing the area’s need for an efficient intermodal freight transportation system. It also supported the Center’s mission of developing integrated solutions and fostering innovative partnerships.

The day-long event featured many speakers from a variety of organizations. The conference was divided into sessions, each focusing on important characteristics of the U.S. - Canada border and its importance to both countries. Each nation serves as the other’s top export market and approximately 7.1 million U.S. jobs directly or indirectly depend on U.S. - Canadian trade.

Session topics included: trade and security; gateways and corridors; industry wants and agency needs; and border performance, governance, and research. The last session, a "wrap-up" of the day’s events concluded the conference. Moderated by NEXTRANS Co-Director Ray Benekohal, the session summarized the day in the following key points:

- Trade and security are not inherently opposed.

"Getting security right" should help promote trade and mobility across the border.

- Possible solutions to border challenges include better risk assessment, pruning redundancies, harmonizing standards, developing better bi-national policy linkages, and fostering stronger state/province involvement.
- Infrastructure funding will continue to present a challenge. High federal deficits mean that future decisions may have to be made in the context of fiscal restraint.
- Trusted traveler and shipper programs such as NEXUS and FAST may represent one of the most important tools for reducing delays and uncertainty at the border; however, improving participation in these programs may require infrastructure investment (extending dedicated FAST lanes) or government subsidies.
• The decrease in trade as a result of the recession may be masking previous border issues that will recur as the economy and Canada - U.S. trade recover. One looming question is how cross-border automotive shipments will recover as the industry comes out of its current crisis.

• Academia should strive to provide "knowledge for action," which can help policymakers make well-informed decisions. At the same time, researchers should exercise their freedom to be visionary, without worrying about the "bottom line."

In addition to the sessions, a networking break featured exhibitor booths. Presenters included the Michigan Department of Transportation, Transport Canada, The Ohio State University, NEXTRANS, Purdue Center for Visual Analytics for Command, Control and Interoperability Environments (VACCINE), and Access Technology Across Indiana (ATAIN).

The keynote address of the day was given by Gregory Nadeau (Deputy Administrator, Federal Highway Administration). Nadeau touched on a number of topics, including the Highway Trust Fund, American Recovery Act and Reinvestment Act, and current FHWA-funded projects.

The NEXTRANS Center would like thank everyone who helped to make the conference an engaging dialogue between stakeholders within and beyond the Great Lakes Region. The Center would especially like to thank the conference steering committee, which was Co-Chaired by David Franklin (U.S. - Canada Border Coordinator, Federal Highway Administration), Daniel McGregor (Senior Policy Advisor, Transport Canada), and Mahmud Farooque (former NEXTRANS Managing Director).
Peter H. Appel, Administrator of the U.S. Department of Transportation’s Research and Innovative Technology Administration (RITA), visited the NEXTRANS Center on August 19, 2010.

Director Srinivas Peeta opened the day with an overview of the Center’s recent research, technology transfer, and educational activities. Professor Mark McComb, NEXTRANS Executive Committee member, of The Ohio State University (Columbus, Ohio), presented findings from his NEXTRANS-funded project, Smart Campus Transit Laboratory for Research and Education.

Following presentations from Director Peeta and Professor McComb, Mr. Appel and NEXTRANS affiliates and staff members toured Purdue University’s Discovery Park facilities. Mr. Appel also toured the Harold L. Michael Traffic Operations Laboratory, provided by Professor Darcy Bullock (Purdue).

Several NEXTRANS researchers made presentations on their projects to Mr. Appel for discussion. Graduate student Josh Mills showcased his work with Professor Jon Fricker (Purdue) on the economic impact of bypasses on communities. Research Associate Sushant Sharma presented research on quantifying the benefits of real-time traffic information to commuters that can be used to leverage public sector investment with private sector participation required for fruition of the USDOT’s IntelliDrive program vision.

To conclude the presentations, Associate Professor Daniel DeLaurentis (Purdue University), introduced a NEXTRANS project exploring on-demand air service (ODAS). Professor DeLaurentis and Director Peeta are co-investigators on the project, exploring multimodal resources (air and ground), transportation policies, and economic variables.

During a luncheon, Mr. Appel answered questions from NEXTRANS faculty and staff and addressed priorities of the U.S. Department of Transportation and RITA. He emphasized the importance of technology transfer as a vital step in the research process.
2010 WORKFORCE DEVELOPMENT HIGHLIGHTS

As a Regional University Transportation Center, NEXTRANS aims to be a leader in attracting and preparing students to be part of a highly-skilled 21st century transportation workforce. In addition to providing graduate students with experiential learning opportunities, the Center strives to attract new students to the field of transportation, as well as enhance the skills of current practitioners. In 2010, the Center’s existing educational and outreach programs continued with success. In the coming year, the Center plans to expand these programs as part of an ongoing effort to assist in the creation of a highly-skilled transportation workforce.

- Partnered with the Illinois Institute of Technology (IIT) to attract women and underrepresented high school students to the field of transportation through a hands-on internship experience at IIT’s Chicago campus.

- Successfully completed the second Undergraduate Summer Internship in Transportation. This program allowed six competitively-selected students the opportunity to work with NEXTRANS-affiliated researchers at Purdue University, the University of Illinois at Urbana-Champaign, and The Ohio State University.

- Graduate student Josh Mills presented research at the 95th Annual Purdue Road School. Dr. Lili Du (NEXTRANS Research Associate) also presented at the annual event.

- Continued the Indiana High School Essay Competition in Transportation. The first contest attracted participants from across the state. Submitted essays covered a broad range of transportation issues in Indiana and the Midwest.

- Hosted an international graduate student, Priyanka Khan, from the Indian Institute of Technology in Kanpur. Khan and NEXTRANS faculty and students benefited from the collaborative research.

- Welcomed the Center’s first undergraduate intern in transportation communications, Anuj Puri. Puri, a Purdue senior majoring in communication, joined the NEXTRANS Center staff during the fall semester 2010 to assist in a wide variety of projects related to communicating the role of transportation in society.
USDOT OFFICIALS CONDUCT RITA SITE VISIT

On November 17, 2009, RITA officials conducted their first official site visit of the NEXTRANS Center.

Amy Stearns, RITA’s University Programs Specialist administering the NEXTRANS Center grant, led the site visit team, which included Robin Kline from RITA and Keith Gates from the Federal Transit Administration. The agenda for the day included programs and activities conducted under the auspices of the UTC grant.

The site visit offered a valuable opportunity for NEXTRANS to showcase its key accomplishments since its inception in 2007, as well as provide an overview of its integrated management approach; innovative partnerships with universities, state DOTs and private sector companies; grant administration and compliance practices; institutional support and fiduciary oversight; and research, education, and technology transfer activities.

A total of ten presentations were prepared by students from Purdue, the University of Illinois at Urbana-Champaign, The Ohio State University, and Wayne State University.

Other highlights of the day included:
- Presentations by Director Peeta (Purdue University), and Co-Directors Ray Benekohal (University of Illinois at Urbana-Champaign) and Rabi Mishalani (The Ohio State University), detailing the Center’s integrated approach; innovative partnerships; and accomplishments in research, education, and technology transfer.
- Poster presentations by graduate and undergraduate students illustrating their work on NEXTRANS-funded research projects.
- A luncheon program featuring student awards, readings by Indiana High School Essay Competition winners, and remarks by former Advisory Council Chair Joe Gustin.

(Continued on next page)
RITA SITE VISIT

(Continued from previous page)

- Presentations by students and teachers from Crawfordsville High School discussing their participation in NEXTRANS-sponsored programs and events.
- Research project presentations by NEXTRANS-funded faculty from Purdue University, University of Illinois at Urbana-Champaign, and The Ohio State University.
- Meetings with Purdue Senior Vice President for Research and Discovery Park Executive Director Al Rebar, and representatives from the business office and sponsored program services.

