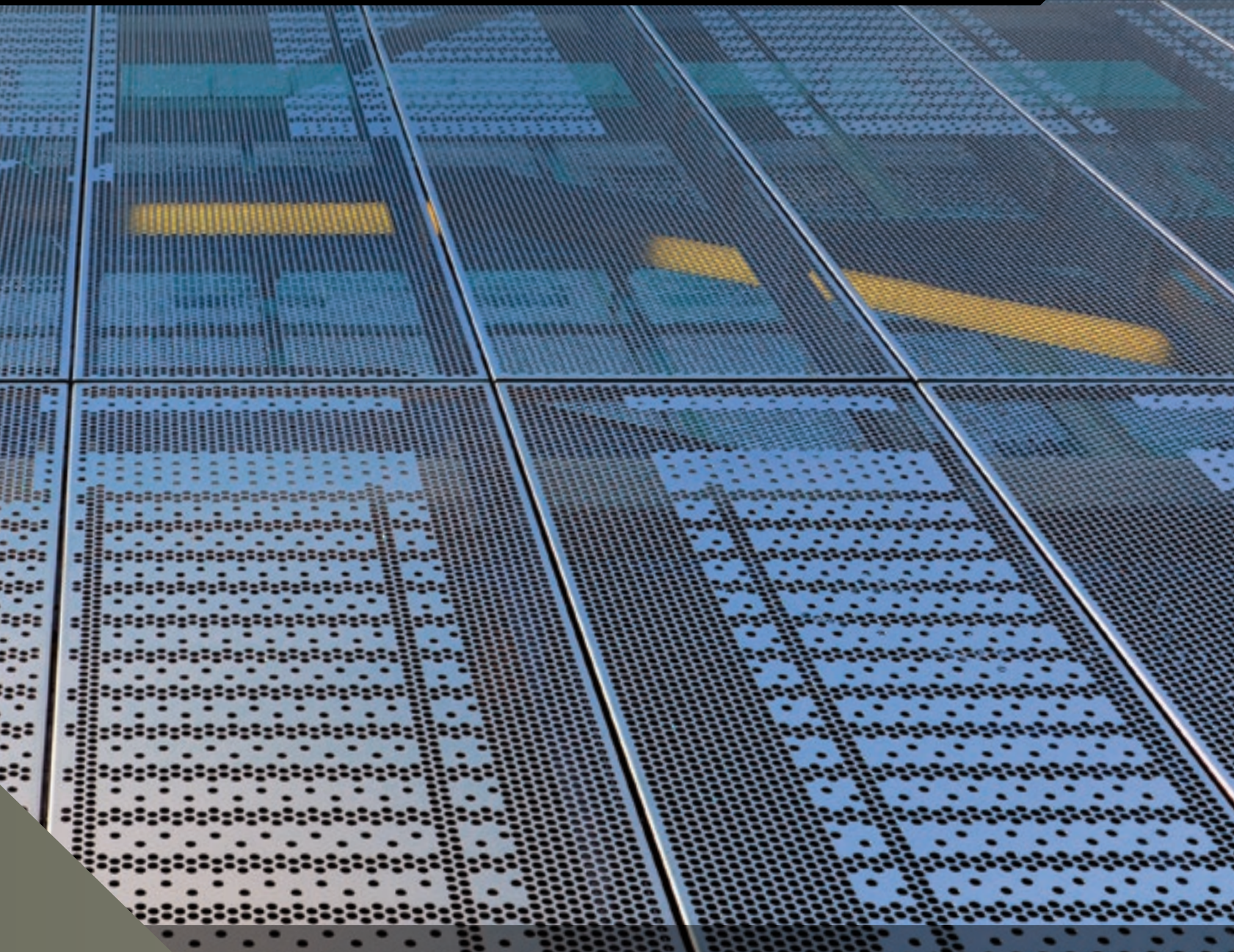




**Northwestern University
Transportation Center**



2013 Progress Report



Research Outreach Education | Mission

A leading interdisciplinary education and research institution, the Northwestern University Transportation Center (NUTC) serves industry, government and the public through a comprehensive research agenda, academic degree programs, executive education programs, and an array of outreach activities. Since its inception in 1954, the Center's mission has been to make substantive and enduring contributions to the advancement

of transportation. The pursuit of the Center's mission is rooted in an interdisciplinary approach to transportation and logistics education and research. Its strength lies in the quality and productivity of its faculty, the focus on both scholarly and applied research, the Center's interactions with industry and public partners, and its continuous recalibration to the forces generated as technology and society change.

NUTC exists to cultivate and share an improved understanding of the economics and science of transportation and logistics systems. The Center brings together academic researchers, students, business affiliates, and others in open exploration of ways to make transportation and supply chain operations more productive, efficient, safe, secure, environmentally friendly, and socially beneficial.



About the cover: Our front and back covers feature two glimpses of the Chicago Transit Authority's Morgan "L" Station in Chicago's West Loop. The station, completed in 2012, typifies the planning and renewal underway system-wide in the CTA. NUTC research has supported the Agency's efforts. (see article on page 15) Back cover photo courtesy of the CTA.



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How We Measure Success | Highlights



By the Numbers

- 23** Sponsored research projects active
- 7** Dissertation Year Fellows supported
- 22** Students supported via research projects
- 32** Workshops, seminars conducted
- 4** Conferences, symposia, distinguished lectures
- 13** New members to the Business Advisory Committee (BAC)
- 93** Total BAC membership

By Student Experiences

"The most valuable thing is the opportunities we have to work with industry and the public sector to solve practical, meaningful problems. I'm motivated by the idea that cities and transportation can be healthier and more sustainable." – **Charlotte Anne Frei**, PhD Candidate

By Evaluations

"This program is well done. The instructors are outstanding. I had a great and informative experience and met very nice colleagues." – **Participant**, Executive Program

By Collaborative Reach

"...hearty congratulations on your transportation module. The reports from Jakarta have been absolutely glowing. You guys did a first-rate job."

– **Jeffrey Winters**, Program Director – Equality, Development, and Globalization Studies Program, Northwestern

By Research Benefits

"In a first-quarter report card to measure the effectiveness of CTA's Crowding Reduction Plan, nearly all of the bus routes that received extra service had reductions in crowding, even as ridership remained steady or grew. In addition, rail riders have seen similar benefits on the six rail lines that received additional service." – **CTA Report** on Crowding Reduction Plan, 5/8/13

Director's Message

Our progress report is an opportunity to review the past year's activities and preview what may lie ahead in the next few months and years. It is also an opportunity to take stock of accomplishments, reflect on the things that went well, and those that may have gone better. It is part of the dynamic that successful research centers engage in to continually evolve, anticipating trends and developments in the field, identifying challenges and opportunities that engage our researchers and students with our substantial and expanding base of industry and agency partners.

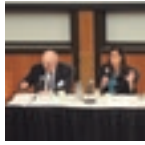
The transportation domain is far from stagnant— notwithstanding the state of poor repair of the infrastructure that users may encounter on a daily basis, the frustration of congested highways and crowded buses, or delays at airports and missed connections, important transformations are taking place in virtually all sectors and modes. Technology remains a major driver of this transformation, but the vision is again getting bolder, as new players and stakeholders are taking more significant roles, and user expectations are on the rise.

Examples abound, some publicized, others less so. Big Data is of course still with us, and will be for the foreseeable future (albeit the buzzwords will undoubtedly evolve), mostly delivering on the promise of more efficient management and service supply, though only taking timid steps in terms of delighting consumers in the transportation world. Smart cities are on every major technology company's strategic agenda, a prime example of the long-promised "internet of everything"—a world of connected systems that share information for the greater

delight of all. Electric-powered vehicles are also making important strides, in technology if not quite yet in market adoption, though the likes of Tesla are clearly shifting the reference point for the technology's desirability from a consumer standpoint. From a long-term long shot possibility, autonomous vehicles have become increasingly part of the short to medium term development scenarios—with major implications beyond the obvious safety and operations issues, holding out the promise of independent mobility for aging citizens, and dramatically changing the cost structure for many services.

Many cities are seriously investing to accommodate non-motorized forms of mobility and provide more walkable, liveable environments. Progressive transit agencies are investing in better design for stations (see cover), an important and often overlooked aspect of the overall user experience. Airlines are again advertising the quality of their seats and the cabin experience, after a long period of focusing only on cheap fares. Heated competition in the "last mile" for home deliveries of online purchases is bringing a host of new players with innovative ideas and fresh approaches.

The Transportation Center is part of the intellectual ecosystem for such developments. Through partnerships with industry, particularly our Business Advisory Council (BAC) member companies, NUTC researchers are developing the analytics and tools that leverage Big Data into operational and strategic knowledge for transportation companies. Working with transportation agencies at the metropolitan and national levels, NUTC researchers are similarly developing the advanced methods



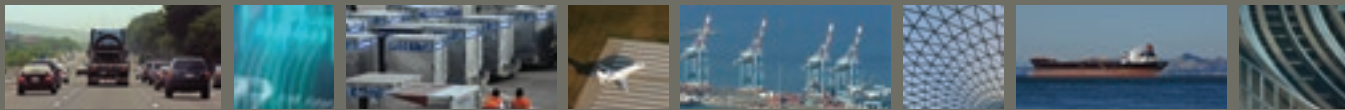
that can take advantage of the growing availability of data provided by sensors and individual probe data (e.g. smartphones). Our researchers similarly help frame and analyze the public policy issues and trade-offs raised by these transformations.

The research, education and outreach activities highlighted in this progress report provide a vivid depiction of the dynamic and forward-thinking research and interaction that take place at the NUTC, and the engagement of our faculty and student researchers with the transportation industry, in both the private and public sectors. We hope this progress report will convey the breadth and richness of our activities in research, education, outreach and industry engagement, the distinction of our faculty and students, and the excitement and dynamism of our community.

Sincerely,

Hani Mahmassani
*Director, Northwestern University
Transportation Center
William A. Patterson Distinguished
Professor of Transportation*

Collaboration & Outreach | Highlights



Regional & National

NUTC hosted the 6th Lipinski Symposium on Transportation Policy and Strategy: *Private Money for Public Infrastructure: Promises, Pitfalls, and the Path Forward* (story p.30)

Dr. Irwin M. Jacobs, Founding Chairman and CEO Emeritus of Qualcomm Inc., delivered the 2013 Patterson Lecture in Transportation: *The Impact of Wireless on Logistics*

and the World from *OmniTRACS to Ubiquitous Smart Devices* (story p.38)

NUTC hosted industry workshops: *Data-Driven Business: Challenges and Best Practices in the Transportation Industry*; and *Smarter Cities / Smarter Mobility* (story p.36)

NUTC faculty and students were active participants in the 92nd

Annual Meeting of the Transportation Research Board (story p.40)

NUTC hosted an executive short course: *Freight Transportation and Logistics: Delivering Results in a Volatile Environment* (story p.42)

NUTC hosted more than 30 Technical Seminars, *Sandhouse Gang* (rail industry) Seminars, and *Icarus Society* (aviation industry) Seminars (story p.41)

SYMPOSIA, CONFERENCES, & COMMITTEES



NUTC is a consortium member of research team selected as part of the Department of Labor's **Trade Adjustment Assistance Community College and Career Training** (TAACCT) program to improve education programs for supply chain management (story p.21)

In collaboration with **PB Americas**, NUTC was selected to develop the next generation of

integrated planning and forecasting tools for the **Chicago Metropolitan Agency for Planning** (CMAP) (story p.20)

Joseph Schofer is leading the preparation of a strategic plan and agenda for the **National Cooperative Rail Research Program** (NCRRP) of the Transportation Research Board (story p.26)

NUTC is teamed up with several companies and universities to support US DOT R&D needs in the areas of System Operations (with **SAIC**) and Policy Analysis (with **Booz Allen**).

NUTC was selected as part of a consortium led by **SAIC** to support strategic research through the **FHWA's Saxton Transportation Operations Laboratory**

RESEARCH COLLABORATION



Research, Analysis, Advising

- Chicago Metropolitan Agency for Planning
- Chicago Transit Authority
- Pace Transit
- Illinois DOT
- FHWA, U.S. DOT
- Transportation Research Board

Illinois Department of Transportation Secretary Ann Schneider and Deputy

Secretary **Bola Delano** visited NUTC and discussed strategic research priorities for Illinois (story p.39)

NUTC developed a comprehensive framework for the implementation and evaluation of congestion pricing strategies for the Chicago metro area, under consideration by the **Chicago Metropolitan Agency for Planning** (story p.21)

NUTC faculty and student researchers are working with the **Utah DOT** on an FHWA-supported project to develop and implement weather-responsive traffic management
Honored Chicago Transit Authority President **Forrest Claypool** with the David F. Schultz Award for Outstanding Public Service in Transportation

FEDERAL AND REGIONAL AGENCIES

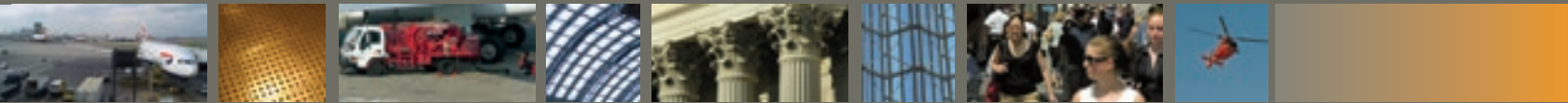


Research Partners (stories p.26)

- Boeing
- Booz Allen
- Carry Transit
- Delcan
- Echo Global Logistics
- Ford Motor Company
- PB Americas
- SAIC
- Sears
- SETS, Inc.
- Teradata
- USBank

Students in NU's **MS in Analytics** program participated in several industry projects as part of an internship program with BAC companies

INDUSTRY RESEARCH



International

INTERNATIONAL SYMPOSIA

Ian Savage organized and served as the 2013 Summer School and Conference Chair for the *Kuhmo NECTAR Conference and Summer School on Transportation Economics: Annual Conference of the International Transportation Economics Association 2013* (story p.34)

NUTC faculty presented papers, conducted workshops, and participated in conferences in:

- Beirut, Lebanon
- Delft, Netherlands
- Dubai, UAE
- Hong Kong
- Jakarta, Indonesia
- Lisbon, Portugal
- Lyngby, Denmark
- Milan, Italy
- Noordwijk, Netherlands
- Novi Sad, Serbia
- Ottawa, Canada
- Prague, Czech Republic
- Seoul, South Korea
- Siracusa, Italy
- Stockholm, Sweden
- Tainan, Taiwan
- Tbilisi, Georgia
- Vienna, Austria
- Zagreb, Croatia

INTERNATIONAL RESEARCH

NUTC hosts and contributes faculty to Chalmers University of Technology, Sweden, for their Supply Chain Management professional education program

In collaboration with SETS, Inc., NUTC is planning and designing a national Road Transportation Research Center of excellence for the **Ministry of Transportation in the Kingdom of Saudi Arabia**

Hani Mahmassani took part in an international summit of experts on the future of transportation hosted by **KTH Stockholm**, in Sweden, in a continuing collaborative effort to formulate and present alternative future visions for urban transport

INTERNATIONAL GOVERNMENT AND INDUSTRY ACTIVITIES

In partnership with the Ministry of Home Affairs of the **Republic of Indonesia** and the **Rajawali Foundation**, NUTC developed and implemented a customized executive course, Transportation Policy Development, Planning and Management in Jakarta, Indonesia for elected city mayors and district leaders and related government officials (story p.33)

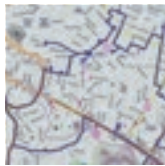
Aaron Gellman serves on the Panama Canal Advisory Board

NUTC Director **Hani Mahmassani** serves on the Advisory Board of the Hajj Center of Research Excellence, Umm-al-Qura University, Saudi Arabia

NUTC was invited to a symposium on future mobility concepts for the **King Abdulaziz City for Advanced Research in Energy (KA CARE)**, a new science city of 50,000 people planned in Saudi Arabia

CCITT | CENTER FOR THE COMMERCIALIZATION OF .. INNOVATIVE TRANSPORTATION TECHNOLOGY

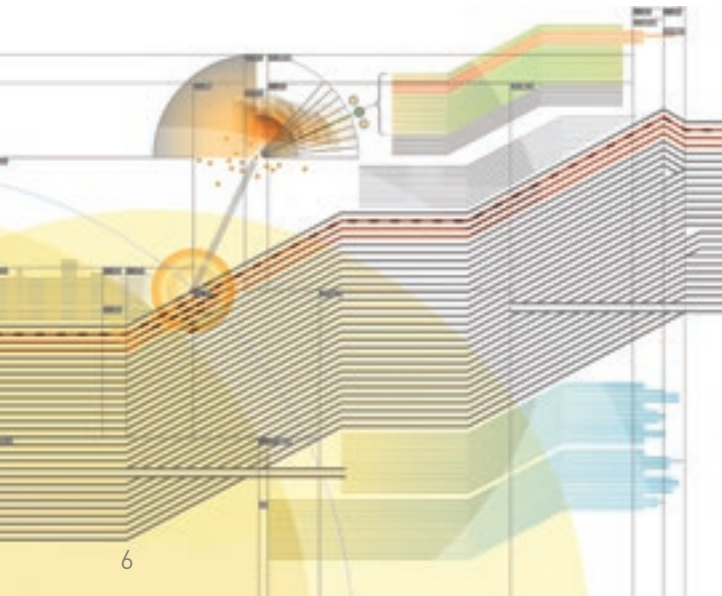
The Center for the Commercialization of Innovative Transportation Technology (CCITT) is part of a nationwide University Transportation Center program operated and funded by the Research and Innovative Technology Administration of the US Department of Transportation. CCITT fosters the implementation of innovative technologies for all modes of surface transportation including, but not limited to, railways, mass transit, highways and waterways.