Advisory Council members enjoy presentations by Crawfordsville High School students during the NEXTRANS Center’s RITA site visit in November 2009.

AL-QADI ELECTED DISTINGUISHED MEMBER OF ASCE

NEXTRANS investigator and former Executive Committee member, Imad Al-Qadi was elected Distinguished Member of the American Society of Civil Engineers (ASCE) for his leadership and innovation in the civil engineering profession.

The ASCE defines a Distinguished Member as one who has made substantial contributions to the area of civil engineering. In addition to his leadership in professional service and technology transfer, Professor Al-Qadi was recognized for his research and technical contributions in pavement engineering, modeling, rehabilitation technologies, pavement interlayer systems, asphaltic mixtures, transportation infrastructure sensing, and ground penetrating radar.

Dr. Al-Qadi is currently the Founder Professor of Engineering at the University of Illinois at Urbana-Champaign and the founding Director of the Illinois Center for Transportation (ICT). He has served as an investigator on a number of NEXTRANS-sponsored research projects, and was a member of the Executive Committee from its inception to June 2010.

Imad Al-Qadi, Ph.D.
Founder Professor of Engineering
Director, Illinois Center for Transportation
INFRASTRUCTURE RENEWAL AND SUSTAINABILITY

Long-lasting and cost-effective pavement is integral to the system-wide goals of improving safety, mobility, and efficiency on our nation’s roadways. In recent years, squeezed budgets have highlighted the importance of sustainable infrastructure. Research is necessary to continually improve the performance of pavement over time and in a variety of climates. With these goals in mind, this NEXTRANS project examined each ingredient of the commonly-used hot-mix asphalt (HMA) and damage resulting from the loading of freight vehicles to understand pavement near-surface failure and cracking mechanisms.

Repeated traffic loading and cyclic thermal effects are the major causes of cracking in HMA. Most cracks initiate at the bottom of the HMA layer, in thin flexible pavements, and move upward to the surface. However, there is increasing evidence in relatively thick pavements that load-related cracks initiate near the surface and propa-
gate downward. The complexity of the variables affecting pavement performance requires a comprehensive methodology to uncover viable solutions for long-lasting pavement. Quantifying the contribution of each ingredient in HMA is needed to fully understand cracking mechanisms and near-surface failure over time under a variety of conditions.

Investigators worked to create a multiscale, digital HMA pavement model that will allow distress predictions related to near-surface failure and cracking mechanisms with simplified user inputs. The model was developed by means of advanced, recently emerged numerical techniques. Specifically, a recently developed methodology, the Generalized Finite Elements Method (GFEM), was used to model pavement structure and its failure mechanisms. This methodology allows for realistic modeling of the complex process of near-surface pavement failure over time. Any computational model bias or constraints are removed by the use of the GFEM, enabling the physics of HMA breakdown to be fully realized.

Split into three phases, the project has the potential to be ongoing to fully understand the breakdown of HMA and feasible solutions. The proposed phases include a simulation of cracking and damage initiation; examination of HMA three-dimensionally; multiscale simulations of a full pavement structure; and the integration of outcomes into a simplified mechanistic model.

The pavement model developed via this study will enable improved understanding of near-surface failure mechanisms with simplified user inputs. Integration of these models into the design procedure will help in developing long-lasting and cost-effective flexible pavements. Once successfully completed, the models will be simplified into equations that can be assimilated into currently available design and analysis approaches to allow engineers to predict near-surface HMA cracking. The results can also be implemented by highway agencies to improve HMA design, mix, and/or incorporation of interlayer systems to ensure long-lasting pavement life.

A fringe benefit of developing accurate near-surface pavement prediction models is the possible improvement to tire configurations. Suggestions made to the trucking industry could increase the life of pavement and tire, while enhancing safety.

This graph visualizes the three-dimensional pavement model with aggregate scale cracks and realistic dual-tire contact stresses on the pavement surface (automatic crack front refinement illustrates locally graded meshes).
The recent emergence of a new class of aircraft, Very Light Jets (VLJs), has renewed interest in the idea of a commercial on-demand air service (ODAS); the new on-demand service would operate non-stop and be accessible at more locations closer to where travelers live and work. Offered at an affordable rate, ODAS is capable of having significant effects on regional economies, demographics, land use, quality of life, and shifts in business activity.

Operated for profit by private enterprise, ODAS would likely employ VLJs carrying six to eight passengers; utilize the abundance of existing regional airports; and present a new option for travelers making regional intercity trips of up to 600 miles. Research is necessary to uncover what multimodal resources (air and ground), transportation policies, and economic variables are likely to enhance “doorstep-to-destination” mobility for citizens seeking personal and business trips.

Automobiles provide reliable, but lengthy travel times for intercity trips. Scheduled, commercial air service provides often unreliable and comparatively lengthy travel times, especially when connections are required. ODAS could provide a third, more efficient method of regional movement using existing airports. Using intercity air transportation networks in the Illinois-Indiana-Ohio region, researchers applied survey data (existing and new); transportation network topology models; regional economic data; and capability models for aviation to investigate the incorporation of ODAS.

Focusing on efficiency, energy use, economic activity, and environmen-
tal impacts, the models created will be used to determine comparative assessments of multimodal regional transportation considering the integration of ODAS using a system-of-systems (SoS) methodology. This method will consider each part of the entire transportation network as it interacts with the system as a whole. Using this method, researchers will be able to make conclusions regarding the benefits of ODAS in terms of technological, economic, and policy factors.

Offered at an affordable rate, ODAS is capable of having significant effects on regional economies, demographics, land use, quality of life, and shifts in business activity.

Examining the potential benefits of ODAS requires the involvement of multiple modes. Using a holistic approach, investigators considered the necessity of the integration of both ground and air infrastructure. By making ODAS widely available and convenient, the congestion associated with current air hubs could be partially alleviated. ODAS would also allow for greater use of existing ground and air infrastructure. The expanded use of existing infrastructure is important to maximize overall efficiency and resourcefulness of a multimodal transportation system.

Enhanced regional mobility via a new transportation capability, on-demand air service, is the goal of this research. And the key criterion for the successful and realistic implementation of ODAS is reduced doorstep-to-destination travel time. As regional travel times are decreased, significant economic growth is possible for the Midwest and constituent states. Areas offering ODAS as a transportation option will be more attractive places to locate economic activity. Employees will have better connectivity to customers and suppliers and individual citizens will be able to move about more freely in shorter amounts of time.

The solutions to shortened regional intercity travel times developed via this research will be applicable to improved transportation planning and policymaking in the Midwest and beyond in terms of personal travel, business trips, and even logistics networks. The intellectual framework developed will be important in bridging the gap between planners in both the public and private sectors and the understanding of long-term regional dynamics. Also, specific ways in which infrastructure and information sharing among service providers can be improved is an added benefit to the research.

Researchers will continue this project in Year 3 by expanding their investigation to include high speed passenger rail in the multimodal network including ODAS. Key components to the successful integration of high speed passenger rail will include technological readiness, economic viability, and the status of existing infrastructure in the Midwest. NEXTRANS investigators will modify the composite network created in this Year 2 project to determine the effects of the inclusion of high speed passenger rail into the system.

Efficient and reliable transportation is crucial to the economic vitality of any region. The careful examination of on-demand air service will provide valuable insight into possible improvements to transportation in the Midwest.
The need to conserve petroleum resources has become more and more critical. At the same time, drivers sensitive to gas prices are pushing the demand for enhanced fuel efficiency. In response to these growing needs, automobile manufacturers are producing vehicles with better fuel economy to fit consumer and environmental demands. In addition, new transportation energy sources are being explored and implemented. The current fuel tax-based transportation financing system needs to be supplemented by an additional revenue stream; a report by the National Surface Transportation Policy and Revenue Commission (2007) established the need for a significant increase in public funding in transportation. Furthermore, there is a need to curb the ever-increasing traffic congestion that contributes to air pollution and threatens economic growth at several of the nation’s metropolitan areas.

Congestion pricing is a possible partial solution to the current funding deficit in transportation, urban congestion, and air pollution. This concept involves the establishment of a direct out-of-pocket charge to road users through fixed- or variably-priced lanes. This study specifically examined the feasibility of dynamic congestion pricing, which allows toll prices to increase...
or decrease in response to traffic conditions.

Thanks to the current availability of sensing and information technologies, highway agencies can continually adjust toll prices according to traffic conditions to maintain free-flowing movement. Under a dynamic congestion pricing system, prices increase when the tolled lane(s) are busy and decrease during less traveled times. At any time, the prevailing price is displayed on electronic signs located at the approaches to the tolled sections. Introducing congestion pricing on highways discourages overuse during rush hour by motivating people to travel at alternate times or to choose transit or carpool. Removing even a small fraction of cars from the highway will allow the system to flow more efficiently.

Aside from direct revenue generation via tolls, the financial benefits of dynamic congestion pricing will extend to the movement of goods, boosting the U.S. economy. Congestion and travel time unreliability threatens transportation productivity by lengthening delivery times and increasing their variability. Shortened and more reliable delivery times will keep business costs low, leading to increased competitiveness of U.S. businesses in international markets. State and local governments will benefit by being able to provide quality, safe transportation services without tax increases or large capital expenditures.

This research used inventory and hypothetical future traffic data from a network in Indianapolis and an existing model to perform numerical experiments to ascertain the practicality of dynamic pricing in the state of Indiana. The efficacy of state-of-the-art software technologies and software for dynamic congestion pricing were investigated for possible use. The study is specifically looking into the feasibility, cost, and effects of dynamic congestion pricing. Researchers are also examining the experiences of other highway agencies using dynamic congestion pricing to identify any threats or opportunities that may arise during implementation. A diversified sample of areas with dynamic congestion pricing include the cities of London, Stockholm, San Diego, Toronto, and Orange County in California.

The benefits of dynamic congestion pricing are numerous. The product of this research is affirmation that the long-term costs of implementation will be significantly outweighed by the long-term benefits. Aside from revenue generation, increased economic viability, and environmental advantages, safety and infrastructure renewal issues are being addressed. Decongesting busy roadways will clearly enhance the efficiency of emergency response personnel in the event of an accident. Furthermore, the funds that are expected to be generated through dynamic congestion pricing can possibly be applied to infrastructure renewal for areas in need.
The infrastructure supporting urban passenger transportation encompasses complementary and competing modes of travel. Options often include private vehicle, urban street bus transit, bus rapid transit, light rail, heavy rail, and even walking and biking in some urban settings. Many citizens are discretionary travelers, meaning they have the choice among two or more modes when making various trips. Urban form and corresponding origin-destination flow patterns directly affect the modes on offer and the choices made by travelers. Travelers consider many factors when deciding which mode of transportation is best for them. Availability, cost, convenience, and energy consumption are all important variables. Transport and land-use policies, made at the government level, play a vital role in the decision making process of travelers across the country. Policies set in place and how consumers react accordingly determines the success or failure of any attempt to encourage use of public transportation.

Research continues to be essential in determining how policies affect public transportation mode share and the impact of public transportation mode share on the environment, in particular greenhouse gas (GHG) emissions. Empirically derived statistical relationships are being developed through the use of a comprehensive and diversified data set compiled by integrating data from multiple reliable sources. The relationship between GHG emissions and transit use could have far-reaching meaning for urban societies, travelers, researchers, planners, and policymakers.
Following decades of industrial and technological growth across the globe, there is strong and widespread concern about the state of the environment and the impact of massive energy consumption. Nearly every mode of transportation requires the use of valuable resources, namely energy and land. Several groups have formed in recent years with the goal of increasing public transportation use in an effort to mitigate the negative environmental effects of urban travel; asserting that public transportation is more environmentally-friendly and energy efficient than personal vehicles.

The primary aim of this study is to investigate the role of public transportation in this regard and quantify its impact under a variety of conditions. To begin, a wide variety of data on urban areas in the U.S. was compiled into a single, consistent database. The data sources, the specifics of the variables, and the data extraction processes were extensively investigated to amass comprehensive and factually sound data set. Variables relating to transportation modes, capacities, travel demand, and land use were considered. This broad, integrated data set is key to developing statistical models capable of capturing the complexities of the phenomenon at hand and, as a result, to better understand and predict the effects of transportation and land use policies at the gross level specifically regarding the role of public transportation in reducing GHG emissions.

In addition to providing validation of detailed travel demand models, the developed statistical models will have the potential to predict the consequences of new transportation and land use policies before beginning detailed and costly analyses. Therefore, this research aids in creating a more informed public and giving policy and decisionmakers essential knowledge and means to formulate efficient and sustainable transportation policies sensitive to current societal challenges.

This project started in Year 2 and will continue into Year 3 as researchers add richness and complexity to the preliminary models developed in Year 2. Within the scope of this NEXTRANS study is the validation of the potential reduction in GHG emissions via increased use of public transportation. One of few studies dedicated to this complex issue, the project was featured at an Urban Public Transportation Roundtable session held at MIT in the fall of 2009, where researchers, policymakers, and public transportation providers discussed, "Climate Change as an Impetus to Improve Transit."
RESEARCH IN PROGRESS

Determining Queue and Congestion in Highway Work Zone Bottlenecks
Investigator: Rahim F. Benekohal, University of Illinois at Urbana-Champaign

Investigators worked to understand how traffic operates in work zones, in order to help agencies devise informed strategies for reducing costly and dangerous congestion. The findings will help practicing engineers design and operate work zones in safer and more efficient ways, providing a better level of service to motorists and safer conditions for travelers and work zone crews.

Traffic Signal Coordination and Queue Management in Oversaturated Intersections
Investigator: Rahim F. Benekohal, University of Illinois at Urbana-Champaign

Traffic signal coordination in congested networks is complex and requires in-depth understanding of traffic flow characteristics. One of the key issues in oversaturated conditions is managing queues and their spillback effects on the network. This research project aimed to develop traffic signal coordination methodology for a network of oversaturated intersections, based on the concept of queue minimization.

Thermal Cracking Performance Prediction and Asset Management Integration
Investigators: William Buttlar, Glaucio Paulino, University of Illinois at Urbana-Champaign

Low-temperature cracking of hot-mix asphalt (HMA) pavements continues to be a leading cause of premature pavement deterioration in cold regions. Researchers worked to create a user-friendly, computationally efficient program that can be used to analyze and design against thermal cracking in asphalt pavements through pavement simulation and cracking performance prediction. A framework for the integration of the predicted performance into a comprehensive asset management system was also developed.

Innovative Vehicle Classification Strategies
Investigator: Benjamin Coifman, The Ohio State University

This project aims to extend length based vehicle classification coverage to single loop detectors and non-invasive detectors that emulate single loop detectors. The data collected will help agencies to better utilize resources in calculating roadway usage, which in turn will lead to more efficient and cost-effective infrastructure maintenance and traffic management strategies.