CCITT wrapped up its research funding cycle from the SAFETEA-LU Transportation Bill and various extensions, on August 31, 2103. CCITT supported progressive research to move innovations from the lab into the hands of practitioners. Since its inception in 2008, CCITT funded 18 projects involving 17 principal investigators that engaged 31 undergraduate, graduate,

and post-doctoral students in cutting edge research projects. The Center also partially supported eight dissertation year fellowships awarded to graduate students in their final year of study. CCITT projects fostered collaboration and the transfer of knowledge or technology to many industry partners including: BNSF Railway; Ford Corporation; Google; Philips Corporation; Norfolk Southern Railroad; PacketVideo Corporation; PTV America; Redondo Optics; and Union Tank Car Company. CCITT also fostered several collaborations to improve transit operations with the public-sector partner, the Chicago Transit Authority. Notable outcomes included:

- a high-strength steel for potential use in next-generation tank cars;
- a cloud-based software to improve rail maintenance planning;
- fiber-optic sensors for deformation monitoring of infrastructure;
- haptic technology to minimize driver distraction when using flat panel displays in moving vehicles;
- improved logistics techniques to manage the distribution of goods and materials in relief settings;
- software tools to estimate lifecycle emissions of freight operations;
- software tools to construct network tools to test transit operations; and
- software technologies to improve the transmission of video data for real-time analytics over wireless networks for transportation operations management.



Transportation Library

Researchers from around the world, in the fields of transportation, law enforcement, and environmental impact assessment use the Transportation Library.

In 2013, the Library published a comprehensive on-line collection of materials documenting O'Hare International Airport, titled: *O'hare@50*.

The Library's staff produces *TRANweb*, a web-based periodical index of transportation and law enforcement articles and conference proceedings. The Library's collections are available to the general public on weekdays, and it provides reference assistance via email, telephone or in person.



The Transportation Library was founded in 1958 to support NUTC's curricula and research programs. Containing close to 500,000 items, it is one of the largest transportation information centers in the world, encompassing all transportation modalities including: air, rail, highway, pipeline, water, urban transport and logistics. It also includes a significant collection on law enforcement materials, 18th-21st century transportation companies' annual reports and its paper collection of environmental impact statements (EIS) is one of the world's most complete.

NUTC educates and promotes awareness of transportation-related research targets through its own initiatives and by forming relationships with institutes and centers that provide enhanced opportunities for students and faculty to acquire knowledge in subjects affecting the transportation industry.

Synergistic Institutes and Centers

The activities they generate are open to the campus and larger transportation communities, contributing to a rich intellectual and professional experience in virtually all aspects of transportation systems. Examples of NUTC's synergistic institutes and centers are below.

Synergy: The interaction of two or more agents or forces which create a combined impact that is greater than the sum of their individual effects.



Infrastructure Technology Institute (ITI)

ITI is a University Research Center of Excellence supported by RITA of the US Department of Transportation. Its theme is to develop strategies and tools to protect and improve the condition, capacity, and performance of the nation's highway, railroad, and mass transit infrastructure systems. Researchers at ITI develop advanced methods for monitoring infrastructure condition and performance to assist owners and operators with critical decisions concerning structural integrity, renewal, and rehabilitation.

Initiative for Sustainability and Energy (ISEN)

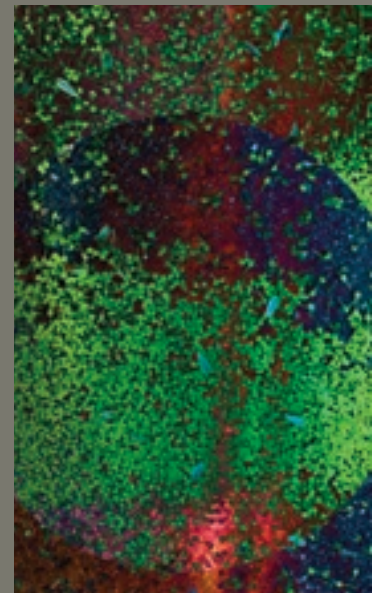
ISEN is an umbrella organization at Northwestern University designed to create, advance, and communicate new science, technology, and policy for sustainability and energy. Its particular focus is on sustainable energy supply, demand, and use. Its goal is to integrate the University's efforts in energy, sustainability, and outreach. Argonne National Laboratory is ISEN's primary research partner.

Northwestern Institute on Complex Systems (NICO)

NICO is an institution that brings together scholars from across the university to study complex, emergent behavior of systems of interdependent actors. Co-located with NUTC in Chambers Hall, NICO increasingly collaborates with NUTC in the interdisciplinary field of network science.

Center for Operations & Supply Chain Management (COSCM)

Based in the Kellogg School of Management, COSCM studies operational research questions in supply chains and other business contexts. It offers executive education and other programs that consistently rank among the nation's best.





Faculty Affiliates | Researchers

Jan D. Achenbach

Walter P. Murphy and McCormick School Distinguished Professor Emeritus; Professor of Mechanical Engineering and Applied Mathematics, McCormick School of Engineering and Applied Science [Airworthiness assurance of aircraft structures](#); ultrasonic methods in quantitative nondestructive evaluation; fracture mechanics



Zdenek Bazant

McCormick Institute Professor and Walter P. Murphy Professor of Civil and Environmental Engineering, McCormick [Mechanics of materials and structures and structural safety, nanomechanics, and hygrothermal effects, and with applications to concrete, fiber composites, tough ceramics, rocks, soils, bone, snow and sea ice](#)

Henry Binford

Associate Professor of History and Urban Affairs, Weinberg College of Arts and Sciences [Urban travel and location forecasting models](#); transportation network analysis and modeling; history of urban travel forecasting methods and practice

David E. Boyce

Adjunct Professor of Civil and Environmental Engineering, McCormick; Professor Emeritus of Transportation and Regional Science, U of I—Chicago [Urban travel and location forecasting models](#); transportation network analysis and modeling, history of urban travel forecasting methods and practice

Ronald R. Braeutigam

Associate Provost for Undergraduate Education; Harvey Kapnick Professor of Business Institutions; Professor of Economics, Weinberg [Applied micro-economic theory and industrial organization](#); regulatory economics

Fabián E. Bustamante

Associate Professor of Electrical Engineering and Computer Science, McCormick [Design, deployment and evaluation of large-scale distributed systems in both wide-area and mobile networks](#); experimental systems, in particular operating systems and distributed computing

Clarke L. Caywood

Professor of Integrated Marketing Communications, Medill School of Journalism, Media, and Marketing Communications [Marketing and communications](#); crisis management and communications; humanitarian logistics; stakeholder relationship management; political and deceptive messages and advertising

Wei Chen

Professor of Mechanical Engineering, McCormick [Engineering design](#); optimization under uncertainty; demand modeling; computational design methods; decision-making; automotive engineering



Sunil Chopra

IBM Distinguished Professor of Operations Management & Information Systems, Kellogg School of Management [Supply chain management and operations](#); design of communication and distribution networks; supply chain risk

J. Edward Colgate

Allen and Johnnie Breed Professor of Design, Mechanical Engineering; Co-Chair, Segal Design Institute, McCormick [Human/machine interface, haptics, mechatronic systems](#)

James G. Conley

Clinical Professor of Technology, Kellogg School of Management; Professor of Industrial Engineering and Management Sciences, McCormick [Product design and development technologies](#); intellectual property strategies; intellectual capital; innovation management

Noshir Contractor

Jane S. & William J. White Professor of Behavioral Sciences; Professor of Industrial Engineering & Management Science, Communication Studies and Management & Organizations, Kellogg [Social and knowledge networks](#); theories, statistical and computational methods; organizational theory

Anne Coughlan

Professor of Marketing, Kellogg [Distribution channel management and design](#); pricing and competitive strategy; reverse channels—product returns

David A. Dana

Stanford Clinton Sr. and Zylpha Kilbride Clinton Research Professor of Law; Co-Director, Northwestern Institute for Sustainable Practices [Environmental and land use law, regulation and technological change in the automobile industry](#); eminent domain reform and urban sprawl

Irina S. Dolinskaya

William A. Patterson Junior Professor of Transportation; Assistant Professor of Industrial Engineering and Management Sciences, McCormick [Optimal path finding](#); analysis of dynamic systems & networks; large scale computationally demanding dynamic programming problems, including vessel, autonomous vehicles, and robot routing



**Pablo Durango-Cohen**

Associate Professor of Civil and Environmental Engineering, McCormick Transportation infrastructure management; modeling/analysis of production control systems; capacity management; statistical performance modeling; contract analysis/design, sustainability analysis

Jonathan Hall

Post-doctorial Research Fellow, NUTC, McCormick, Recipient of the Dan Searle Fellowship in Economics Applied micro-economic theory; transportation economics; urban economics; industrial organization

Paul M. Hirsch

James L. Allen Distinguished Professor of Strategy and Organizations, Kellogg Organizational change; human resources and mass media

Seyed Iravani

Professor of Industrial Engineering and Management Sciences, McCormick Stochastic modeling/analysis; production/logistics; optimization of queuing systems

Bret Johnson

Associate Director of NUTC; Director of CCITT; McCormick Technology transfer and commercialization; technology based economic development; space and technology innovation policy



The field of NUTC affiliations and activities is wide and deep, reflecting the interdisciplinary nature of transportation-related challenges and opportunities.

David C. Dunand

James N. and Margie M. Krebs Professor of Materials Science and Engineering, McCormick; Co-director of Initiative for Sustainability and Energy at Northwestern Light-weight metallic materials (alloys, composites, foams, sandwiches) for energy-efficiency; high-temperature alloys for internal-combustion and jet engines

Steven Franconeri

Assistant Professor of Psychology, Director of Undergraduate Studies, Cognitive Science, Weinberg Guidance and capture of visual attention/awareness; visual cognition; object tracking

Andreas Frei

Post-Doctoral Fellow, NUTC, McCormick Social networks and their implication on travel behavior; analysis of activities; modeling of transportation behavior; changing behavior towards a sustainable transportation system

Aaron J. Gellman

Professor of Transportation, NUTC; Adjunct Professor of Management & Strategy, Kellogg Transportation, technology and innovation management, economics and policy; aviation management; regulation; financial analysis; technology forecasting

Robert J. Gordon

Stanley G. Harris Professor in the Social Sciences, Weinberg Macroeconomic and monetary theory; airline economics, management, history, and customer experience

Kimberly A. Gray

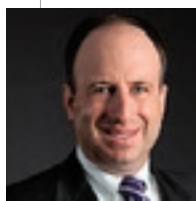
Professor of Civil and Environmental Engineering, McCormick Urban sustainability; brownfield/urban redevelopment; environmental impacts of transportation on health; energy efficient technology

Brian Hanson

Director of Programs, Research, and Operations, Buffett Center of International and Comparative Studies; Lecturer, Political Science and International Studies, Weinberg International political economy and trade; globalization; role of the state in world politics

Joel Horowitz

Charles E. and Emma H. Morrison Professor of Market Economics, Weinberg Econometrics; travel demand modeling; urban transportation

**Thomas N. Hubbard**

Elinor and H. Wendell Hobbs Professor of Management; Senior Associate Dean, Strategic Initiatives, Kellogg Industrial organization; trucking industry; economics of strategy; applied econometrics; economics of technology

John C. Hudson

Professor of Anthropology; Director of the Geography Program; Associate Director of Environmental Sciences Program, Weinberg Cultural and physical geography, North America; bio- and economic geography; cartography; geographic information systems

Albert Hunter

Professor of Sociology; Director of Urban Studies, Weinberg Transportation in urban areas; public policy; urban sociology; community; ethnicity, culture and literature

Arthur P. Hurter

Professor Emeritus of Industrial Engineering and Management Sciences, McCormick Logistics; applied micro-economic analysis; routing and risk analysis; facility locations; plant/equipment investment and replacement

Richard Joseph

John Evans Professor of International History and Politics; Roberta Buffett Center of International and Comparative Studies, Weinberg; Growth, governance, and sustainable development; comparative democratization; African politics; HIV prevention strategies; energy, environment and transportation

William L. Kath

Professor of Engineering Sciences & Applied Mathematics; Center for Photonic Computing and Communication; Professor of Neurobiology and Physiology, McCormick Computational neuroscience; fiber optics; wave propagation; nonlinear dynamics; complex systems

Leon Keer

Walter P. Murphy Emeritus Professor of Civil and Environmental Engineering, McCormick Engineering mechanics; tribology

Diego Klabjan

Professor of Industrial Engineering and Management Sciences, Director, Master of Science in Analytics Program, McCormick Business intelligence and analytics in air transportation, logistics, railway industry, retail, and supply chain management

**Frank S. Koppelman**

Professor Emeritus of Civil and Environmental Engineering, McCormick Travel demand modeling and prediction; yield management; urban, regional and intercity transportation planning; development of advanced travel demand modeling concepts and methods

Raymond J. Krizek

Stanley F. Pepper Professor of Civil & Environmental Engineering, McCormick Injectability and mechanical properties of grouted sands; disposal of waste slurries; problems involving soil-structure interaction; engineering behavior of dredged materials; dynamic response of soils

**Hani S. Mahmassani**

Director, Northwestern University Transportation Center; William A. Patterson Distinguished Professor of Transportation, McCormick **Multimodal transportation systems analysis, planning and operations; dynamic network modeling and optimization; dynamics of user behavior and telematics; telecommunication-transportation interactions; real-time operation of logistics and distribution systems.**

Therese McGuire

ConAgra Foods Research Professor in Strategic Management; Director, Guthrie Center for Real Estate Research and Real Estate Program, Kellogg **State and local public finance; fiscal decentralization; property tax limitations; education finance; regional economic development**

Leon N. Moses

Professor Emeritus of Economics, Weinberg **Applied microeconomic analysis; logistics and transportation economics; economics of regulation safety, risk; urban and regional economics**

Barry L. Nelson

Walter P. Murphy Professor; Chair, Department of Industrial Engineering and Management Sciences, McCormick **Computer simulation of dynamic, stochastic systems; design and analysis of simulation experiments**

Yu (Marco) Nie

Associate Professor of Civil and Environmental Engineering, McCormick **Network optimization; traffic flow theory and simulation**

**Maciek Nowak**

Associate Professor; Director, Master of Science in Supply Chain Management Program, Quinlan School of Business, Loyola University Chicago **Vehicle routing and tracking; supply-chain management; operations research and management; logistics/data analysis; quantitative methods; heuristic search**

John C. Panzar

Professor Emeritus of Economics, Weinberg **Theoretical and policy issues relating to network industries (telecommunication, electric transport, air transport and postal services); industrial organization; regulatory economics**