Machine Vision Inspection of Railroad Track
Investigators: J. Riley Edwards, Christopher Barkan, Narendra Ahuja, University of Illinois at Urbana-Champaign

The objective of this research project is to develop new methods to increase the efficiency and effectiveness of railroad track inspection through the application of machine vision, an advanced visual sensing technology.
Transportation and Socioeconomic Impacts of Bypasses on Communities: An Integrated Synthesis of Spatial Econometric Methods and Agent-Based Simulation

Investigator: Jon Fricker, Purdue University

This ongoing project seeks to minimize the adverse impacts of bypasses on communities. Researchers are continuing their work to examine a variety of characteristics in communities affected by bypasses. The results of the study will have real-world applications in terms of mobility, safety, and economic vitality.

Public-Private Partnerships (PPPs) in Highway Reconstruction, Rehabilitation, and Operations

Investigators: Samuel Labi, Kumares Sinha, Purdue University

Researchers worked to develop an evaluation and decision support framework for highway agencies to decide on public-private partnership (PPP) adoption for a given project, and where PPP is recommended for adoption, the type of PPP that would yield minimum possible costs or maximum possible benefits to the agency. The research will help agencies seeking innovative ways to reduce the costs associated with infrastructure maintenance and renewal, without lowering the standards of safety, mobility, or convenience for travelers.

Incorporating Image-Based Traffic Information for AADT Estimation: Operational Developments for Agency Implementation and Theoretical Extensions to Classified AADT Estimation

Investigators: Mark McCord, Prem Goel, The Ohio State University

Investigators worked with the Ohio DOT to develop a prototype of a software system that extracts traffic information from existing air photos and combines this information with traditional ground-based traffic counts to produce more accurate estimates of Annual Average Daily Traffic (AADT). Implementation of the software system integrates ODOT’s GIS and traffic monitoring database to produce AADT estimates with limited manual intervention.

Optimal Condition Sampling of Infrastructure Networks

Investigators: Rabi Mishalani, Prem Goel, The Ohio State University

Infrastructure systems consist of spatially extensive sets of interconnected facilities with long life spans and, therefore, the process of determining optimal inspection sampling strategies to support maintenance decisions is a complex one. This is a continuing study aimed at solving this problem taking into account the various uncertainties associated with condition inspection, sampling, and forecasting. A method has been developed and numerically validated based on a set of realistic literature- and practice-derived example networks of facilities.

Smart Campus Transit Laboratory for Research and Education

Investigators: Rabi Mishalani, Prem Goel, Mark McCord, The Ohio State University

NEXTRANS investigators worked with OSU's transit providers and Clever Devices, Inc. to take advantage of OSU's living Campus Transit Lab (CTL). CTL incorporates OSU’s Campus Area Bus Service, which serves a diverse set of land-uses in and around campus and which has recently been equipped with a state-of-the-art "smart bus" system. Activities included research on service planning, operations, and traveler perceptions; outreach to transit and technology providers; and development of course modules.
Development of Carrier-Carrier Collaboration and Transfer Location Models for Less-Than-Truckload (LTL) Freight Logistics

Investigator: Srinivas Peeta, Purdue University

Decreased demand, rising fuel costs, increased competition, and operational inefficiencies are threatening the viability of many small-to-medium-sized less-than-truckload (LTL) trucking firms. This project aims to develop models for carrier-carrier collaboration in the LTL industry, which will leverage existing transportation infrastructure and advances in information and communication technologies (ICT).

Development of a Mobile Probe-Based Traffic Data Fusion and Flow Management Platform for Innovative Public-Private Information-Based Partnerships

Investigators: Srinivas Peeta, Purdue University; Xuesong Zhou, University of Utah

This project aimed to maximize the value of mobile probe data collected by private sector vendors (GPS, mobile phones, etc.) in an effort to encourage information-sharing under public-private partnerships.

Using Detector Data to Identify and Examine Crashes and Incidents on Freeways

Investigator: Peter T. Savolainen, Wayne State University

This study used data collected by the Michigan Intelligent Transportation System (MITS) Center to evaluate freeway operations in metro Detroit. Researchers will continue their work to examine a multitude of variables affecting efficiency, safety, and traffic flow.

Effect of Friction on Rolling Tire-Surface Interaction

Investigators: Ilinca Stanciulescu, Imad Al-Qadi, University of Illinois at Urbana-Champaign

In an effort to improve driver safety and reduce cost associated with pavement damage, investigators implemented nonlinear frictional contact models for tire-pavement interaction that take into account vehicle sliding velocity (applicable to scenarios involving ice, sand, etc.).

NEXTRANS has developed a holistic framework for project selection that is systematic, integrated, amenable to continuous improvement, and adaptable to changing priorities.

More detailed descriptions of all NEXTRANS research projects in progress are available at www.purdue.edu/dp/nextrans/research
Integrated Hazardous Materials Transportation Safety Risk Management Framework

Investigator: Christopher Barkan, University of Illinois at Urbana-Champaign

Rail transport plays a key role in the multimodal supply chain needed to safely and economically move hazardous materials from production to consumption points. Using comparative analysis, this research aims to develop an integrated risk management framework model to assess safety and risk at the local, regional, and national network levels. The results of this comprehensive project will be applicable to the continued study of risk management in rail and other modes, making it relevant to a wide variety of stakeholders.

Computing Moving and Intermittent Queue Propagation in Highway Work Zones

Investigator: Rahim F. Benekohal, University of Illinois at Urbana-Champaign

Long queues and heavy congestion are common in busy highway work zones. These congested areas can be dangerous for drivers entering stop-and-go traffic unexpectedly. Alerting drivers to queue presence in work zones could reduce the frequency and severity, increasing safety and efficiency. In this research project, user-friendly computer programs will be developed to accurately calculate queue propagation and shrinkage. Real-world applications would include the implementation of online systems placed in work zones to manage the growth of queues based on the data collected.

Agent-Based Traffic Management and Reinforcement Learning in Congested Intersections

Investigators: Rahim F. Benekohal, University of Illinois at Urbana Champaign; Satish Ukkusuri, Purdue University

The loss of time and resources due to congestion, especially in urban areas, is significant. Appropriately operated traffic signals help to smooth the flow of traffic, leading to a reduction in commute time and fuel consumption. This study seeks to develop an agent-based traffic management technique with reinforcement learning principles. Agents, working independently within the same network, will learn from their environments to minimize travel time and reduce stoppage. The information produced by this innovative research will be applicable to improvements in mobility and reliability in the region.

Integration of Pavement Cracking Prediction Model with Asset Management and Vehicle-Infrastructure Interaction Models

Investigators: William G. Buttlar, Glaucio H. Paulino, University of Illinois at Urbana-Champaign

Sustainable pavement infrastructure will lead to decreased maintenance costs and safer, more reliable roadways for travelers. This project will build upon previous research to develop a user-friendly pavement cracking prediction tool to assist in infrastructure renewal planning across multiple modes. Researchers will integrate cracking prediction software with actual infrastructure conditions to generate more realistic and timely data.

Using Probe Vehicle Data to Understand Bottlenecks and Congestion

Investigator: Benjamin Coifman, The Ohio State University

Freeway congestion results in lost time and resources for goods and travelers. The congestion arises from bottlenecks and to date, these phenomena have predominantly been studied with point detectors, which are limited in their scope. This project proposes the use of an instrumented probe vehicle, equipped with both positioning sensors and ranging sensors, to collect data along I-71 in Columbus, Ohio. Research
findings will lead to more accurate traffic flow models, impacting safety and fuel efficiency in heavily traveled areas.

**Increasing Accuracy of Vehicle Speed Measurement in Congested Traffic Over Dual-Loop Sensors**  
*Investigators: Benjamin Coifman, The Ohio State University; Heng Wei, The University of Cincinnati*

Data from loop detectors is used throughout all levels of transportation planning and traffic operation. It is almost always assumed that the data provided by detectors is accurate and reliable. Unfortunately detector errors are common, so this project aims to develop a suite of cost-effective tools to improve the accuracy of detector measurements. The approach will integrate quality control in the controller and off-line assessment. Improved loop detector measurements will enrich real time traffic control, vehicle classification, and aggregate performance measures; this feedback will assist operating agencies and policymakers to allocate resources more efficiently.

**Incorporating High Speed Passenger Rail into a Multimodal Network Model for Improved Regional Transportation Planning**  
*Investigators: Dan DeLaurentis, Srinivas Peeta, Purdue University*

This project will study the interplay of four modes of transportation: auto, commercial air, on-demand air service (ODAS), and rail, with the purpose of reducing travel times for regional intercity trips. Investigators will update their current multimodal transportation analysis model to include high speed passenger rail, while considering transportation policy and economic variables. Shorter doorstep-to-destination travel times could have significant effects on regional economies, demographics, land use, and quality of life, and lead to shifts in business activity.

**Improved Concrete Railway Crosstie Design and Performance**  
*Investigators: J. Riley Edwards, David A. Lange, University of Illinois at Urbana-Champaign*

Rail transportation is consistently viewed as one of the most viable solutions to the transportation system capacity deficiencies that exist in North America, due to its efficiencies in both fuel and land use. The primary objective of this research project is to identify methods of improving concrete railroad crosstie and fastening system design and performance through research, testing, and a thorough failure mechanism investigation. The conclusions reached from this research will allow the investigators to provide design recommendations to the railway industry, increasing safety and reducing the life cycle costs for certain railway infrastructure components.

**The Regional Economic Impacts of Bypasses: A Longitudinal Study Incorporating Spatial Panel Econometrics and Multilevel Modeling**  
*Investigators: Jon D. Fricker, Joshua B. Mills, Purdue University*

This project seeks to understand the economic impacts of bypasses on communities at the ZIP code-level. The simultaneous analysis of 60 different bypasses across Illinois, Indiana, and Ohio, will allow researchers to make broader conclusions, while keeping in mind the individual characteristics of communities across the Midwest. Research findings are expected to have real-world applications in terms of enhancing mobility and safety by diverting trucks and other traffic; maintaining or restoring the economic vitality of affected communities’ central business districts; and minimizing transportation costs.
Measuring and Documenting Truck Activity Times at International Border Crossings
Investigators: Mark McCord, Prem K. Goel, The Ohio State University; Colin Brooks, Michigan Tech Research Institute

Efficient international commerce is critical to the U.S. economy. In this project, NEXTRANS researchers will work with technical experts in Michigan and the freight industry to collect truck activity time data at major US-Canada gateways using existing remote sensing and spatial information technologies in an innovative manner. In addition, integration of US and Canadian R&D efforts on monitoring freight traffic at US-Canada gateways will be pursued.

Impact of Public Transit Market Share on Energy Consumption and GHG Emissions: Developing Statistical Models for Aggregate Predictions and Validation of Mechanistic Transportation Models
Investigators: Rabi G. Mishalani, Prem K. Goel, The Ohio State University

This continuing study aims to clarify and quantify the impacts of increased public transportation use on reducing energy consumption and greenhouse gas emissions (GHG) in urban areas. Researchers will develop rich statistical relationships between GHG emissions and transit use under a variety of conditions using the comprehensive data set amassed during the first year of this project. The captured complexity will allow gross prediction of the impacts under various policy scenarios and validation of detailed travel demand models in terms of their ability to capture these impacts. Results will provide policymakers with the knowledge and means to develop more effective transportation and land-use policies that are sensitive to current environmental concerns.

Smart Campus Transit Laboratory for Research and Education
Investigators: Rabi G. Mishalani, Mark R. McCord, Prem K. Goel, The Ohio State University

NEXTRANS investigators will work with OSU’s transit service providers and Clever Devices, Inc., to take advantage of OSU’s living Campus Transit Lab (CTL) in research, education, and outreach activities. CTL incorporates OSU’s Campus Area Bus Service, which serves a diverse set of land-uses in and around campus and which has recently been equipped with a state-of-the-art "smart bus" system. Data from the system will support the continued advancement of transit planning, service design, and operation methods, as well as development of course modules. Results of this NEXTRANS showcase project will have meaningful implications for a variety of stakeholders.

Field Deployment to Quantify the Value of Real-time Information by Integrating Driver Routing Decisions and Route Assignment Strategies
Investigator: Srinivas Peeta, Purdue University

This showcase project aims to adequately understand the value of real-time information in real-world contexts for multiple stakeholders. An Indianapolis-based field experiment will allow researchers to study the actions of participants as they respond to real-time traffic information during their morning commute. A secure website will be developed for the initial survey of participants, as well as daily recording of trip diaries. Implications of real-time traffic information will be considered in terms of mobility, safety, and efficiency.

Investigators: Srinivas Peeta, Purdue University; Shou-Ren Hu, National Cheng Kung University, Taiwan

Origin-destination (O-D) patterns are crucial in traffic operations and transportation planning. This research will estimate a network O-D demand pattern using information from partial link counts, obtained by strategically installing detectors/sensors. The strategic placement of sensors allows researchers to make O-D demand estimates about the entire network under a limited budget. This research will help transportation/highway management agencies to develop transportation planning and infrastructure strategies by leveraging limited fiscal resources.

Highway Reservation System Design and its Application to Freight Transportation

Investigators: Srinivas Peeta, Purdue University; Chih-Peng Chu, National Dong Hwa University, Taiwan; Mei-Ting Tsai, National Dong Hwa University, Taiwan

Efficient and reliable freight transportation is a key contributor to economic development in both the United States and Taiwan. A lack of adequate government funding has motivated both nations to look to the private sector for innovative solutions to the various problems in the existing transportation systems. Researchers have proposed a highway reservation system for freight carriers using a truck-only lane that guarantees a threshold speed by charging a fee. The mutually beneficial system can potentially help to mitigate congestion; improve freight transportation efficiency and safety; and create a new financing source for highway infrastructure.

Investigation of Freeway Operations in Metro Detroit

Investigator: Peter T. Savolainen, Wayne State University

This study will continue to interpret data collected along four freeways in metro Detroit by the Michigan Intelligent Transportation Systems (MITS) Center. Researchers will further their examination of freeway operations to determine how site-specific variables impact accidents and response times. The results will also allow researchers to verify the reliability and accuracy of data collected by traffic detectors for use in future projects.

Estimating the Economic Impacts of Disruptions to Intermodal Freight Systems

Investigators: Satish Ukkusuri, Fred Mannering, Amlan Mitra, Purdue University

Disruptions to the movement of goods can have significant long-term and short-term consequences. This collaborative project intends to identify and estimate the impact of such disruptions through the integration of engineering, economics, and policy frameworks. Researchers will critically evaluate data from two case studies in the Midwest: one along the Borman Expressway and another at the Markland Locks and Dam. There is potential to strengthen transportation systems by analyzing the effects of disruptions to the movement of goods across multiple modes.
### Project Title

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*Figure 4: Dimensions Addressed by Year 3 Projects*
# COMPLETED RESEARCH

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To view final research reports of completed projects, please visit: [www.purdue.edu/dp/nextrans/research/completedprojects.php](http://www.purdue.edu/dp/nextrans/research/completedprojects.php)
As a Regional University Transportation Center, NEXTRANS aims to be a leader in attracting and preparing students to be part of a highly-skilled transportation workforce.
STUDENT OF THE YEAR: BRANDON STROHL

The NEXTRANS Center selected Brandon Strohl as its 2009 Student of the Year. Brandon is a March 2010 graduate of The Ohio State University; he received his master’s degree from OSU in civil engineering.