Kalyan Raman

Professor of Integrated Marketing Communications, Medill; Courtesy Professor, Marketing, Kellogg **Integrated marketing, marketing mix optimization; sales force compensation; brand name recall – implications for advertising and markets; supply chain mgmt.**

Mark A. Ratner

Professor of Chemistry, Weinberg College of Arts and Sciences; Co-Director, Initiative for Sustainability and Energy at Northwestern **Organic electronics and photovoltaics; energy storage materials; energy concentration routes, including exciton fission; agent-based modeling of complex systems**

Kathryn Reid

Research Assistant Professor of Neurology, Associate Director of the Sleep and Circadian Rhythm Research Program, Feinberg School of Medicine **Impact of sleep loss and circadian disruption on human performance; health/safety with emphasis on shiftwork**

Roberto Sarmiento

Library Department Head, Transportation Library, Northwestern **Management issues for the digitization of transportation collections; analysis of transportation library collections at national level; role of journal article indexing**

Ian Savage

Associate Chair, Department of Economics; Distinguished Senior Lecturer, Weinberg **Transportation safety; transportation economics; urban transit**

**Joseph L. Schofer**

Associate Dean for Faculty Affairs; Professor of Civil and Environmental Engineering, McCormick **Urban transportation policy planning; data information and**

decision making in transportation; traveler behavior and market research; intelligent transport systems; pedestrian and motor vehicle safety

Karen Smilowitz

Associate Professor of Industrial Engineering and Management Sciences, McCormick **Design and operations of logistics networks; vehicle routing and scheduling; supply chain management; applications in commercial and non-profit; humanitarian logistics**

Richard Sobel

Visiting Scholar, Buffett Center for International and Comparative Studies **Political science, public opinion/policy; intersection of security and domestic politics, civil liberties, right to travel, travel privacy, security and identification policies; housing and community development, and transportation articulation**

Joseph A. Swanson

Visiting Scholar of Finance, Kellogg **Corporate bankruptcy; econometrics; investment banking; mechanism design; regulation; transportation**

Fred W. Turek

Director of Center for Sleep and Circadian Biology; Charles E. and Emma H. Morrison Professor of Biology, Weinberg; Department of Neurobiology & Physiology, Feinberg **Circadian rhythms and their importance to health, safety, performance and productivity; fatigue and alertness in workplace and transportation industry**

Jan A. Van Mieghem

Harold L. Stuart Professor of Managerial Economics; Chair of Department of Managerial Economics & Decision Science; Professor of Operations Management, Kellogg **Operations management and strategy; supply chain management and analysis; management and investment under uncertainty (e.g. pricing, dynamic control of stochastic processing networks)**

Michael Watson

Adjunct Professor, Department of Industrial Engineering and Management Sciences, McCormick **Supply chain network design and facility location; analytics for the supply chain**

New to NUTC**Hongcheng Gan**

Visiting Scholar, NUTC; Associate Professor of Transportation; Deputy Director, Center for Super-networks Research of University of Shanghai for Science and Technology **Dynamic traffic system management; network modeling and optimization; dynamics of user behavior and telematics; environmental impacts of transport strategies**

**Conrado Borrás-Sánchez**

Post-Doctoral Research Fellow, Center for Sustainable Energy Analytics, Department of Industrial Engineering and Management Sciences, McCormick **Computer sciences and mathematical programming (optimization); private sector decision making problems: natural gas transportation, railways, and electric vehicles**



Faculty Recognition

NOTED LECTURE PRESENTATIONS

Zdenek Bazant

Presented the Fowler Distinguished Lecture at Texas A&M University in Oct. 2012; Delivered the Distinguished Lecture in Mechanical Engineering at Carnegie-Mellon University in Nov. 2012

Hani Mahmassani

Presented the paper *Dynamic Network Simulation* at the Freight Transport Colloquium held in Honor of the late Professor Marvin L. Manheim at the University of Antwerp in October 2012

Karen Smilowitz

Lectured on: *Operations Research for Non-Profit Settings* in November 2012 and April 2013 at Loyola University, Chicago, IL, and at Rensselaer Polytechnic Institute, Troy, NY, respectively

AWARDS AND APPOINTMENTS

Zdenek Bazant

Elected honorary member of the American Society of Mechanical Engineers and Fellow of the ASCE Engineering Mechanics Institute

Dirk Brockmann

Won the 2012 Cole-Higgins Award for Excellence in Teaching given by the NU McCormick School of Engineering and Applied Science

Diego Klabjan

Received one of ten IBM 2012 Watson Solution Awards to implement a new course in the Master of Science in Analytics (MSiA) program focusing on big data analytics

Ian Savage

Recipient of the Victor Olivera Educator Award for outstanding effort to help promote railroad safety awarded by the DuPage Safety Council in October 2012

Jan Van Mieghem

Received a MSOM Distinguished Fellow Award in 2012 for outstanding research and scholarship in operations management given by the Manufacturing & Service Operations Management Society (MSOM)

NOTEWORTHY ACHIEVEMENTS OR RECOGNITIONS

Jan D. Achenbach

Honored by the NU McCormick School of Engineering with the establishment of the Jan D. Achenbach Lecture Series for his extraordinary contribution to the field of mechanics and to the MCC Department of Mechanical Engineering

Zdenek Bazant

Served as Chairman of the International RILEM TC-MDC (Multi-Decade Creep) Committee

David Boyce

Paper titled: *Predicting Road Traffic Route Flows Uniquely for Urban Transportation Planning* received the Best Paper Prize at the 50th Anniversary Meeting of the Japan Section of the Regional Science Association International, October 2012

Wei Chen

New book published: *Decision-based Design: Integrating Consumer Preferences into Engineering Design* that utilized choice modeling techniques

Irina Dolinskaya

Named to the 2012 Northwestern Associated Student Government (ASG) Faculty & Administrators Honor Roll, by students, for her undergraduate course in Stochastic Models and Simulation

Robert J. Gordon

Was featured in op-ed pages around the world and profiled in the *New York Magazine* for his ideas expressed in his paper *Is American Economic Growth Over? Faltering Innovation and the Six Headwinds*

Therese McGuire

Chaired the Committee on Transportation Investments in Response to Economic Downturns at the meeting of the National Academy of Sciences / Transportation Research Board Study meeting held in Washington DC in November 2012

Ian Savage

Chaired the Organizing Committee for the International Transport Economics Association (ITEA) 2013 Summer School and Conference held at Northwestern in July 2013. Chaired the "Safety Analysis and Policy" Special Interest Group for the 2013 World Conference on Transport Research (WCTR), Rio de Janeiro in July 2013

Roberto Sarmiento

Named Chair of the TRB Library and Information Science for Transportation Committee (LIST) for 2012-2015

Richard Sobel

Co-edited the book *Public Opinion and International Intervention: Lessons of the Iraq War*

Michael Watson

New book published: *Supply Chain Network Design*; Co-founded Opex Analytics, a company dedicated to bringing analytics to businesses



Karen Smilowitz lectures to an OR class.



Emerging Challenges In Transportation

Image courtesy of: Aeon Project,
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www.michaelharboun.com/aeon.html

NUTC research is driven by major challenges facing the transportation industry and society. Mobility, safety, environment, energy, economic development, resilience, infrastructure renewal, and financial viability are at the forefront of transportation agencies' policy agendas. Competitiveness, globalization, collaboration, uncertainty, volatility and technological change are major drivers of strategic and operational decision-making for transportation enterprises.

The portfolio of research projects and activities at NUTC is continually evolving to anticipate, identify, and characterize significant issues faced by the transportation industry, in both private and public sectors. Faculty and student researchers work together with industry and agency partners to gather information and devise methodologies to analyze these problems, formulate strategies, design solutions, and work towards engaged implementation and evaluation. Transportation Center faculty periodically review developing industry, technology, policy and societal trends to identify emerging challenge areas that constitute opportunities for significant impact through Center research and outreach.

Building on the core strengths of its faculty researchers, enhanced through collaboration with other research centers and entities, NUTC faculty have identified the following eight emerging challenge areas:

- **Re-inventing the User Experience in Transportation**
 - Freight and Passenger
 - Business Intelligence in Support of Marketing, Operational Efficiency
 - New Focus on Design – Urban Design, Facility Design
- **Smart Cities, Driverless Vehicles, Connected Systems**
- **Freight Logistics and Economic Competitiveness, "Last Mile" Deliveries**
- **Leveraging "Big Data" for Transportation Agencies**
- **Transportation Energy and Sustainability**
- **Mixed Traffic Flow: Recognizing the Growing Role of Bicycles in Traffic Mix**
- **Humanitarian Logistics and Disaster Relief**

These areas share the following characteristics: (1) impact on society and/or industry; (2) fundamental and methodological challenges; (3) cross-disciplinary; and (4) strategic dimension. In addition, they draw on particular areas of strength and expertise at Northwestern, and form the focus of efforts both inside Northwestern as well as with our industry and agency partners. The top three in this list have gathered considerable momentum in the past couple of years, and are featured in this report.

Smart Cities

Pervasive sensors, wireless communications, and connected computing systems are already beginning to shape the urban experience, from mobility to social activities, energy efficiency to infrastructure service delivery. Imagine the city as one big connected computing cluster, where myriad transactions (corresponding to financial, information, energy, material, people, and vehicle flows) are sensed in real-time, where virtually all machines and people are interconnected, and provide status information passively and can receive information and instructions through various media. Thus the city's vital infrastructure systems would be always-on, always-aware of the demands on their different components, and would accordingly adjust allocation of resources to meet and anticipate spatial and temporal patterns of demand. And entities would transact seamlessly in that environment, matching customers to retail, recreational and other opportunities. In this environment, the user's urban experience would be paramount, while enabling sustainably optimized operation of vital infrastructures.

The above vision of smart cities as the logical outgrowth of connectivity in an internet of things is not only the target of marketing efforts by virtually all major information technology providers, but increasingly an opportunity that is capturing the attention of public and private stakeholders in metropolitan areas. Additional opportunities arise from two key developments in automotive technology: electrification, and autonomous vehicles. Both could thrive in a smart city environment, the ultimate smart grid for wirelessly-charging circulating vehicles, while autonomous vehicles of all types could fundamentally alter the economics of many forms of person and freight mobility.

Bringing the vision to light, in whatever form it might eventually take, raises critical challenges—technological, methodological, operational, organizational, and institutional, among others. Research at the Transportation Center already informs several facets of the problem, such as use of real-time sensor and probe data for predictive system management and control, development of simulation and optimization tools to optimize real-time operational aspects of transportation and logistics systems, understanding of individual perceptions, preferences and usage patterns with regard to smartphones and other personal wireless devices. However, considerable fundamental and applied research and development is required to enable the vision and its promise. Through a recent industry workshop, the Center gathered leading industry participants in delineating some of the challenges and opportunities in the evolving vision of the smart city. Considerable additional attention, and partnerships with industry and public agency partners are targeting more comprehensive approaches to address the system-level aspects of these developments. .



Reinventing the User Experience

In many realms of personal products and services, new technologies and devices continue to please and delight consumers. Through focus on the user experience, personal communication devices have become virtual hubs for social interaction, instant connectivity and context-specific information, creating community oases.

Drawing upon the lessons of highly successful consumer products and service concepts, reinventing the user experience calls for rethinking the very definition of the output of a transportation system, or of the nature of the service provided by a transportation company. This means rethinking the total experience. Such thinking calls for a multidisciplinary perspective that blends the contributions of product/service designers, behavior researchers, and planners and transport system specialists.

NUTC researchers continue to devise novel operating concepts and advanced methodologies that provide the intelligence required for flexible real-time operation of transport systems, delivering personalized information to travelers.

On the freight side, quality-of-service issues are paramount to system users and logistics managers. NUTC researchers are partnering with selected BAC member companies in pushing the frontier in freight service design and reliability—exploiting real-time tracking and transaction records to better design and control all aspects of the transportation and logistics process.

Leading this effort at NUTC is Dr. Hani Mahmassani. Key BAC industry partners include Teradata and Echo Global Logistics. Agency collaborators include the Chicago Transit Authority and PACE transit.



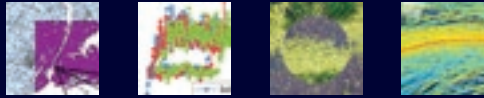
Connectivity and context-specific information and services have revolutionized the personal device user experience. In transportation, reinventing the user experience calls for rethinking the very definition of the output of a transportation system, or of the nature of the service provided by a transportation company. See related story on 32nd Annual Patterson Lecture, page 38.

Freight Mobility and Intermodalism for Global Competitiveness

Freight and logistics are core topic areas at the Transportation Center. The renewed emphasis identified in this area is on the growing role of international trade and global freight movement, and its implications for developments at national and regional levels in the US as it interacts with the rest of the world. Notwithstanding its growing economic significance, and the contribution of transportation and logistics costs to the overall cost of consumer goods, this area has seen only limited research in academic institutions and research centers. The primary issues and research goals articulated by NUTC faculty in this area include:

1. Enhancing intermodal connectivity for an integrated, globally competitive, national system (ports, rail, trucking) to support economic activity patterns while minimizing negative externalities of freight to local communities.
2. Harmonizing infrastructure, technology and policy for seamless and secure border crossings that support trade and economic activity.
3. Meeting capacity needs and alleviating congestion at critical urban hubs to eliminate bottlenecks through judicious combination of technological innovation, infrastructure investment, and policy initiatives.
4. Channeling global logistics chains to drive local economic renewal and employment.
5. Assuring reliability, resilience and consumer responsiveness of freight and logistics networks.
6. Defining models for public-private partnering in infrastructure development, financing and operation to achieve national objectives regarding multimodal freight corridors.
7. Developing knowledge bases, data and tools to support freight planning, policy development and investment decisions at statewide and metropolitan levels within a national competitiveness framework.

These issues are of considerable strategic importance to both industry as well as state and national-level agencies.



Core Research Areas

Transportation and Logistics Systems

and the development of advanced methods for systems and network planning, management, and operations

New insights, concepts, and tools can be utilized by industry, business, and government to support decision-making towards more efficient and responsive services and systems.

- Logistics and Supply Chain Management
- Network Modeling and Planning
- Transportation Demand, Economics, and Forecasting
- Transportation Asset Management
- Transportation Policy
- Human Performance and Transportation Safety
- System Operations



A Hyperpath Tool for Commuters and Transit Systems — To Help Reduce Uncertainty and Minimize Travel Times

Project: Reliable Routing in Transit Networks

Transit system reliability is one of the most important factors that influence commuters' choices for travel (what method of transit, where and when to begin the trip, what routes to take) second only to travel time. Transit systems are affected by variations in road traffic conditions as well as disruptions caused by weather conditions, accidents, mechanical failures, and human errors. While these hard-to-predict variations disrupt transit services, their overall impacts are rarely documented and understood in existing systems.

Due to the rapid evolution in smart connected networks, many transit agencies now have the capability to track their entire fleets, make short-term projections, archive the data and distribute passenger information—all in real time. Professor Yu (Marco) Nie, with assistance from graduate students Qianfei Li and Peng Chen, has sought to make this new data more useful for evaluating the variations in transit services—especially the time gaps between successive trains or buses at a given stop, know as headway—and to help passengers find optimal routing strategies to hedge against the uncertainty in these service variations.

The research team has developed a transit routing tool built on the notion of a hyperpath. A hyperpath represents not a single path and set of stops along the way, but a sequence of routing strategies along possible paths. Routing

based on a hyperpath promises to make better use of the availability of alternative routes in the transit systems. It also offers the flexibility of incorporating real-time information, such as the arrival times of all transit vehicles approaching a stop. A commuter's boarding decision at a stop depends on the waiting time as well as the remaining travel time to the destination once the selected transit line is boarded. This remaining travel time, in turn, is affected by future events such as waiting at subsequent transfers and travel between stops. In light of these uncertainties, the developed tool chooses an optimal hyperpath to minimize the expected journey time.

The tool helps transit users save travel time and improve the reliability of

their travel experiences by enabling them to make better-informed routing decisions. In the long run, the improved user experience could attract more passengers to use mass transit and thereby promote sustainable transportation by reducing the incidence of commuters driving to their destinations. The results from this project may also help managers understand the nature of uncertainty in large-scale transit systems. Passengers could evaluate the reliability of their trips (such as the likelihood of arriving at their destination on-time), and agencies could assess the overall reliability performance of their systems. Understanding the properties and effects of variabilities in their system could also help transit agencies design measures that aim to reduce variation.