Brandon’s interests are in the area of transportation systems analysis and planning. His research involves the advanced evaluation of estimation procedures that produce transit bus route origin-destination (OD) flows from boarding and alighting data. This data is obtained from OSU’s Campus Transit Lab using Automatic Passenger Count (APC) technologies.

Brandon was selected based on his strong academic standing, research contributions, leadership and management skills, broad professional experience, and keen interest in advancing the field of transportation systems analysis and planning.

CENTER HOSTS INTERNATIONAL GRADUATE STUDENT

The NEXTRANS Center hosted an international visiting scholar as part of its continuing mission to develop institutional linkages at the global level.

From January to May 2010, Priyanka Khan, from the Indian Institute of Technology in Kanpur (IIT-K), conducted research-in-residence at Purdue University. She graduated in August 2010 and now works for V R Technique Consultants Pvt. Ltd.

While at Purdue, Khan worked on a joint-research project under the guidance of Dr. Partha Chakroborty (IIT-K) and Director Peeta.

The project, titled, "Addressing Uncertainties in Travel Time Estimates Using Artificial Intelligence Techniques for Intelligent Transportation Applications," marks the beginning of an international collaboration between NEXTRANS and IIT-K. This research aims to determine if standard traffic models can be used to study traffic in India, where a variety of non-motorized vehicles share the road and there is a lack of lane discipline.
2010 UNDERGRADUATE SUMMER INTERNSHIP

The second annual NEXTRANS Summer Undergraduate Internship concluded July 23, 2010 with final presentations at Purdue University’s Discovery Park. This event was an opportunity for interns to showcase their research accomplishments to faculty, staff, graduate mentors, and other undergraduate students from the Center’s major partner universities.

The Undergraduate Summer Internship in Transportation provides six competitively-selected undergraduate students with the opportunity to complete a ten-week program of transportation research and activities at Purdue University, the University of Illinois at Urbana-Champaign, and The Ohio State University.

This year’s program attracted students from Penn State University, the Missouri Institute of Science and Technology, and Villanova University, as well as the Center’s major partner universities. Interns participated in a broad range of transportation modes and topics. They were challenged to learn basic modeling techniques, develop surveys, participate in the collection of field data, and utilize a variety of innovative technologies. Collectively, their research aimed to:

- Evaluate the likelihood of commuters to switch routes based on real-time traffic information
- Determine the comfort level of bicyclists when sharing the roadway with passenger vehicles
- Increase the efficiency of railroad track inspection using advanced machine vision technology
- Conduct research on public-private partnerships (PPPs)
- Investigate a potential relationship between increasing gas prices and transit ridership
- Analyze bus headways using advanced vehicle location (AVL) data

Undergraduate interns (seated), faculty, and graduate students pose after formal presentations at Purdue University on July 23, 2010.
2010 INTERNS

Mark Asmuth is currently pursuing a B.S. in electrical engineering at Penn State University (University Park, PA). For his internship, Mark worked with J. Riley Edwards, Dr. Narendra Ahuja, Dr. Christopher Barkan, and John Hart at the University of Illinois at Urbana-Champaign on research that aims to increase the efficiency of railroad track inspection. Researchers are currently recording images of track from a moving vehicle and using advanced machine vision algorithms to detect broken or defective track components. Mark participated in field testing and worked to improve video capture in adverse lighting conditions and accurately determine the locations of defective track components. After receiving his degree, Mark plans to attend graduate school.

Michael Lodes holds a B.A. in music education (2006), and is currently pursuing a B.S. in civil engineering at the University of Illinois at Urbana-Champaign. For his internship, Michael worked with Dr. Ray Benekohal at UIUC on a project that aimed to determine the comfort level of bicyclists in relation to motor vehicles based on passing distance, lateral positions, and the operational space of cyclists. He developed a survey utilizing photos taken at varying distances between curb, bicycle, and vehicle, asking respondents to indicate their relative comfort levels for each image. His future plans are to immediately attend graduate school and work in the public sector, specializing in issues relevant to bicycle/alternative transportation.

"I was given freedom, support, and guidance to pursue a topic that was interesting to me."

- Michael Lodes

Skyler Martin is currently pursuing a B.S. in civil engineering at the Missouri University of Science and Technology. For his internship, Skyler worked with Dr. Ray Benekohal at the University of Illinois at Urbana-Champaign on a project that aimed to determine if there is a relationship between increasing gas prices and transit ridership. Skyler tracked increases in gas prices over the last ten years, and attempted to correlate this with a decrease in passenger vehicle miles traveled and an increase in transit ridership; he concluded there are too many factors to establish a definitive relationship. Skyler is interested in attending graduate school and would enjoy the opportunity to pursue career in a transportation-related discipline.
James Pokorny is pursuing a B.S. in civil engineering at Villanova University. For his internship, James worked with Dr. Srinivas Peeta and Dr. Sushant Sharma at Purdue University on research that aims to understand the benefits that real-time traffic information provides to commuters. The content of this real-time information can include congestion warnings, expected delays, and alternate route suggestions. James designed a Stated Preference (SP) survey and developed a model to help determine what environmental factors and demographics affect a commuter’s likelihood of switching routes based on real-time information. James is interested in participating in more transportation-related internships and attending graduate school.

Jarrett Powell is pursuing a B.S. in civil engineering at Purdue University. For his internship, Jarrett worked with Dr. Samuel Labi at Purdue on research exploring public-private partnerships (PPPs). Since further shortfalls in public infrastructure funding are expected over the next five years, expanding private sector involvement may provide a sustainable means of financing America’s infrastructure needs. Jarrett researched the history of PPPs, their characteristics, and the mechanisms involved in the decision-making process. This project seeks to create a simple, Excel-based expert system that will help agencies select the most cost-effective PPP approach based on the project’s characteristics. His future plans are to pursue a career in transportation engineering.

Justin Vayda is pursuing a B.S. in computer science and engineering at The Ohio State University (OSU). For his internship, Justin worked with Dr. Rabi Mishalani, Dr. Mark McCord, Dr. Prem Goel, and Dr. Paul Sivilotti at OSU on research involving the Smart Campus Transit Lab. The new state-of-the-art bus system includes advanced autonomous vehicle location (AVL), automated passenger counting (APC), and a passenger information system. Justin used this data to analyze bus headways and load profiles. He developed data structures to organize AVL and APC data consistently for long-term use in various studies, and worked on a Web site that features the Campus Transit Lab and collected data. Following graduation, Justin intends to enter the workforce.
COMMUNICATIONS UNDERGRADUATE INTERNSHIP

The NEXTRANS Center welcomed its first Undergraduate Intern in transportation communications, Anuj Puri, in August 2010. He is a senior at Purdue University majoring in communications.

Throughout the fall semester, Puri has assisted the Center’s Communications Coordinator with a variety of activities including the 2010 Indiana High School Essay Competition, website design and maintenance, and editing of the 2010 Annual Report.

Following his December 2010 graduation from Purdue, Puri plans to pursue a career in marketing and advertising.

CRAWFORDSVILLE AND NEXTRANS MAKE A CONNECTION

Since 2004, Helen Hudson’s English students at Crawfordsville High School (CHS) have made it their mission to improve their local Amtrak station. With the help of a problem-based learning (PBL) grant, CHS students have removed massive amounts of trash, painted the shelter, created a garden, installed a welcome sign and logo, and had the road leading to the station repaired.

Their hard work caught the attention of Director Peeta, who invited the PBL classes to become secondary school partners. CHS student Chelsea DeLarm received a special award from former RITA Administrator Paul Brubaker in May 2008 for her display booth at the NEXTRANS Inaugural Summit. One of Hudson’s students, Jim Caraher, was selected to become the NEXTRANS Center’s first high school intern, and Crawfordsville High School had strong participation in the Center’s first Indiana High School Essay Competition.