The team tested and evaluated the new tool using a large-scale case study built from real transit system data provided by the Chicago Transit Authority. These tests confirmed that the hyperpath tool provides useful improvements in reducing uncertainty, and Nie is hopeful that it will be incorporated into future commuter-facing and transit system management platforms.

NUTC Research Assists CTA in Effective Route Restructuring

Project: Optimal Frequency Setting for Large-Scale Urban Transit Networks: A Data-Driven Approach

In May of 2013, three months after adding service to the busiest bus and rail routes under a crowding-reduction plan facilitated by NUTC research, the CTA reported in a news release that

“riders are experiencing less crowded conditions and better service on numerous bus and rail routes across the city. In a first-quarter report card to measure the effectiveness of CTA’s Crowding Reduction Plan, nearly all of the bus routes that received extra service had reductions in crowding, even as rider-ship remained steady or grew. In addition, rail riders have seen similar benefits on the six rail lines that received additional service.”

The Initial Challenge Transit agencies in large metropolitan areas, such as the Chicago Transit Authority (CTA) are seeking ways to utilize the growing data bases available through automated fare collection and other sources of ridership information to better allocate resources to improve service and the resulting user experience. NUTC has partnered with the CTA in developing data-driven approaches and decision support tools for service planning and allocation.



While it is desirable from the user’s perspective to increase frequencies over the entire network, transportation agencies have limited resources in terms of budget, fleet (number of available buses) and personnel. Agencies need to make allocation decisions that provide the greatest benefit in terms of quality of service for the most riders, subject to various requirements that are essential to their public mandate. Better decisions call for maximal use of available information, and mathematical techniques that consider service patterns and ridership responses across the entire system rather than on an individual route basis.

Approach The project entailed understanding and integrating both the demand side and supply side of the problem. On the demand side, ridership response (elasticity) to frequency changes needs to be captured. On the supply side, a mathematical model is formulated to optimally allocate available resources (e.g. budget and fleet) over the routes



in order to increase ridership, reduce waiting times and limit overcrowding.

Service Elasticity Estimation

Lower service frequencies generally discourage ridership, whereas higher frequencies attract additional riders. However, the extent of the ridership response depends on several factors that vary with the availability of convenient and affordable alternatives at different locations and by time of day. The demand response to changes is captured by the elasticity of demand to the provided service frequency. Typical agency practice has been to use across-the-board elasticity estimates. In this project, NUTC researchers estimated elasticities at a finer resolution, using detailed boarding and alighting data over multiple years provided by the CTA. The NUTC elasticity estimation model provides elasticities for every route, stop, and half hour while capturing the effects of land use, socio-demographics, walkability and accessibility.

Understanding and Modeling Service Patterns

Transit agencies in large urban areas use multiple “service patterns” for most of their routes to improve service



A map of a portion of the bus route restructuring, excerpted from the CTA Crowding Reduction Plan. Added bus services appear in green, restructured routes appear in red.

Core Research (continued)

along certain segments. A service pattern is defined over a subset of stops along a route. A commonly used pattern is the “short-turn” pattern, which provides additional service along a higher demand segment of a route; it typically overlaps the “full-length” pattern, which serves the entire route (including the higher demand segment). The CTA also schedules specific patterns for sports events, sponsoring companies and major schools.

The modeling challenge arises from the fact that riders are mostly unaware of the details of such patterns, which are not directly relevant to their choice, as they perceive only the overall service resulting from the juxtaposition of these different patterns. NUTC researchers introduced a mathematical formulation that recognizes the pattern frequencies as the key decision variable for the agency, while capturing the ridership response to resulting overall service using the detailed elasticity estimates mentioned previously.

Setting Frequencies: Exploring Trade-offs

Given the detailed elasticity estimates and modeling the pattern-route coupling, NUTC developed a mathematical decision model with two main formulations. The first formulation seeks to increase ridership and reduce wait time subject to operational budget, fleet, policy headway and overcrowding prevention constraints. The second formulation seeks to minimize the net operational cost subject to the same constraints, while retaining certain minimum ridership levels and not exceeding maximum waiting time constraints

in order to not compromise existing quality of service. The two formulations can be used in concert to explore trade-offs amongst agency cost, ridership and wait time (user cost) under varying funding and service quality scenarios in order to make better informed decisions.

Results The study concluded that it is possible to improve the quality of service by serving more riders and reducing waiting times, and still save on the operational cost by using a network-wide mathematical optimization approach. The study is unique in

- estimating the ridership response at a very fine spatial and temporal resolution relative to existing agency practices,
- capturing the complicated structure of multiple patterns serving a route, and
- estimating crowding levels in transit vehicles as the combined result of changing pattern frequencies and the ridership response to these frequencies in a time-dependent manner.

With improving data collection capabilities and computational advancements, more transit agencies today can utilize network-wide optimization models in order to assess their existing service and improve it by changing service schedules at the operational level and restructuring their service patterns at the strategic level.

This research was funded by Chicago Transit Authority (CTA) and conducted by NUTC director Hani Mahmassani, and professor Joseph Schofer. Omer I. Verbas, Charlotte Frei, and Raymond Chan were the principal graduate student researchers on the project.



Photo: Chicago Sun Times

Tackling the Problem of Travel Time Reliability in Network Planning

Project: Incorporating Reliability Performance Measures in Operations and Planning Modeling Tools

Challenge Travel time reliability is a critical dimension of service quality in a transportation system. Highly variable and unpredictable travel times are a growing concern for individual travelers and freight shippers alike, especially when trips are under tight time constraints. Modeling tools used to support planning and operations decisions generally do not capture this important performance dimension. Incorporating travel time reliability in network planning and traffic operations is the principal objective of this study.

Approach The project seeks to produce reliability performance measures as output of traffic simulation models. A comprehensive framework and conceptually coherent set of methodologies were developed to characterize travel time reliability, assess the impacts of various sources of unreliability on the transportation system, and determine the effectiveness and value of proposed counter measures.

• **Sources of Travel Time Unreliability** Several factors account for the uncertainty associated with travel time, such as traffic incidents, work



zones, weather, special events, traffic control devices, fluctuations in demand, and inadequate base capacity. The study categorized these variability sources based on three aspects: (i) demand vs. supply-side, (ii) exogenous vs. endogenous, and (iii) systematic vs. random; and provided a systematic approach to capturing different types of variability sources.

▪ **Scenario-based Reliability Analysis Approach**

The project proposed scenario-based approaches for obtaining travel time distributions using microscopic- or mesoscopic-traffic simulation models. The goal of this approach is to characterize the range of variation in travel time under a given system or policy by simulating multiple scenarios that reflect various sources of uncertainty in roadway capacity and demand.

▪ **Modeling Framework**

The project established a modeling framework for performing scenario-based travel time reliability analysis. The framework consists of the following three components: (i) Scenario Manager, which captures exogenous unreliability sources by generating input scenarios to traffic simulation tools consisting of mutually consistent combinations of demand- and supply-side external factors (e.g., special events, adverse weather, work zone and travel demand variation); (ii) Particle-based (micro- and meso-) Traffic Simulation Models, which capture

endogenous sources of unreliability (e.g., user heterogeneity and flow breakdown) and produce individual vehicle trajectories as simulation output; and (iii) Vehicle Trajectory Processor, which constructs travel time distributions from the resulting vehicle trajectories and extracts various reliability measures to characterize the overall system reliability and compare the impacts of different scenarios on travel time reliability.

Results This project developed and demonstrated a unified approach with broad applicability to various planning and operations analysis problems, which allows agencies to incorporate reliability as an essential evaluation criterion. The approach as such is independent of specific analysis software tools, in order to enable and promote wide adoption by agencies and developers. The project also developed specific software tools intended to prototype the key concepts, namely those of a scenario manager and trajectory processor, and demonstrated them with two commonly used network modeling software platforms.

More This study, funded by the Transportation Research Board's Strategic Highway Research Program (SHRP2), was conducted by NUTC in partnership with Delcan, Inc. and PB Americas. Professor Hani Mahmassani served as NUTC Principal Investigator, with Jiwon Kim as the lead graduate student researcher.



Will High-speed Rail Be Effective in the Northeast Corridor?

Project: High-speed Rail Passenger Services – What Market Sizes and Station Spacings Are Indicative of Success?

High speed rail passenger service may be an optimal way to travel for destinations having certain population sizes, and certain distances between stations. Funding from CCITT (a center within NUTC) helped to make possible a preliminary analysis to answer the question: What would be the effects of upgrading the Northeast Corridor (Washington/Boston) to high-speed rail passenger service?

Introduced in Japan in the 1960s and in France in the 1980s, high-speed rail has more recently come to Korea, Taiwan and China. These services operate on specially constructed, grade-separated lines at velocities of 270 to 320 km/hour (170 to 200 mph). Departure times for routes between principal city pairs range from 15 to 30 minutes.

This research project sought to identify the following: In cases where high speed railroad passenger service has proven to be successful, what is the range of inter-station spacings (measured in travel time), and what is the population size of the markets served?



Single railroad lines serving several stations, such as the Tokyo/Hakata line in Japan, and the Seoul/Busan line in Korea, were analyzed in regard to inter-station travel time and the population sizes of their markets, using passenger count data and survey data.

This analysis served as the basis for projecting high-speed passenger

counts for Amtrak's Northeast Corridor services. From this comparison, conjectures about the possible effects of upgrading the Northeast Corridor line to high-speed rail passenger service were examined. Work is currently underway to increase the usefulness of this form of analysis, as the public and various

agencies discuss the benefits and costs of High-Speed Rail in the U.S.

This research is being pursued by Professor David Boyce, with assistance from Jacqueline Lo and Jiwon Kim, Northwestern University; Satish Ukkusuri, Purdue University; and Seungmo Kang, Korea University.

Sandy: Recent Weather Catastrophe Focuses Research on Mitigating Future Impacts

Project: Dynamics of Urban Network Traffic Flow during a Large-Scale Evacuation

By October 29, 2012, news reports and images were conveying to the world the immense scale and damaging impact of Superstorm Sandy as it engulfed coastal communities in New Jersey, New York, and adjacent densely populated regions. On the previous day, mandatory evacuation had been ordered for the 375,000 residents living in New York City's "Zone A" including low-lying and coastal areas in anticipation of the hurricane.

NUTC doctoral researchers Ali Zockaie, Meead Saberi, and Ömer Verbas—under the guidance of director Hani Mahmassani—recognized the need for additional research on the dynamics of weather-related large-scale evacuation traffic on road networks. Specifically, the research team saw an opportunity to use the Long Island, New York, network model covering the counties of Kings, Queens, Nassau, and Suffolk in order to model an evacuation of a large-scale urban complex network in a weather-responsive simulation environment.

The results of the simulation confirm that the planned structure of the evacuation—its traffic origins and destinations, starting times for different locations, and timed intervals (recovery periods) between phases—can be configured in ways that improve the overall effectiveness of the evacuation effort. Also addressed in the simulation were the possible variations in route choices that indivi-

dual drivers' might take during their trip out of the evacuation zone.

This evacuation traffic flow study, motivated by the real-world events of October, 2012, provides insights that can be extended into further research, and can be of value to urban and regional agency planners looking to improve the effectiveness of large-scale evacuations in complex traffic networks during weather-related events.



In the weather-related traffic management case study, the team studied how different operational interventions would influence traveler choice and subsequent network performance. For example, school related trips make up 8.9% of the traffic volume during the simulated morning hours, and the departure time distribution of school trips is more narrowly distributed than work trips in the same time period. By shifting school trips an hour later, the peak traffic can be distributed. The resulting difference in network densities is illustrated at right with the top network showing typical density, bottom showing reduced density through shifting school-related trips by one hour.

Core Research (continued)

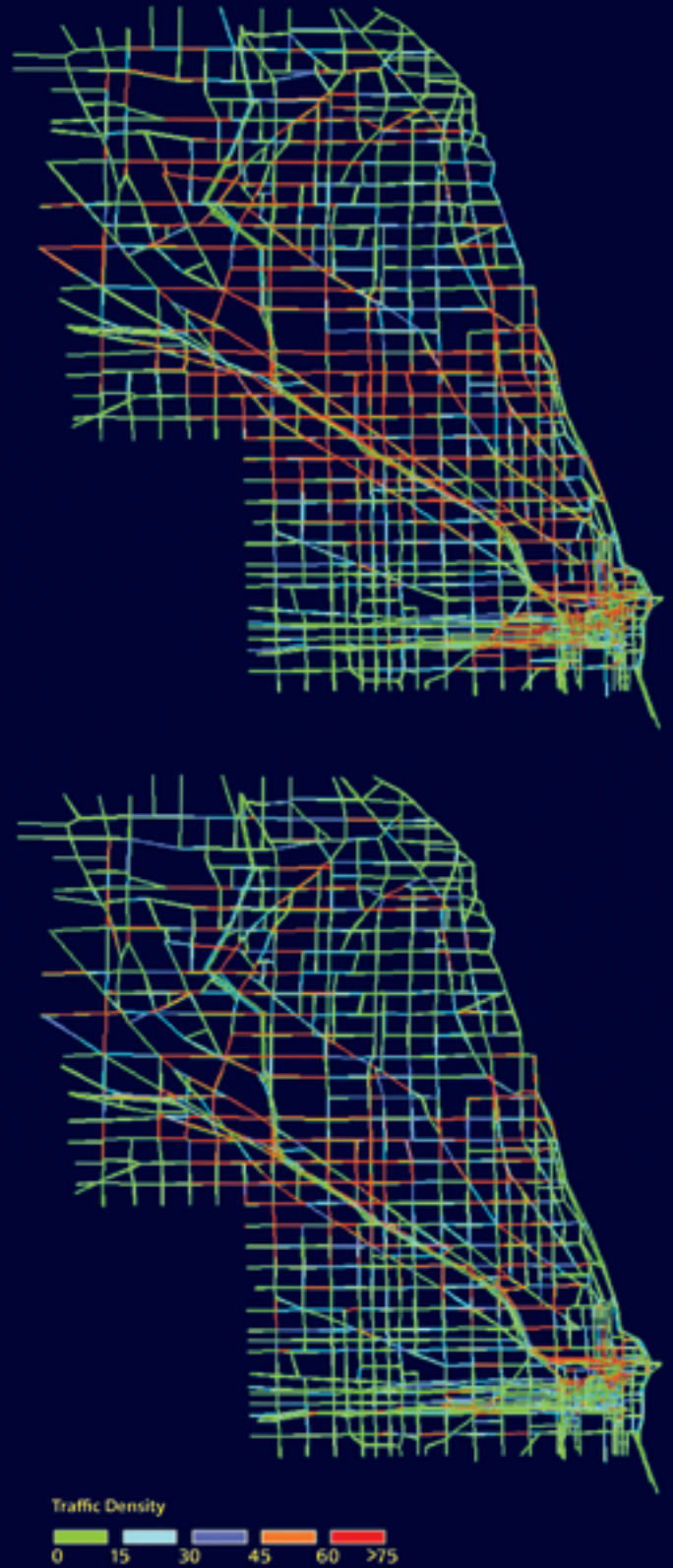
Seeking to Improve Traffic Conditions and System Safety and Sustainability

Project: Analysis of Network and Non-Network Impacts upon Traveler Choice – Improved Modeling Accuracy for Better Transportation Decision Making

Challenge The need to reduce congestion, enhance safety and make our transportation systems and cities more sustainable has given rise to various programs, technologies and policies of varying time horizons, spatial scale and cost. The effectiveness of many of these interventions depends on how users respond, interact and in some instances modify their travel and activity choices — choices of where to live, work, which activities to engage in and with whom, where, when, by what mode and along which path. These choices reflect travelers' activity patterns, situational and environmental variables (e.g. weather), as well as attributes of the transportation system which determine users' experienced service levels, particularly congestion and reliability.

Our understanding of traveler choice behavior in transportation systems, and the approaches used to capture its outcomes, have undergone several paradigm shifts over the past 50 years—often through the involvement of different disciplinary perspectives that have enriched the body of knowledge of this most elusive yet critical aspect of transportation system performance. While significant advances have taken place in the field of travel behavior research and travel demand forecasting, the ability to operationally represent traveler choices for the purpose of predicting responses to various interventions—from demand management to operational controls to pricing to real-time information provision—remains limited.

Approach This project, funded by the US Department of Transportation, addresses this important gap in modeling capability to support a variety of initiatives that seek to improve traffic conditions and system safety and sustainability by targeting user choices before and during their travel. Through six case studies, this project provides a synthesis of the state of knowledge in travel behavior research and showcases how to improve current models with relevant behavioral realism. These case studies range from long-term policy interventions, e.g. urban design policy affecting land use and



Core Research (continued)

neighborhood walkability, to short-term en-route interventions, e.g. traveler information systems for weather-responsive system management. The case studies also include interventions aimed at environmental as well as congestion avoidance objectives. The applications provide an enhanced capability to capture traveler choices in both the main evaluation tools as well as in supporting the design process actively.



Findings and Impact

A main finding of the study is that there is not one integrated model to capture all facets of travel behavior. Rather, for each inter-

vention, the key behaviors must be modeled on an individual level with

sufficient detail and clarity to help forecast the impact of different policies and interventions. As the time horizon increases for interventions, the ability of our tools to help forecast the impact of different interventions diminishes, as more complex behavioral choices are involved. Nevertheless, as long as model platforms allow individual representation, the behavioral richness of the models can be improved and enhanced over time as more data becomes available and the state of the art of behavioral modeling continues to improve.

While the study demonstrated powerful modeling and simulation frameworks, the available data and observational basis to calibrate and gain confidence in these tools remains inadequate. This is especially true with regard to understanding and modeling the dynamics of individual

choices in congested systems that are subject to disruptions, variability, or dynamic control strategies such as pricing and real-time information. In this regard, new technologies can help to close the gap on data as long as the context of actual choices—and a more complete characterization of the alternatives available to an individual—are observed as well. While better data helps to forecast behavioral responses more accurately, the behavior of users will remain a moving target for many interventions as people adapt and change dynamically. Although these dynamic mechanisms can be modeled, this dynamic behavior calls also for a new paradigm in designing and implementing interventions: policies that measure, influence and adapt to user behavior over time.

A Major Advance in Transportation Planning Agency Capabilities

Project: Next-Generation Strategic Planning and Forecasting Tools for Metropolitan Areas: Integrating Activity-Based Behavior Models with Dynamic Network Simulation

A team consisting of NUTC and PB Americas, Inc. was selected to develop the next generation of integrated planning and forecasting tools for the Chicago Metropolitan

Agency for Planning (CMAP), the main planning agency for the Chicago metropolitan area. The methodology consists of integrating two heretofore separate components: (1) an activity-based model (ABM) system for modeling individual and household travel and activity at a very high level of spatial and temporal resolution, and (2) a dynamic network microsimulator that propagates individual and vehicular traffic flows, including transit and non-motorized modes, on to the area's multimodal transportation network to determine associated performance levels and identify potential problem spots.

Integrating ABM and dynamic network assignment platform has only been partially accomplished in the past, and previous attempts have lacked a theoretically and methodologically coherent integrated platform to accomplish the task. Starting with essentially existing but separate components, the focus of the project is to address a critical gap in existing approaches and advance the state of the art along with the state of the practice. Integration entails using internally consistent values of all variables, especially network level of service attributes in all components and processes of the model system. It also entails recognizing the

Better Modeling for Evaluation of Congestion Pricing Strategies

Project: Modeling and Forecasting of Toll Revenues

Challenge The goal of this study is to forecast both toll revenues and operational impacts associated with congestion pricing strategies, alone or in conjunction with other operational measures. The project showcases the integration of an Activity-Based Model (ABM) and Dynamic Traffic Assignment (DTA) tool in one coherent modeling framework for implementation and evaluation of congestion pricing, and its application to the Chicago metro area network to evaluate a comprehensive set of pricing proposals under consideration by the Chicago Metropolitan Agency for Planning (CMAP).

Approach Specific methodological approaches were developed and detailed technical activities were undertaken:

- ABM-DTA Integration
- Estimation of Behavioral Parameters

heterogeneity of the user population in a consistent manner through multiple activities and network processes.

The result will be a major advance in planning agency capabilities in terms of evaluating alternative future scenarios that encompass a range of capital as well as operational improvements to the transportation system and urban fabric.

Professor Hani S. Mahmassani and Andreas Frei, post-doctoral researcher, are leading this effort at NUTC; Ali Zockaie and Omer Verbas are the lead graduate student researchers.

- Calibration of Reliability Measures
- Travel Demand Forecast

Implementation and Evaluation of Congestion Pricing Strategies

We demonstrate application of the multi-criterion dynamic traffic assignment model to the Chicago metropolitan area network. To assess the impacts and revenues of congestion pricing strategies, various performance measures are identified. User demand, toll revenues, and system performance are analyzed.

Findings This study demonstrated the importance of capturing the heterogeneity of user preferences in their response to prices, particularly dynamic prices. The integration between the ABM for the demand side and the DTA model platform accomplished in this application is one of the most advanced successfully completed for a large-scale metropolitan network. The choice dimensions of the ABM include route, mode and departure time choices. While these are largely sufficient for evaluating toll forecasting impacts over a three to five year horizon, higher-level choice dimensions may need to be considered over longer horizons.



Image: CMAP Web site



Illinois Senator Richard Durban, NUTC Associate Director Bret Johnson, Dr. Kenneth Ender, President, Harper College, and Karen Norrington-Reaves, CEO, Chicago Cook Workforce Partnership, announce the grant award for the Department of Labor's Trade Adjustment Assistance Community College and Career Training.

NUTC to Provide Curriculum Development Expertise

Project: Leveraging, Integrating, Networking, Coordinating Supplies (LINCS) in Supply Chain Management (SCM)

NUTC is contributing member of a consortium that will provide workers with improved skills in supply chain management. The group—Leveraging, Integrating, Networking, Coordinating Supplies (LINCS) in Supply Chain Management (SCM)—was selected as a grant awardee for the Department of Labor's Trade Adjustment Assistance Community College and Career Training (TAACCCT) grant program, a multiyear, nearly \$2 billion initiative to expand targeted training programs for unemployed workers.

The LINCS SCM consortium, led by Broward College in Florida, is developing a set of eight stackable and latticed credentials that will provide workers with skills suitable for entry and middle-level employment in supply chain management. Program content will be delivered through traditional, hybrid and online instruction. NUTC will provide guidance on developing curriculum that can lead to advanced degrees and access to the supply chain industry through our Business Advisory Council.

The eight newly created industry-recognized certifications will be based on an evidence-based design endorsed by the Council of Supply Chain Management Professionals (CSCMP), a member of the NUTC Business Advisory Council. Other consortium members include Columbus State Community College, Essex County College, Florida State College at Jacksonville, Georgia Institute of Technology, Harper College, Long Beach City College, Rutgers University, San Jacinto Community College, St. Petersburg College, and Union County College.

Core Research (continued)



Dynamic Freight Operations Management

Project: City Logistics: Predictive Analytics for Real-Time Freight Management

Challenge Dynamic freight management is intended for environments in which information is dynamically revealed to the decision maker (carrier). This information may not be known at the initial planning stage, and/or may change during plan execution. The principal focus of this research is to devise good and computationally efficient approaches that a commercial vehicle fleet operation manager, or dispatcher, can use to take advantage of real-time information and dynamically manage available resources to serve time-sensitive customer requests while recognizing prevailing and anticipated traffic conditions on the road network.

Approach The methodological framework provides for the integration of both known and still uncertain customer requests along with the real-time predictions of unfolding traffic conditions. It consists of the following key modules:

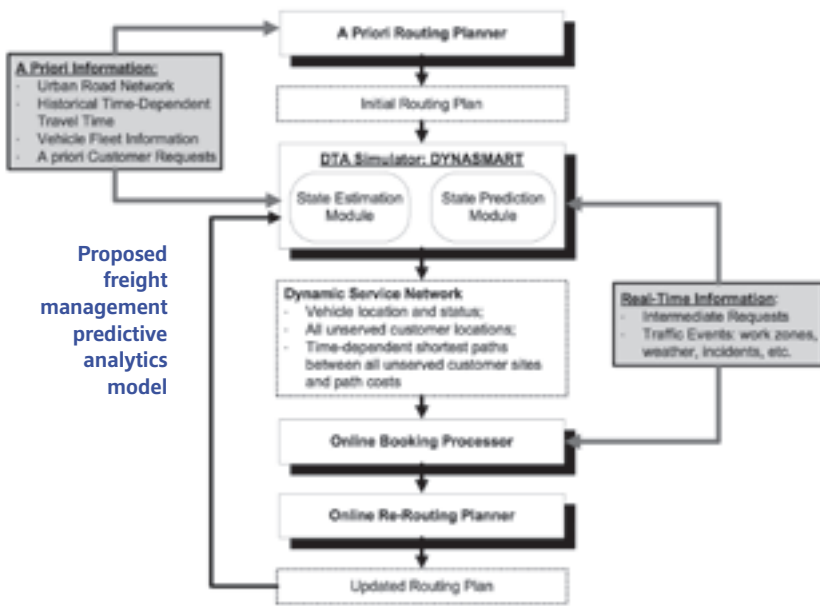
- **A Priori Routing Planner:** this module uses time-dependent travel times and a priori requests to generate the initial work plan (schedules and routes) for each truck before the service day.
- **Online Booking Processor:** decides whether or not a request is accepted into the system during the service day.
- **State Estimation Module:** simulates the traffic flows including passenger cars and the fleets and incidents on the network. It provides traffic conditions such as time-dependent travel times, incident information and current locations of the trucks at different time intervals.
- **State Prediction Module:** projects the network state for a period into the future (in a rolling horizon fashion) and thus provides

predicted travel times that reflect current and forecast conditions to the online re-routing planner.

- **Service Network:** Represents an abstraction of the network formed by the loads to be served and the transportation network that connects them; It differs from the physical road network in that links consists of subpaths corresponding to shortest paths between nodes. It evolves dynamically as loads are progressively revealed.
- **Online Re-routing Planner:** receives all real-time and anticipated information and updates and/or re-optimizes current work plans for all vehicles in the fleet during the service day.

Summary The study addressed the real-time fleet management problem in congested urban networks with significant sources of uncertainty. To handle the inherent dynamism of the system, we integrate real-time information and utilize the dynamic traffic assignment model and simulator to obtain prevailing and anticipated traffic conditions on the network. A heuristic approach and real-time policies are developed to find good and computationally efficient routing plans that dynamically manage available resources to serve time-sensitive customer requests while recognizing the prevailing and anticipated traffic information on the road network. The potential benefits of this research include:

- **Improve information utilization:** the efficiency of the fleet management system is greatly reliant on the quality of available information. The GPS can track the status and



Proposed freight management predictive analytics model

location of vehicles and help in constructing routing plans for new customer requests. The real-time information provides prevailing states on the road network and also serves as the basis for anticipated traffic conditions;

- **Reduce operation cost:** with better planning and operation guidance, the fleets operates more efficiently at higher performance levels;
- **Increase customer service:** with the aid of the proposed model, carriers are able to respond to new requests in a timely manner with more reliable routing plan, thus fewer delays at the customer locations;
- **Evaluate the efficiency and effectiveness of services:** the proposed model is capable of modeling various operational components with considerable realism and recording most of the necessary information needed for evaluation, so as to improve the performance in the future.



Credit: AP

Better User Experience in Demand-Responsive Transit

Project: Flexible Transit Operations for Dynamic Mobility

Challenge In low-density communities, where demand is low or sparse, fixed route transit service does not provide efficient, high quality service. To satisfy varying demand at lower costs, researchers and operators have developed and implemented systems for providing demand-responsive transit (DRT). To serve the last mile for transit trips, such demand-responsive systems are typically integrated with higher capacity fixed route services (e.g. light rail/heavy rail stations, park and rides). The planning procedures for each type of service differ: For fixed-route, many decisions are made at the strategic level (route configuration and coverage) whereas for demand-responsive systems, most decisions are left to the operational level (trip insertion and vehicle routing). As a result,

there is some fragmentation of fixed route and demand-responsive services. If either system experiences some variation, users incur the costs. Better design and integration of demand-adaptive systems is needed to improve transportation access in low-density communities.

Approach The research team reviewed the role of customer satisfaction and schedule flexibility in mode choice in order to explicitly model behavior in the design of flexible transit operations.

To a customer, every element of the transit experience- from walking out the front door, to purchasing fare, to boarding the vehicle and completing the first and last mile-contributes to their satisfaction and to the perceived value they derive from the service. Variables such as transfer cost, walk time, and effort required to request/reserve service will influence the demand for the service. As such, planners should consider these variables when configuring service for their area. The focus of this work is on integrat-



ing key determinants of the user experience in the techniques used for service planning and operation.

Impact The primary contribution of this work is a methodological framework for balancing user convenience and service productivity in flexible transit system design. Transit service should be intuitive and reliable in order to meet

Information availability is important to users and is changing the types of service agencies can offer. (Photo: Flickr, Steven Vance)

Core Research (continued)

customer expectations and attract new demand. Designing such service requires leveraging information about customers to structure the service appropriately.

This work is on-going through Spring 2014 to estimate the sensitivity of service structure to demand patterns in low-density areas. The resulting methodology can be used to determine the location and timing for stops on flexible transit routes. It could also provide guidance on whether pure dial-a-ride or some semi-flexible service is warranted. The methods could also be used for the case where an agency wants to impose structure on a demand-responsive system to serve emerging demand patterns.

The principal investigator for this CCITT funded study is Dr. Hani Mahmassani. Charlotte Frei is the lead doctoral student working on this research.

During Inclement Weather, Can Mobile Data Enhance the Performance of Traffic Management Systems?

Project: Use of Mobile Data for Weather-Responsive Traffic Management Models

The goal of this study is to assess the availability and applicability of mobile data in order to enhance the flexibility and performance of traffic models used to evaluate Weather Responsive Traffic Management (WRTM) strategies.

What Are Weather Responsive Traffic Management Models?

Weather Responsive Traffic Management (WRTM) models incorporate the supply- and demand-side effect of weather on a road network transportation system. The supply-side effects of weather reflect the reduced capacity of a road segment during inclement weather, especially reduced operating speeds. The demand-side effects of weather relate to the reduced usage of the transportation system as drivers re-schedule or cancel trips due to inclement weather. The Traffic Estimation and Prediction System (TrEPS) used in this study is DYNASMART-X—a weather responsive, real-time system linked to loop detectors, roadside sensors, and vehicle probes, providing real-time estimates of traffic

conditions and predicted traffic states under different intervention scenarios.

Why Incorporate Mobile Data into WRTM Models?

The evolution of wireless technologies and telecommunications presents new opportunities to collect real-time traffic data. Relying on GPS or cellular location data, probe-based systems can provide significantly broader coverage (especially for major arterials) with little or no cost to maintain.

This study addresses mobile data collected from three sources:

- Floating car data from electronic transponders collected along the roadway;
- GPS-based mobile data (typically from fleet vehicles) equipped to transmit positional data to a control center; and
- Cell phone-based mobile data determined by cell-tower triangulation or hand-over data. In contrast to the previous sources, cell phone mobile data requires no additional hardware or roadside infrastructure.

Incorporating Mobile Data into WRTM

The study provided a systematic review and assessment of how mobile data, such as that available from GPS-equipped vehicles, can improve the performance of WRTM models.

Study Network Location and Data Sources

The only available mobile data source, within candidate networks



suitable for this effort, was vehicle trajectory data collected by TomTom GPS devices in the New York City area. In addition to the mobile data collected from TomTom GPS devices, calibration and validation of the TrEPS required a set of weather data and fixed sensor traffic data for comparison. Weather data was collected from Automated Surface Observing System (ASOS) stations at six nearby airports. The study team was not able to identify a source of comprehensive data from the New York City area. However, one advantage of mobile data is that it allows us to update the original parameters (in this case from the Maryland area) with local mobile data from New York even as the latter does not have suitable fixed sensor locations.