Helen Hudson and her classes were also invited to Purdue University on November 17, 2009 to participate in a NEXTRANS Center site visit. CHS students displayed their interest in promoting passenger rail travel in Indiana and beyond to USDOT officials, faculty from NEXTRANS partner universities, Advisory Council members, and other Center guests.
NEXTRANS is pleased to invite the Illinois Institute of Technology (IIT) to expand their role with the Center as a strategic partner. Formerly an institutional resource partner, the Illinois Institute of Technology continues to stand out for their efforts in providing exemplary outreach programs, focusing on science, technology, engineering, and math. Specifically, the PRETRANS program at IIT promotes career exploration in the field of civil/transportation engineering and provides a taste of college curriculum for women and underrepresented high school students.

The PRETRANS Program is designed to motivate and encourage a diverse population of high school students to gain exposure to civil/transportation engineering in an effort to support the development of communication, problem solving, critical thinking, and interpersonal skills.

Since 2006, college-bound students from the Chicago area have spent time at IIT learning about all that civil/transportation engineering has to offer. The PRETRANS Program is comprised of two phases. Phase I is arranged in the regular spring semester. At least three high schools involved with the IIT TORCH (Technical Out Reach Community Help) Program are identified to participate in the PRETRANS Program. Each school selects 40-50 third year (junior) students to attend a career day at IIT. Students are selected on the basis of their career goals, academic performance, and motivation. Approximately ten Phase I participants are selected to participate in Phase II. The traditionally week-long program engages students in lectures and educational videos on civil/transportation engineering; tours of actual civil engineering work sites and businesses; and participation in lab experiments on survey instruments, bridge design and failure analysis, and traffic software demonstrations.

In 2009, Phase II of the PRETRANS program grew to a two-week summer internship experience. Students were introduced to hands-on research under the guidance of IIT faculty and graduate students. Participants were asked to journal about their experiences, future educational and professional goals, and research topics of interest to them.

Dr. Zongzhi Li, Associate Professor of Civil, Architectural, and Environmental Engineering at IIT, is the Director of the PRETRANS Program. In addition to the NEXTRANS Center, The American Society of Civil Engineers (ASCE) Headquarters and Illinois Section, Institute for Transportation Engineers (ITE) Illinois Section, and Illinois Institute of Technology support the PRETRANS Program.
GRADUATE STUDENTS

Kivanc A. Avrenli, Univ. of Illinois at Urbana-Champaign
Jonathan Bradley, Ohio State University
Cheng Chen, Ohio State University
Ying Ding, Ohio State University
Jinguo Gao, Ohio State University
Indrajit Ghosh, Wayne State University
Ali Hajababaie, Univ. of Illinois at Urbana-Champaign
Salvador Hernandez, Purdue University
Yu-Ting Hsu, Purdue University
Rex Hu, Ohio State University
Xudong Hu, Ohio State University
Apichai Issariyanukula, Purdue University
Yuxiong Ji, Ohio State University
Aditya Joshi, Purdue University
Georgios Kalafatas, Purdue University
Jacquelyn Kawa, Wayne State University
Seoungbum Kim, Ohio State University
Yong Hoon Kim, Purdue University
Andrew Landgraf, Ohio State University
Ho Lee, Ohio State University
Sofie Leon, Univ. of Illinois at Urbana-Champaign

Pingbo Lu, Ohio State University
Stephan Maxe, Wayne State University
Juan C. Medina, Univ. of Illinois at Urbana-Champaign
Joshua B. Mills, Purdue University
Luis Fernando Molina, Univ. of Illinois at Urbana-Champaign
Daniel Moorhead, Ohio State University
Hasan Ozer, Univ. of Illinois at Urbana-Champaign
Hani Ramezani, Univ. of Illinois at Urbana-Champaign
Herbert Reinhold, Ohio State University
Chenbo Shangguan, Ohio State University
Dong Yoon Song, Purdue University
Brandon Strohl, Ohio State University
Matthew Volovski, Purdue University
Hao Wang, Univ. of Illinois at Urbana-Champaign
Ashley Westra, Ohio State University
Xiaofei Xu, Ohio State University
Yufang Zhang, Ohio State University
Dunke Zhou, Ohio State University
Honglei Zhu, Ohio State University

UNDERGRADUATE STUDENTS

Dan Brandesky, Ohio State University
Jack Bringardner, Ohio State University
Justin Vayda, Ohio State University
NEXTRANS SEMINAR SERIES PROMOTES TECH TRANSFER

The NEXTRANS Center’s major university partners hosted guest speakers as part of the NEXTRANS seminar series.

Dr. Samer M. Madanat presented a seminar titled, "Reliability-Based Optimization of Maintenance and Replacement Policies for Heterogeneous System of Infrastructure Facilities," to an audience of students and faculty at the University of Illinois at Urbana-Champaign on May 7, 2010. The discussion addressed the determination of optimal maintenance and replacement policies for a heterogeneous system of facilities, utilizing a reliability-based framework developed from optimal policies at the facility level.

Dr. Madanat is the Xenel Distinguished Professor in the Department of Civil and Environmental Engineering, and Director of the Institute of Transportation Studies at the University of California at Berkeley.

On May 11, 2010, Dr. Xuesong Zhou delivered a seminar at Purdue University. The lecture, titled, "High-speed Passenger Trains on Freight Tracks: Modeling Issues on Capacity Analysis, Train Timetabling and Real-Time Dispatching," discussed utilizing existing freight rail lines to operate high-speed passenger trains, a shared-use strategy currently being considering in the U.S.

Dr. Zhou is an Assistant Professor in the Department of Civil and Environmental Engineering at the University of Utah.

Dr. Michael Shiffer, from Vancouver, British Columbia, presented a seminar at The Ohio State University on June 28, 2010, titled, "Reshaping Transit Planning in Metro Vancouver Through Dynamic Illustration, Solid Evidence and Careful Conversations." With a focus on Vancouver, Dr. Shiffer described how transportation agencies can leverage new data sources, multimedia tools, and participatory techniques to reshape their approach to planning. Dr. Shiffer discussed the recent successes surrounding delivery of transit services during the 2010 Winter Olympics, as well as recent transit and roadway infrastructure improvements.

Dr. Shiffer is Vice President for Planning at TransLink, where he is responsible for planning activities that support major roads, bridges, bikeways, freight and public transit networks in the Vancouver region.
STUDENTS AND FACULTY "INFORM THE GLOBE"

A number of NEXTRANS graduate students and faculty affiliates from Purdue University and the University of Illinois at Urbana-Champaign presented research at the 2009 INFORMS Annual Meeting, held October 11-14, 2009 in San Diego. Each year, the INFORMS annual meeting hosts more than 1,000 sessions and just under 4,000 papers, covering a broad range of topics in operations research and management sciences. The 2009 theme was "INFORMing the Globe."

Graduate researchers Salvador Hernandez (Purdue), Yu-Ting Hsu (Purdue), Georgios Kalafatas (Purdue), Amit Kumar (Purdue), Xiaopeng Li (UIUC), and Onur Pekcan (UIUC) participated in the 2009 technical sessions. They were joined by NEXTRANS faculty affiliates Christopher Barkan (UIUC), J. Riley Edwards (UIUC), Ananth Iyer (Purdue), Yanfeng Ouyang (UIUC), Srinivas Peeta (Purdue), F. Sibel Salman (Koc University - Turkey), and Satish Ukkusuri (Purdue), as well as Research Associates Lili Du and Sushant Sharma.