Calibration and Validation

After calibrating supply- and demand-side parameters, the capacity of the TrEPS model to capture weather effects on the traffic

flows was tested by performing simulations with specific weather scenarios. Days with rain or snow events during the morning peak hours were identified and corresponding traffic observations were collected. Simulated results from the mobile data-calibrated TrEPS model were then compared to real-life traffic conditions under various weather conditions. Two sets of validations were conducted—one using speed information and the other using travel time information.

Conclusions and Recommendations

Focusing on the suite of models developed in previous FHWA-funded projects, this study identified a set components within the WRTM framework to which new sources of traffic data, from mobile vehicle sources, could be incorporated. On the supply-side, mobile data can contribute to the calibration of various relationships, particularly those that govern link propagation and flows through nodes. The most immediate demand-side application is the estimation of time-dependent origin-destination trip information. While the work accomplished as a result of this research project advances the state of the practice in using mobile data for WRTM models, additional efforts are needed to study the application of mobile data in on-line TrEPS implementation.



AP Photo/The Vail Daily, Preston Utley



Research for Industry | Network Modeling • Data Analytics • City Logistics



Seeking Input from Rail Industry Stakeholders

Project: National Cooperative Rail Research Program Strategic Plan and Research Agenda

Principal Investigator Professor Joseph L. Schofer is leading the preparation of a strategic plan and agenda for the National Cooperative Rail Research Program (NCRRP), operated by the Transportation Research Board (TRB) and funded by the Federal Railroad Administration. The program conducts research on policy, economic, and institutional issues of concern to passenger and freight rail stakeholders at the local, regional corridor and national levels.

Northwestern researchers have conducted a national outreach effort, contacting nearly 70 rail stakeholders who were asked to identify both problems and opportunities facing the rail industry. Outreach was accomplished through face-to-face and telephone contacts, focus groups, and a web-based survey of rail professionals. Information from stakeholders was used to formulate a five-element research strategy designed to supplement and support work funded by the Federal Railroad

Administration and American Association of Railroads.

The work addresses the importance of coordinating research across rail and other programs to take advantage of synergies and avoid duplication of effort. It also lays out a plan to track and evaluate the outcomes of research efforts to build long term support for rail research.

Big Data: Finding the Hidden Value in Large Volumes of Stored Information

NUTC is collaborating with BAC member company Echo Global Logistics (Echo) to use large volumes of archived and near real-time transactional data in conjunction with offline and online real-time models to build better tools for decision making. Echo provides technology-enabled business process service for companies seeking to outsource their shipping needs with Echo's network of transportation carriers. As a third party logistics (3PL) provider Echo uses sophisticated systems and trained personnel in the practice of logistics to lower the client company's transportation costs. Furthermore as a non-asset-



based 3PL provider Echo is free to use other providers' assets (carriers) to leverage asymmetries in the logistics market and expertise in order to drive optimal service for their customers. Because their systems, along with their personnel's expertise and knowledge of the market, are their primary asset, this collaborative research project enhances tools that help them navigate this complex environment. Specifically, the tool addresses quoting prices to a potential customer (i.e., a shipper) and sourcing capacity (i.e., find a carrier) in spot markets.

The research developed a comprehensive framework and decision support system for truckload pricing and



Aerial view of a multimodal rail and over-the-road freight center outside a major metropolitan area.

carrier load matching by modeling the transactional behavior of shippers and carriers with off- and online predictive analytics. It recommends to Echo's agents prices to quote a shipper in real time, reflecting historical and prevailing market conditions, along with a ranked list of potential carriers to source the load. Within this framework three primary models are used: discrete choice models from both shipper and carrier perspectives, and a pricing engine that operates in real time. Large volumes of data are processed off-line to estimate the parameters of the choice models and generate choice sets for each lane, using econometric and clustering techniques. The real-time model uses the parameters from the

choice models along with information about an incoming shipment in a stochastic profit maximization model to determine an optimal price to quote to the shipper as well as a ranked list of potential carriers to contact for acquiring capacity.

The models and tools developed as part of this effort are adaptive, in that they update themselves to reflect incoming data. They are installed and running in real-time on Echo's servers. They demonstrate the tremendous potential of historical and real-time data for internal business process enhancement, as well as the potential to improve the value of services offered by transportation providers to customers.



A Routing Platform that Addresses the Same-Day Delivery Business Challenge

In a project supported by Sears, professor Diego Klabjan and graduate student Jie Yang are investigating potential solutions to the challenge facing all companies competing in the emerging same-day delivery market. Google and eBay are both testing same-day deliveries in the San Francisco Bay area; while Amazon, Sears, and Wal-Mart are conducting trial delivery programs



in various regions. Established and new courier service providers including FedEx, Same Day, Shufl, and Deliv are looking for a way to profit from the retailers' desire for rapid deliveries of purchased goods to the customer.

Some of the same-day models attempt to aggregate local seller pick-ups and deliveries, but they face a unique routing problem. Existing information and routing platforms exist in a conventional dispatch environment where operations are coordinated in sequence as orders come in. This ignores the advantages of real-time data from product orders and dispatch vehicles that can approach the challenge in a batch environment. Additionally, the existing tools do not provide adequate analysis capability for the aggregators to determine the best operating model.

Diego and Yang have constructed a localized algorithm that minimizes transportation expense for the aggregator while honoring the constraints, which include the time window obligations and the on-the-ground configuration of delivery resources. The algorithm further optimizes the mode of delivery (car, bike, van, walker) and allows for multiple pickup sites for the same product ordered (e.g. items from, let us say Whole Foods, can be sourced from multiple stores in the region depending on the customer locations and other pickups). Such a platform will allow the aggregator or retailer to understand the economic viability of same-day delivery under various operating models. Some elements of the operating model include the time windows offered to customers, the service time between order and delivery, and the optimal geographic boundaries for a delivery area serviced by a single hub. The software platform has a

web-based output that plots the routes on a map so the solution can quickly be digested and validated.

As retailers and online businesses continue to explore and develop the same-day delivery offering, the platform developed at Northwestern may be useful in predicting the cost per customer stop under various volume and resource assumptions; and thus provide the basis for pricing and marketing decisions. This is an arena where research will continue to seek insights into the optimal business models, tools, and practices.



Environmental Concerns Spur the Development of Smarter Emissions Estimating Software

Project: A Framework for Estimating Emissions of Freight Transport Operations

Sensors and wirelessly networked data collection systems have gradually opened up new portals through which companies should be able to view and manage transportation engine emissions, and provide information to agencies that assess their impact on the environment. Tools exist for creating such estimates—notably ones developed by the U.S. Environmental Protection Agency and the European Environment Agency. But these platforms utilize methods that are simplistic and aggregate, based on average rather than event-specific contributions to emissions.

Corporations not only face intensifying regulatory demands, but also the evolving responsibilities and objectives of their own environmental stewardship and community engagement programs. They require greater accuracy in measuring and reporting greenhouse gas emissions (carbon dioxide, carbon monoxide, and other pollutants) produced during supply-chain and product shipping operations. In the past, these reporting requirements were seen as messy obligations that were difficult to address and drained resources rather than adding value.

Principal investigator Pablo Durango-Cohen and students Yikai Chen, Madison Fitzpatrick, and Yidan Luo have created a rigorous, flexible, and practical approach to the challenge of better estimating engine emissions. Working in partnership with

BAC member Phillips, a world-wide corporation with extensive shipping operations, Durango-Cohen's team began with insights about the nature, availability, and utility of existing industry data. Phillips provided the use of its own North American transportation data to assist Durango-Cohen's group. Over the course of three years of work, the researchers developed a software tool that makes better use of the data being generated at the shipment level. The program produces reports on emissions that display detailed information previously unavailable through other methods of input and analysis. The tool can also grade the accuracy of its own reporting results, which are dependent on the kinds of data selected and the assumptions made at the front end of its processing. Phillips now has a more accurate way to estimate, report, and manage its emissions.

The research team is launching a Web-based version of the software so that any company can access, adopt, and benefit from the improvements.

As the tool is further developed Durango-Cohen expects that more managers will take advantage of the approach. He hopes that the analytically sophisticated software will create a new path of least resistance for freight emissions reporting. Gaining a clearer picture of their transportation systems' emissions output is immediately helpful to companies as they fulfill reporting requirements. The next logical step for managers is to look at the finer-grained emissions information this tool generates and find ways to restructure their supply-chain operations in order to increase efficiency and reduce emissions. Greater efficiency rewards businesses with lower operating costs—transforming what was once an onerous emissions reporting burden into a means for environmental and financial progress.

Exploring Novel Technologies in an Effort to Decrease Driver Distraction

Project: Haptic Interface for Vehicular Touch Screens

Touch screens, so familiar now as the interface to smart phones and tablets, are increasingly showing up on the instrument panels of automobiles. This trend raises concerns that drivers will more frequently – and for longer periods of time – glance away from the road in order to complete even simple tasks, such as adjusting temperature settings or selecting a radio station. One potential way to mitigate this form of distraction is to provide haptic (tactile) feedback, enabling drivers to complete tasks more easily without looking at the screen.

Principal Investigator J. Edward Colgate, and Co-PI Michael Peshkin, both Professors of Mechanical Engineering, have developed a number of novel technologies for providing haptic feedback on a touch screen. What interests them is altering the physics of the glass surface of a touch screen in order to create the perception by a user that his or her fingertips have engaged and can move a control element—a sliding bar or turnable knob. For

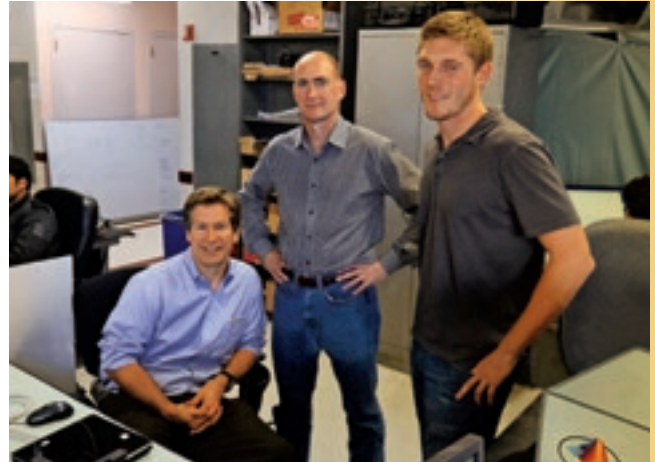


instance, one version of the haptic touch screen—by modulating and localizing minute vibrations of the glass surface—creates the impression that a specific area of the smooth screen is “sticky” or produces more friction on the fingertip. The screen control technology, sensing where the finger is making contact with the glass, can then respond, track, and move the “sticky” zone to correspond to the fingertip movement. It is as if a user had touched a 3-dimensional sliding switch and moved it to adjust some device in the car—a music volume control or air conditioner fan speed, for instance.

Three of the advantages in using a smooth glass surface screen over other kinds of touch devices, such as laminated plastic button panels, are: (1) the glass screen is less susceptible to wearing out or being damaged in the typical range of conditions in a vehicle interior; (2) the programming is what determines the placement and function of the buttons, sliders, or knobs—thus, engineers can reprogram the screen rather than design and manufacture new instrument control panels; and (3) the visual graphics under the glass and the tactile sensations on the glass surface move and respond together, providing more effective feedback than just visual or tactile signals alone.

The researchers have partnered with BAC member Ford Motor Company in this recent CCITT funded study that takes advantage of Ford’s advanced driving simulator, the VIRTTEX, in Dearborn, Michigan. Working with Colgate and Peshkin, graduate student Joe Mullenbach built a device known as a TPaD and integrated it into a Ford Edge vehicle mock-up within the driving simulator. Mullenbach then ran experiments with 25 volunteer drivers, testing those drivers on two types of tasks: a

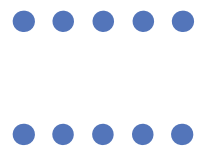
Industry Research (continued)



Left to right: Bret Johnson, CCITT Director, Professor Ed Colgate, and graduate student Joe Mullenbach in the McCormick Engineering Haptics Lab. Lower left photo: a haptic feedback touchscreen.

simple button acquisition, and a more complex level adjustment. Drivers consistently performed better with haptics, spending less time looking away from the road and completing the tasks just as easily as with vision alone. Moreover, drivers had an overall preference for the combination of visual and haptic cues.

Mullenbach is now working with Colgate and Peshkin to develop an even more advanced haptic touchscreen that the team expects will further improve the technology. Additional research is exploring the development of haptic interface devices that incorporate inexpensive off-the-shelf e-book readers.





Outreach Events

The Honorable William O. Lipinski, at left, visits with the Symposium's keynote speaker, the Honorable Jerry F. Costello, recently retired Member of the U.S. House of Representatives

SIXTH WILLIAM O. LIPINSKI SYMPOSIUM ON TRANSPORTATION POLICY & STRATEGY

Private Money for Public Infrastructure: Promises, Pitfalls, and the Path Forward

In January 2013, NUTC hosted the sixth event in a series of symposiums that have marshalled a broad range of viewpoints to examine the current issues of transportation planning and policy. The namesake for the Symposium—the Honorable William O. Lipinski, who served as a Member of the U.S. House of Representatives and was a Ranking Minority Member on Subcommittees on Aviation, Rail and Highways—has summed up the legacy and mission of the gathering: “This series has consistently provided a unique forum for the exchange of important ideas about transportation, bringing together leadership, professionals, students, and community members.”

The 2013 Symposium explored the characteristics of public-private partnerships (P3s)—for financing and/or managing transportation infrastructure projects. Against the backdrop of reduced government funding for the creation and maintenance of transportation infrastructure, expert panelists from the public, private, and academic sectors discussed the benefits and risks of P3s. All agreed that they are a necessary component in many of today's transportation projects due to the associated costs, risks, and urgent needs. Several presenters were quick to cite the well-known examples of P3s that served as cautionary tales rather than success stories. More than one panelist suggested that no one today would advocate selling off state or city assets for the sake of a quick infusion of cash into ongoing government operations.

After the guests and attendees were welcomed by McCormick School of Engineering and Science dean Julio Ottino, William Lipinski provided opening comments and introduced the keynote speaker, the Honorable Jerry F. Costello, recently retired Member of the U.S. House of Representatives from Illinois's 12th district.

Jerry Costello spoke candidly about the current inadequacies in U.S. transportation infrastructure, calling it a real crisis. “Our infrastructure is crumbling as we speak,” he stated. Citing the disagreements and partisan political gridlock in Washington, D.C., Costello expressed doubts about the possibility of seeing comprehensive funding and policy solutions coming from the U.S. Capitol anytime soon. He therefore urged everyone to take the need for public-private partnerships seriously.

The next segment of the morning session turned to a panel of leaders: Congressman Daniel Lipinski, current U.S. Representative for Illinois's 3rd congressional district; Matthew Rose, CEO of BNSF Railway Company; and Ann Schneider, Secretary, Illinois Department of Transportation.

Matthew Rose provided the railroad perspective. His first comment emphasized that private industry money drives most rail infrastructure building and maintenance. Rose stated that BNSF has its own \$4 billion capitol program in progress. But the rail industry sees the value in public and private partners sharing costs for projects that neither, alone, could afford. In addition:



Matthew Rose, CEO, BNSF Railroad

- public-private financial agreements should supplement traditional funding sources
- some of the revenues should be generated by the users of the infrastructure; i.e., a road can have tolls
- there is an urgent need for a national freight transportation policy
- raising sales taxes and income taxes are not the answer.

Above all, Rose stated, we need to do a better job of communicating the value of transportation to the nation, so that the infrastructure can be equitably and adequately funded.

Ann Schneider noted that Illinois is looking at P3s more closely than in the past. A recent Illinois DOT analysis of needs suggests that transportation infrastructure in the state requires \$90 billion to be brought up to current standards. Congress has made it clear that there will be no more earmarks—approved funds to be spent as seed money on large projects. This means a loss of critical Federal dollars. She explained the various current sources of funding. Right now the money being raised does not meet the needs.

In deciding how to finance infrastructure projects, the value-for-money, inflation savings, risk and risk-transfer, life cycle costs—these must all be a part of the analysis of whether, when, and how to bring private partners into any project

Congressman Daniel Lipinski reviewed some of the specific government funding programs that have been in place, such as TIFIA loans

and MAP 21. He also stated that the DOT is working to facilitate P3s by establishing best practices, centers of excellence, and the development of model contracts. His key remarks:

- there are no signs of leadership nor the will to legislate for progress on transportation financing
- a gas tax, vehicle miles tax (VMT), tolling, and P3s are all potential sources of funds for a Federal Transportation Bill
- While important, P3s will not supplant government funding.

Lipinski pointed out that roads, for instance, are public assets and are mentioned in the U.S. Constitution.

Following the leadership panel, professor Joseph L. Schofer, NUTC faculty member, moderated a panel that provided the “Overview of Public-Private Partnerships.” The panel participants were Samara Barend, Vice President & Strategic Development Director, Public-Private Partnerships and Alternative Delivery, AECOM; Thomas Lanctot, Partner and Group Head, William Blair & Company; and Adrian Moore, Vice President of Policy, Reason Foundation.

From a session packed with useful information points stand out:

- What is covered by the media concerning P3s does not provide much of the real picture. The P3 markets are not well developed yet in the U.S. But public-private partnerships have been taken much further in the UK and Canada.
- As they have been used around the world, P3s are a means of transferring risk to private parties and injecting better performance and accountability into projects. There are several models for P3 processes and management structures that are used in the design/construction/maintenance of large public assets (roads, bridges, tunnels, overpasses, etc.).

- More potential benefits can be derived through P3s: design and construction efficiencies, focus on whole life cycle costs, integrated planning and design, private sector management and accountability.
- The private sector has a lot more flexibility to approach projects in innovative and efficient ways.
- Bidding and transactions have to involve a fair, transparent, and robust process that moves predictably to conclusion, rather than involving political risk and significant uncertainties.
- Money-saving concepts and planning are more likely to be brought into play within P3s, because there is a business incentive to minimize long-term life-cycle costs, rather than simply try to save on initial construction costs.

A luncheon for guests and those attending the Symposium was the setting for a special presentation. The David F. Schulz Award for Outstanding Public Service in Transportation and Infrastructure has been bestowed at each Lipinski Symposium to honor an individual for technical or legislative innovation, or for public-policy leadership in transportation and infrastructure.

Forrest Claypool, President of the Chicago Transit Authority, received the 2013 award. In accepting the award, Claypool stated: “Northwestern... was my partner in completing some very extensive and complicated analytical work that led to a recent comprehensive restructuring of our bus and rail service to better meet ridership demands and trends. We have appreciated the partnership with Northwestern University and continue to work with the Center. We are moving fast at the CTA.”

In the afternoon, principle managers of three different P3s presented case studies that offered lessons learned in public-private transportation projects. Presenters were:



Richard Clarke, Assistant General Manager of Capital Programs, Denver RTD; Fernando Redondo, Chief Executive Officer, Chicago Skyway; and Greg Ciambone, Vice President, The Walsh Group—East End Crossing of the Louisville-Southern Indiana Ohio River Bridges Project. The key insights:

- If approached properly, the financial aspects of a P3 should enhance the long-term financial position of the public-sector entity. This may be through unique funding structures that combine appropriate public debt with private investment.
- In procuring the design and construction of a P3 project, keep more than one bidder in the field and address their concerns about risk allocation.
- Allow for innovations.
- Keep the process confidential, so that bidders can trust the process.
- Follow and maintain a schedule to assure bidders that the process will reach a conclusion.
- Keep your board of directors and the public engaged and informed.
- Complex transactions involving multiple state and municipal agencies and multiple private investment and design/construction firms can work within the

newer models for P3 projects to properly structure the financing, risk allocation, payment mechanisms, schedules, operation/maintenance responsibilities and complete asset (road, bridge, etc.) life-cycle management.

The Symposium's final panel

session proceeded as a discussion among several experts including: Hani Mahmassani, Director, NUTC; Randy Blankenhorn, Executive Director, Chicago Metropolitan Agency for Planning; Peter Skosey, Vice President, Metropolitan Planning Council (Chicago); and others from earlier presentations. Various members of the panel commented on the need to think more strategically about the overall transportation system so that resources are applied where they will have the greatest benefit. Dr. Mahmassani stated that the key to utilizing P3s properly requires finding the specific projects that are most likely to create win/win outcomes. He raised a question for all those present to consider: Where does a specific transportation asset end and the overall network or system begin? More consideration needs to be given to the system implications of privately

managed or maintained assets within a transportation network. Mahmassani cited examples of P3s in other countries that were configured to actually improve the overall system management and performance through the novel application of private expertise and control.

The most important take-away from the Symposium is that P3s are sophisticated transaction structures that take into account long term business and public sector needs. Facing the challenges of funding and managing transportation infrastructure projects in this era will require that new P3 stories and successful models be developed and communicated to the public and to all other stakeholders.



Two panelists respond to questions from attendees toward the end of the Symposium's afternoon session. At left: Samara Barend, and at right: Randy Blankenhorn.



A group of northeastern Illinois transportation professionals came together during the afternoon break.



A luncheon for guests and those attending the Symposium was the setting for the presentation of the David F. Schulz Award for Outstanding Public Service in Transportation and Infrastructure. Forrest Claypool, President of the Chicago Transit Authority, received the 2013 award.

Left to right in the photo: the Honorable William O. Lipinski, the Honorable Daniel Lipinski, Mrs. David (Jo Ann) Schulz, Forrest Claypool, Joseph Schofer, Henry Bienen, and Hani Mahmassani.



Seven-Day Intensive Education Program for Public Agency Executives in Jakarta, Indonesia

In partnership with the Ministry of Home Affairs of the Republic of Indonesia (MOHA) and the Rajawali Foundation, NUTC developed and implemented a customized executive education course, Transportation Policy Development, Planning and Management (TPDPM) in Jakarta, Indonesia.

The attendees were forty elected-government officials and public sector policy professionals, who have responsibility for district-level governance, including the provision of transportation infrastructure and services in Indonesia. Professors Joseph Schofer and Hani Mahmassani led the seven-day program during the last week of August, 2013. Other faculty and instructional staff included Pablo Durango-Cohen, Professor of Civil Engineering, Northwestern; Ralph Gakenheimer, Professor Emeritus of Urban Planning, MIT; Martin Wachs, Professor Emeritus of Civil & Environmental Engineering and of City & Regional Planning, University of California, Berkeley; Debra Miller, Senior Consultant, Cambridge Systematics, Inc. and Secretary (former), Kansas Department of Transportation; and Bret Johnson, Associate Director, NUTC.

Jeffrey Winters, Professor of Political Science, Program Director for the Equality, Development, and Globalization Studies (EDGS) program at Northwestern and an expert in Indonesian political affairs, introduced NUTC to MOHA through the Rajawali Foundation. Rajawali Foundation is a non-profit institution, founded by Peter Sondakh, Chairman & CEO of Rajawali Corporation, an investment holding company that operates in diverse industries and services. The Foundation's objective is to engage in social and humanitarian activities, particularly in the areas of education, social research, human development, community advancement, and other activities that create economic value, promote diversity, as well as activities that contribute to improve the society's quality of life. Rajawali Foundation has provided support to the EDGS program through a renewable five-year gift of \$2 million. The Foundation's subsequent support for NUTC's TPDPM program extends the philanthropic legacy that the Foundation initiated at Northwestern with EDGS.



Outreach | Events (continued)

Jakarta Program (contd.)

In Jakarta the TPDP course addressed several topics, including: an introduction to transportation systems, policies and outcomes; transportation policy and decision making; the transport planning process; cases studies in transport system design and agency development; predicting system performance using forecasting and data modeling; data and analytics in the policy evaluation process; transportation finance; sustainable transportation systems; freight transportation and economic competitiveness; and strategic policy making and examples from the perspective of U.S. state government. The week-long session concluded with a group exercise assignment. Each pair of officials from a common District or city was asked to develop an action plan to address a real and important transportation problem or opportunity facing the officials' own cities and districts to be discussed during the second stage of their program in the United States.

As a part of a broader public policy program initiative supported by MOHA, the Indonesian delegation traveled to the United States in late September through mid-October. At Northwestern on October 17, their last stop in the country, the delegation engaged in work sessions with NUTC faculty and reported on their "action plan" assignment, which demonstrated the application of the principles and techniques taught in the Jakarta session. The program included a field visit to the United Airlines Control Center, the

Chicago Metropolitan Agency for Planning, and a presentation by Professor Jeffrey Winters. NUTC looks forward to working with a new MOHA-selected class of officials in 2014.



KUHMO NECTAR CONFERENCE AND SUMMER SCHOOL

NUTC Hosts 2013 International Transportation Economics Association (ITEA) Annual Conference and Summer School

Leading transportation economists and researchers from more than 20 nations gathered at Northwestern University to share policy-relevant scientific research findings and to informally exchange views and promote further education. From July 8 through 12, 2013, the conference and associated summer school put the University's Evanston campus at the center of transportation economics research and scholarship. The Northwestern University Transportation Center, as official host, provided planning, communications, and management support for this global event.

Ian Savage, NUTC faculty member and Distinguished Senior Lecturer in Economics at Northwestern, chaired the Conference (as well as the planning committee), and was one of the instructors for the associated summer school consisting of two days of intensive classes.

Conference Proceedings

During the three days of the Conference proceedings, researchers presented more than 100 papers, addressing the full spectrum of transportation-related economic issues including:

- aviation economics – air traffic growth, route networks, and flight delay
- economic solutions to highway congestion – congestion pricing, toll roads, road capacity
- forecasting travel demand – urban transit systems, infrastructure costs, high-speed rail
- environmental concerns – carbon pricing, CO2 emissions reduction, the social cost of driving
- economic implications of smart vehicles – car sharing, parking, smart cities
- transport investment and funding; land use planning and urban economics.

Special Session: Demand Forecasting in Action

A special ITEA conference session, Demand Forecasting in Action, was sponsored by the International Transport Forum, an intergovernmental transportation thinktank with 54 member countries working within the Organization for Economic Co-operation and Development (OECD). Contributing to the session were presentations by NUTC director Hani Mahmassani; Chandra Bhat, Director, Center for Transportation Research, The University of Texas at Austin; Kenneth Small, President of ITEA and professor emeritus, Department of Economics, University of California-Irvine; and Mark Wardman, professor of Transport Demand Analysis, University of Leeds.

Keynote Address: “Forming Transportation Policy in an Uncertain World.”

Charles Manski, Board of Trustees Professor of Economics at Northwestern, delivered the Conference keynote address. In a candid and relaxed presentation, Manski reminded those present that all research involves reaching into the unknown from a position characterized by a set of “knowns” and assumptions. He then made the case for researchers to acknowledge the uncertainty that is incorporated into their work—inherent in the known data, in the assumptions, and/or in the processes. He advocated exploring ways to communicate that real uncertainty exists in the findings delivered to policy-makers.

Citing examples of research results that gave no hint of the real uncertainty embedded in the research results, Manski suggested that government planners and decision-makers are uncomfortable receiving answers that contain significant ranges of possible outcomes. What they value are research reports that



NUTC faculty member Ian Savage, ITEA Conference Chair, provides introductory remarks at the ITEA International Summer School on transportation economics.

offer them a clear picture of the consequences of their decisions, even if that clear picture is based on fuzzy data or uncertain assumptions. Implied in his remarks was a call for more intelligent and dispassionate policy decision-making based on research findings that incorporate realistic disclosures of the ranges of uncertainties that exist.

His recent book *Public Policy in an Uncertain World* (Harvard University Press) argues broadly that society should face up to the uncertainties that attend policy formation.

The summer school classes were held at NUTC’s Chambers Hall where an international selection of graduate students took advantage of the opportunity to learn about the field’s research from faculty representing the world’s advanced



Professor Charles Manski delivers the ITEA Conference keynote address.

academic programs in transportation economics. One of the students in these classes, Jonathan Hall, who is a post-doctoral research fellow at NUTC, received the Best Paper Award from the Conference for his work titled Pareto Improvements from Lexus Lanes: The Case For Pricing a Portion of the Lanes on Congested Highways.

The combined gatherings—known officially as the Kuhmo Nectar Conference and Summer School—have their origins in several regionally planned academic meetings that ITEA organizers recently consolidated into one global event. The ITEA Conference and Summer School on Transportation Economics 2014 will be held in Toulouse, France, organized through the Toulouse School of Economics.



Attendees enjoyed a Chicago skyline boat cruise and banquet.



Best Paper Awards were presented by Robin Lindsey, Chair, ITEA Scientific Committee (center) to Jonathan D. Hall (left) and Alejandro Molnar.

INDUSTRY WORKSHOP

Data Driven Business: Challenges and Best Practices in the Transportation Industry

In October, 2012, NUTC held an industry workshop providing the transportation perspective on Big Data.

During the Industrial Revolution, manufacturers sought out fast-flowing rivers as a source of readily available energy. In 2012—decades into the Information Revolution—companies now face a flood of an analogous kind: data. Like a river, data presents powerful opportunities and poses significant challenges for businesses. This data originates and flows from many sources: It can be mined from social media, obtained from customer surveys, input by operations and field representatives, collected from environmental sensors, and gleaned from geo-positioning devices.

Panel I Presentations

Professor Diego Klabjan provided the Big Data subject overview and stressed its implications for businesses. After Klabjan's introduction, Ogi Redzic, Vice President of Nokia Location & Commerce, filled in several details and stressed some of the same fundamentals.

Their key points can be summarized as answers to three basic questions:

What Is Big Data?

A way to manage and gain value from the tide of data now flooding the transportation business and agency landscape from both conventional and emerging sources:

- vehicle/equipment sensors
- customer and employee probes, surveys, questions, and comments
- archived records
- incident and event alerts.

How Is Big Data Characterized?

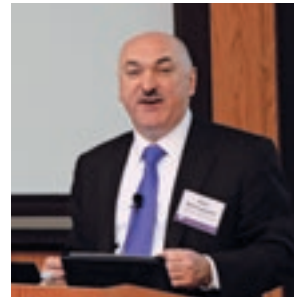
- high volumes and velocity, variety, complexity
- arriving in real time
- new openings to analyze questions
- prompting innovation to create better, targeted services and products, faster.

How to Get Started in Big Data?

- start small, ask good questions that relate to your core business
- build a team, look for a “hybrid” data analytics business manager to lead the way
- create a distributed computing platform that is flexible and can grow and adapt—there is no monolithic hardware / software box to buy
- scale up as you get results.

Panelist Ken Sain, Managing Director, Professional Services, Boeing Commercial Airplanes, discussed “The Digital Airline”—how new methods of data collection, transmission, analysis, and distribution are set to improve aircraft design, engineering, and maintenance; and decrease down time and flight schedule disruptions.

Panelist Steve Wooledge, Senior Director of Marketing, Teradata Aster, talked about two primary aspects of big data: (1) bringing order and purpose to all the data that is stored and all the data that is available through emerging technologies and (2) extending the usefulness of the data—enabling new business discovery and innovation. He offered two case studies that illustrated his message.



Panel II Presentations

Leading off Panel II, NUTC Director Hani Mahmassani urged the industry executives in attendance to keep in mind that all data is not equal—make sure you have data that pertains to you pressing questions, and then extract the “meaningful signal from the noise.” A suggested acid test for big data is: “How is more data going to allow me to: Do things differently? Do different things?”

The transportation business themes enabled by big data are clear:

- integration—transportation integrated with logistics processes (sourcing, manufacturing, warehousing, distribution); supply and demand chains
- collaboration—information sharing; improved efficiency by reducing dead miles; coupled with online information
- dynamic (real-time) optimization—visibility through supply chain at all times; tracking technologies; reducing inefficiency, exploiting opportunities.

Mahmassani offered these takeaways:

- a volatile business environment places a higher premium on good data
- the challenge is to extract simplicity from complexity (the explosion of data sources)
- data is power—a critical competitive asset; leaders will exploit the opportunities
- business intelligence and analytics—these are the broad categories in which it is critical to create information and knowledge from big data.

Big Data

Outreach Events (continued)

- more data and greater data dependence creates vulnerabilities: bias, security risks, obsolescence
- make data your friend.

Zahir Balaporia, Director of Intermodal Operations, Schneider National, Inc., laid out the following themes:

- abundance and scarcity: data is abundant; information is available; insight is scarce
- quantity and quality: quantity can mitigate some quality, the economics of data storage supports this; but data alone should not drive operational processes
- people and decisions: big data can enable descriptive, predictive, and prescriptive analytics; the most powerful model sits between our ears; are we improving our mental models?