These participants presented research on topics including, but not limited to: traffic surveillance, supply-chain management, dynamic traffic assignment, mass evacuation, and Less-Than-Truckload (LTL) carrier-carrier collaboration.
CENTER CO-HOSTS RECEPTION AT TRB ANNUAL MEETING

On January 10, 2010, the NEXTRANS Center co-hosted a reception at the Transportation Research Board's 89th annual meeting in Washington, D.C. Co-sponsored by NEXTRANS, Purdue, and the Joint Transportation Research Program (JTRP), this year's Purdue University Civil Engineering Reception offered participants the opportunity to interact with transportation professionals, as well as NEXTRANS partners, faculty, and students.

The Network Modeling Committee (ADB30), chaired by Director Peeta, successfully unveiled a website to facilitate more efficient information exchange (www.nextrans.org/ADB30) for the associated community of interest; Kumares Sinha (former JTRP Director and former NEXTRANS Executive Committee member) was awarded the 2009 Roy W. Crum Distinguished Service Award for his leadership in transportation research and education; and a number of NEXTRANS investigators presented research in their areas of expertise.

CONTINUING COMMITMENT TO COMMUNITY OF INTEREST

The Transportation Research Board’s (TRB) Transportation Network Modeling Committee (ADB30) promotes research and information exchange in transportation network modeling, an interdisciplinary field spanning computer science, logistics, mathematics, operations research, telecommunications, and transportation science.

The committee has over two hundred members and friends. In 2009, ADB30 received a commendation from TRB’s Technical Activities Council and TRR Publication Board for successfully reviewing over 155 papers and completing 550 reviews.

As part of technology transfer activities, NEXTRANS staff members are continuing their support of this active committee by hosting a Community of Interest website. Communications Undergraduate Intern Anuj Puri and Research Associate Sushant Sharma worked together to create a new, more user-friendly design for the year-old web site.

The Center hopes this site will serve as a venue for the effective and rapid sharing of information and experiences among researchers, practitioners, and decision-makers. This site can be viewed at www.nextrans.org/ADB30.
#### PROFESSOR VISITS NEXTRANS FROM TAIWAN

Dr. Chih-Peng Chu, Professor from the Department of Business Management at National Dong Hwa University in Taiwan, visited the NEXTRANS Center in January 2010.

Professor Chu's week-long visit allowed him to share ideas with faculty and staff, and discuss opportunities for future joint-research initiatives. NEXTRANS has undertaken a Memorandum of Understanding with National Dong Hwa University aimed at collaborating on projects related to logistics management and land cargo flow.

The visit was part of the Center's ongoing commitment to foster institutional linkages at the global level.

![From left: NEXTRANS Secretary Nija Phelps; Professor Chih-Peng Chu (National Dong Hwa University); Director Srinivas Peeta; Research Associate Lili Du; graduate student Yu-Ting Hsu; graduate student Yong Hoon Kim; and Research Associate Sushant Sharma, in the NEXTRANS Center office.]

#### RESEARCHERS PRESENT AT PURDUE ROAD SCHOOL

The NEXTRANS Center was pleased to host a session on March 10, 2010 during the 95th Annual Purdue Road School. The session, titled, "Striking the Balance Among Transportation Goals: Economics, Energy, and Safety," included presentations on three NEXTRANS-sponsored projects that highlighted the integrated nature of the Center's research.

Graduate researcher Josh Mills presented research that establishes a link between highway bypasses and changes in the local economy. Professor Wallace Tyner (Purdue) discussed the impacts of cellulosic biofuel production on Indiana road infrastructure. Finally, Research Associate Lili Du addressed how to best allocate limited resources in order to improve the functionality of infrastructure networks during natural or man-made disasters.

In addition to this session, hundreds of participants visited the Center's exhibit booth.

The 2010 Road School was coordinated by the Joint Transportation Research Program (JTRP), and chaired by Dr. Kumares Sinha, and NEXTRANS Investigator Professor Jon Fricker (Purdue).
NEXTRANS DIRECTOR VISITS AUSTRALIA

Dr. Srinivas Peeta visited Australia for four weeks in April 2010 where, among other activities, he delivered a public lecture on infrastructure network survivability in disasters. He received a 2010 UniSA Distinguished Researcher Award from the University of South Australia in Adelaide (UniSA). The award is given by the Australian Competitive Grants and Fellowship Development Committee for the purpose of attracting distinguished international researchers with outstanding track records in their respective fields to visit UniSA to strengthen research collaboration and outcomes.

Director Peeta was also invited to visit Monash University in Melbourne, where he made two seminar presentations. There he met with their Deputy Vice Chancellor Dr. Edwina Cornish and Pro Vice Chancellor Dr. Simon Adams to discuss opportunities for collaboration at the institutional level. Using the NEXTRANS Center and Monash's Institute for Transport Studies as points of contact, Purdue and Monash are exploring collaborations on research in the domains of intelligent transportation systems and sustainability.

ITS WORKSHOP PROMOTES COLLABORATION

Research Associate Sushant Sharma co-chaired a session at the ITS JPO (Intelligent Transportation Systems Joint Program Office) Strategic Research Plan UTC/University Workshop, held on April 28 - 29, 2010 at USDOT headquarters in Washington, D.C.

Dr. Sharma co-chaired a session on the potential environmental applications of ITS from a university perspective. He presented a number of environmentally-related research projects recently conducted by NEXTRANS and Purdue University, discussing their potential overlap with ITS research. He emphasized that real-time data procured by ITS could more effectively quantify CO2 emissions, providing better data for research and allowing agencies to develop policies for CO2 reduction. He also discussed the benefits of moving toward a "system of systems" approach, in which all modes and systems are integrated to achieve sustainability (improved efficiency, reduced cost, and energy consumption).
PUBLICATIONS & PRESENTATIONS *


Coifman, B., “Innovative Vehicle Classification Strategies: Doing More For Less,” Funded and Affiliated Faculty Presentation, NEXTRANS Center Site Visit and Review, Purdue University, West Lafayette, IN, November 2009.


DeLaurentis, D., "System Methods for Uncovering Economic, Technological, and Policy Enablers of an ‘On-demand air service’ Regional Passenger Transportation Solution," presented during visit of RITA Administrator, Mr. Peter Appel, Purdue University, West Lafayette, IN, August 19, 2010.


Ji, Y., "Assignment-based Methodology to Match Automated Vehicle Location Transit Bus Trip Trajectories to Schedules," Student Poster Presentation, NEXTRANS Center Site Visit and Review, Purdue University, West Lafayette, IN, November 2009.


PUBLICATIONS & PRESENTATIONS


McCord, M.R., Mishalani R.G., “The OSU Campus Transit Lab for Research, Education, and Outreach,” RITA Administrator Mr. Peter Appel Visit to NEXTRANS Center, Purdue University, West Lafayette, IN, August 19, 2010.


Mills, J., "An Analysis of the Socioeconomic Impacts of Bypasses on Small- and Medium-Sized Communities Incorporating Spatial Econometric Methods," presented at Regional Population and Health Economics Third Annual Midwest Graduate Student Summit, Purdue University, West Lafayette, IN, April 9-10, 2010.


Mishalani, R.G., McCord, M.R., Goel, P.K., “NEXTRANS at The Ohio State University: Overview and Campus Transit Lab,” Presentation to USDOT RITA Review Committee, NEXTRANS Center Site Visit and Review, Purdue University, West Lafayette, IN, November 2009.


Zhang, Y., “Incorporating Aerial Image-Based Information in AADT Estimation,” Student Poster Presentation, NEXTRANS Center Site Visit and Review, Purdue University, West Lafayette, IN, November 2009.

* This list is not comprehensive, but represents a sampling of presentations & publications related to NEXTRANS projects.