Bill Driegert, Chief Innovation Officer, Coyote Logistics, brought up the

issue of cost vs. value: What is the value of the data versus the cost to capture it? Is more data better?

The data should help you create actionable intelligence to support decision-making that is:

(1) executional; (2) tactical; or (3) strategic. Driegert described the system design guidelines that Coyote Logistics follows to make the most of data and information:

- focused: the presentation of data should be focused around a user and a task
- intelligent: real-time predictive analytics and intelligently designed computer screen layouts improve the effectiveness of decision-making
- automated: users shouldn't have to dig for information relevant to them, it should be displayed and prioritized by relevance.



Big Data panel I participants fielded questions after their presentations.

INDUSTRY WORKSHOP

Smarter Cities /Smarter Mobility

Our Spring 2013 workshop on April 24 highlighted several visions for “smarter cities and smarter mobility” for both passengers and the movement of freight and products. The presentations examined how the deployment and use of sensor and wireless technologies, and the increasing computing power and integration of networks and systems are poised to impact the urban mobility experience.



After an introduction from event co-chair Bret Johnson, Chris Borroni-Bird, Vice President, Strategic Development, Qualcomm, spoke of the major trends driving humanity toward smarter mobility: cities are continuing to increase in population, young people are driving less, carbon emissions from transportation must be reduced, petroleum prices will keep rising, and current traffic modes contribute to preventable disease and fatalities. Qualcomm is pursuing transportation solutions including wireless charging systems for electric vehicles; improved vehicle-to-vehicle connectivity, connections between vehicles and transportation systems, and user-based connectivity by means of smart phones and devices.

Amine Haoui, CEO, Sensys Networks, described wireless sensor networks in transportation, and provided examples of the current state of the art and near-future developments.

Hardik Bhatt, Director, S+CC IoE Strategy and Global PPPs, Industry Solutions Group, Cisco Systems, offered glimpses of personal mobility in a smart and connected world—one in which technologies are converging to enable the integration of once-separate aspects of living: education, energy, entertainment, safety, healthcare, real estate, and transport.

Ogi Redzic, Vice President, Traffic & Automotive Cloud, Nokia Location & Commerce—using a bus operations case study—described the creation of better transit services through enhanced data analytics and methods taking advantage of real-time information.

Brian Shapiro, Vice President Smarter Mobility, Veolia Transdev, described the transition from real-time information systems to predictive information systems that anticipate the future state of a transit system for users.

Smarter Cities /Smarter Mobility (contd.)

NUTC Director Hani Mahmassani provided an informative overview of the context for the workshop's discussions: mobility as a process in connected systems. He summed up the key messages as follows: (1) prediction is essential in the real-time management of traffic and urban logistics; (2) the opportunities for innovation are many as new sources of information and technologies emerge; (3) the behavior of users of smart devices and operators of connected systems will constantly adapt, and they represent a moving target for those developing solutions—hence, the solutions will need to be adaptive; (4) the private sector will play a more important role in the evolution of smart cities as their business models become more compelling.



32ND ANNUAL WILLIAM A. PATTERSON LECTURE

Qualcomm Co-founder Irwin M. Jacobs Delivers William A. Patterson Transportation Lecture

Jacobs, an accomplished engineer, innovator, and businessman, spoke at Northwestern April 24. Nearly 200 students, faculty members, and industry leaders listened with interest as Irwin M. Jacobs, the accomplished engineer, innovator, and businessman who co-founded the global telecommunications company Qualcomm, provided stories and some technical details mapping his career in wireless communications. His April 24 evening presentation marked Northwestern University's 32nd annual William A. Patterson Transportation Lecture.

A Fortune 500 company, Qualcomm is known primarily for its contributions to the cell phone industry as a chipmaker and for its innovations in code division multiple access (CDMA), technology fundamental to today's 3G mobile wireless standards. But Qualcomm's technologies have directly impacted the transportation sector as well.

"Many of us know Qualcomm for what we have in our pockets: our cell phones," said Hani Mahmassani, director of the Transportation Center, which sponsors the annual lecture. "But Qualcomm has also been an innovator in the logistics field."

Short for "Quality Communications," Qualcomm got its start in 1985, after Jacobs had been working in the electrical engineering field for nearly three decades. In 1968, after a 13-year career in academia, during which Jacobs taught at MIT and at the University of California-San Diego, he co-founded his first company, Linkabit Corporation. The technology company would eventually spin off more than 100 communications companies, including Qualcomm, but not before making significant advances in wireless communications; its projects included VideoCipher, an analog scrambling system for television, and very small aperture terminals (VSAT), a two-way satellite ground station that Linkabit developed and sold to WalMart for employee communications.

Jacobs retired from Linkabit after 17 years, but his retirement lasted just three months before he and his collaborators founded Qualcomm. They were armed with lots of knowledge — but as pioneers in an exciting new field, lacked a firm grasp of what products they would create.

"We knew wireless," Jacobs said. "We knew these things were going to have a future, and we hoped we'd find things to do with them." They soon did. Qualcomm's first product, OmniTRACS, a communications and asset location system for the trucking industry, launched in 1988. The system provided a means of communication between trucks and headquarters. Trucks were rigged with an antenna that had to be designed to continually point toward a satellite; the satellite sent signals to a control center, which was connected by landlines to trucking dispatch centers.

Jacobs also discussed Qualcomm's advances in CDMA and how the technology has rapidly changed over the years. The company began pursuing CDMA technology in 1990; it took seven years to launch the first commercial system. He noted that in 1991, three chips were required to implement a 2G CDMA modem in a handheld mobile phone; in 2013, a single chip can support 2G, 3G, and 4G modems, as well as a central processing unit (CPU), GPS, graphics, and



Outreach | Events (continued)

more. Today, Qualcomm remains on the cutting edge of smart devices and sensors that impact all our lives.

Jacobs dedicated a substantial portion of his lecture to the global work of Qualcomm Foundation, an outlet that uses wireless technology and mobile computing to better lives and communities in the United States and abroad. In rural Whiteville, North Carolina, Qualcomm's Project K-Nect has provided mobile devices for use in a ninth-grade classroom, demonstrating a marked improvement in standardized test scores. An app designed for fishermen in India shows them what prices they can expect in ports, and a healthcare app virtually links dermatologists with people who need care in Egypt.

Looking forward, Jacobs said, wireless technology will continue to push the bounds of communication and connectivity, reinforcing the



idea of "the Internet of everything." Wireless features in vehicles will lead to added safety features, while interactions between biosensors and wireless mobile devices will transform healthcare.

"Technology presents challenges, but opportunities as well," Jacobs said. "It's all a balancing act, and we're in for a lot of fun."

Named for William A. "Pat" Patterson, former president and CEO of United Airlines, lifetime trustee of Northwestern University, and co-founder of the Transportation Center, the Patterson Lecture is a focal point of transportation activity at Northwestern. The event has featured industry leaders from Alfred Kahn to Herb Kelleher speaking on the most relevant and impacting transportation issues of the day.



Dr. Jacobs and his wife Joan (above center and right) were the guests of honor at a dinner for BAC members prior to the Patterson Lecture.

NUTC Hosts Illinois Department of Transportation (IDOT) Secretary Ann Schneider

NUTC hosted Illinois Department of Transportation (IDOT) Secretary Ann Schneider and Bola Delano, IDOT Deputy Director for Planning and Programming, at Northwestern in September 2013. In the morning,



Secretary Schneider met with a core group of faculty, led by Director Mahmassani, from civil and environmental engineering and industrial engineering and management science, including Senior Associate Dean Rich Lueptow and Associate Dean Joseph Schofer of the McCormick School of Engineering and Sciences. During the discussion with faculty, Schneider shared her vision to take a system-level approach with respect to Illinois' transportation challenges and address multiple modes of transportation while creating a strategic plan for 2050.

In the afternoon, Schneider addressed more than 60 students and faculty and re-emphasized this comprehensive vision. She commented that Illinois' transportation strategy must take into account its "long stretches of navigable waterways, huge freight network, and airport capabilities," in addition to the road network.

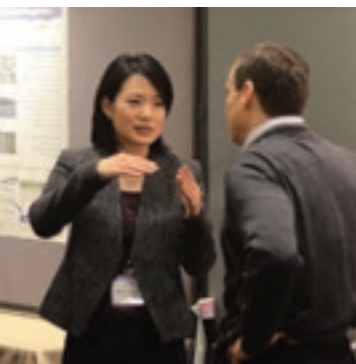
In 2013, Secretary Schneider was appointed chair of the U.S. Department of Transportation's National Freight Advisory Committee that was formed to provide advice and recommendations to the U.S. Secretary of Transportation on matters related to freight transportation in the United States.

THE TRANSPORTATION RESEARCH BOARD (TRB) 92ND ANNUAL MEETING

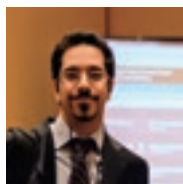
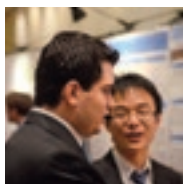
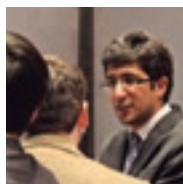
NUTC Contributes to TRB Activities, Hosts Reception and Alumni Reunion

NUTC faculty members, researchers, librarians, and students shared research findings through their participation in 48 sessions at the Transportation Research Board (TRB) Annual Meeting in Washington, D.C., January 13-17, 2013. The National Academies program drew nearly 12,000 transportation professionals from around the globe.

NUTC participants chaired sessions and committees, led panel discussions, conducted workshops, presented papers, and gave poster presentations on a variety of transportation-related research. Presentation topics included network modeling, driver behavior, data and information innovations for researchers, planning methods and models, infrastructure systems and operations, and traffic management. NUTC faculty, researchers, and librarians presenting (or serving on committees) were Hani Mahmassani, Joseph Schofer, Surendra Shah, David Boyce, Yu Nie, Aaron Gellman, David Kosnik, Roberto Sarmiento and Paul Burley. NUTC students presenting were YiKai Chen, Chalotte Frei, Andreas Frei, Tian Hou, Lan Jiang, Jiwon Kim, Christopher Lindsey, Yang Liu, Meead Saberi, Alireza Talebpour, Omer Verbas, and Ali Zockaie.



NUTC graduate researcher Jiwon Kim was given the 2013 Best Presentation Award at the Doctoral Student Research in Transportation Modeling Workshop. The honor was awarded by the TRB's Transportation Network Modeling Committee



NUTC also hosted its annual TRB Reception and Alumni Reunion on Sunday evening. The popular event attracted more than 400 guests and was one of the largest reception events at TRB. Guests were members of NUTC's expansive network of transportation professionals representing industry, academia, and government.



NUTC Seminar Series Events

05/16/2013 *Road Safety Analyses using Data from Naturalistic Driving Studies: Challenges and Opportunities*; Paul P. Jovanis, Professor of Civil & Environmental Engineering, Pennsylvania State University

05/09/2013 *Electric Vehicle Recharging: Decision Support Tools for Drivers and Infrastructure Providers*; Tim Sweda, PhD Candidate, Department of Industrial Engineering and Management Science, NU

04/18/2013 *Minimizing Greenhouse Emissions in Vehicle Routing*; Gilbert Laporte, Professor, Dept of Management Sciences, HEC Montreal

04/11/2013 *Integrated Planning of Bin Allocation and Vehicle Routing in Solid Waste Collection*; Vera Hemmelmayr, Assistant Professor, Institute of Transport and Logistics Management, Vienna University of Economics and Business

04/04/2013 *Flight Delays, Capacity Investment and Welfare under Air Transport Supply-Demand Equilibrium*; Bo Zou, Assistant Professor, Dept. of Civil and Materials Engineering, University of Illinois, Chicago

02/28/2013 *Cost Recovery from Congestion Tolls with Long-run Uncertainty*; Robin Lindsey, CN Chair in Transportation and International Logistics; Professor, Operations and Logistics Division, Sauder School of Business, University of British Columbia

02/14/2013 *Understanding the Evolving Transportation Market and the Changing Role of 3PLs*; Bill Driegert, Chief Innovation Officer, Coyote Logistics, Inc.

01/24/2013 *Coordination and Optimization of Urban Mobility in Smart Cities*; Nikolaos Geroliminis, Assistant Professor, Urban Transport Systems Laboratory, École Polytechnique Fédérale de Lausanne, Switzerland



12/06/2012 *Pareto Improvements from Lexus Lanes: The Case for Pricing a Portion of the Lanes on Heavily Congested Highways*; Jonathan D. Hall, Don Searle Post-Doctoral Research Fellow in Economics, NUTC

11/29/2012 *Transportation Information Session: Institute of Transportation Engineers, Illinois Chapter*; Joel Christell, ITE-IL Section President; Joshua Harris, ITE-IL Student Affairs Director

11/15/2012 *Traffic Monitoring with Smartphones*; Professor Daniel B. Work, Assistant Professor, Civil and Environmental Engineering, University of Illinois, Urbana-Champaign

11/13/2012 *Disaster Management Based on Multi Agent Transportation Simulation*; Seungjae Lee, Department of Transportation Engineering, Seoul; Shinhae Lee, Research Fellow, Seoul Institute

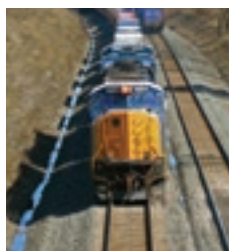
11/08/2012 *The Role of the Built Environment in Reducing Driving and Promoting Active Travel*; Professor Susan Handy, Director, Sustainable Transportation Center, University of California, Davis

10/25/2012 *Bringing the Boeing 787 into Operational & Commercial Service in LATAM Airlines*; Justin D. Siegel, Vice President, Fleet Projects, LATAM Airlines Group, S.A.

10/18/2012 *State of Good Repair and Beyond: Analyzing Metra's 2013 Strategic Plan*; Alexander Clifford, Executive Director & CEO, Don Orseno, COO, and Joe Lorenzini, Chief Engineering Officer, METRA

10/11/2012 *A Data-Driven Paradigm for Arterial Traffic Flow Monitoring, Modeling, and Control*; Dr. Henry Liu, Associate Professor, Department of Civil Engineering, University of Minnesota

The Hagestad Sandhouse Gang



The Sandhouse Gang is a railroad-oriented discussion group hosted by NUTC. The group meets monthly to explore a wide range of current rail-related issues and to link active and semi-active rail practitioners with students and academics at Northwestern and other schools. Formed in 2005, the group has nearly 300 members.

7/16/2013 *Passenger trains on freight railroads: truth is a constant casualty*; Don Phillips, Noted Transportation Journalist

6/04/2013 *CN's Acquisition of the EJE: The Story behind the Headlines*; Eric Jakubowski, Chief Commercial Officer, Anacostia Rail Holdings

5/07/2013 *Intermodal from Birth to Maturity*; Ron Suckic, Principal, RSE Consulting, Inc.

4/08/2013 *Amtrak's Relations with its Host Railroads*; Paul Vilter, Assistant Vice President, Host Railroads, Amtrak

3/14/2013 *The Value in Writing Railroad History*; H. Roger Grant, Kathryn & Calhoun Lemon Professor of History, Clemson University

2/21/2013 *Chicago Transportation Coordination Office (CTCO) and CREATE – A Progress Report*; Dave Nelson, General Manager Operations, CTCO with CP; William Thompson, Create Railroad Program Manager, Association of American Railroads

1/24/2013 *The Enduring Legacy of the Chicago North Shore & Milwaukee Railway*; Norman Carlson, Chairman, Carlson Consulting International, LLC

12/05/2012 *Transportation Trends and Investment Implications*; Christopher J. Ceraso, Director & Senior Equity Research Analyst, Credit Suisse, New York

The Icarus Society



The Icarus Society provides a forum for the discussion and dissemination of national and international issues impacting the aviation industry in order to share knowledge about all things relevant to aviation with the widest possible audience. The Society promotes in-depth dialogue about airlines, aircraft manufacturing, aviation services, technology, government oversight, and significant elements of business aviation. In addition to co-sponsoring seminars and events described elsewhere in this report, the Icarus Society was responsible for the following speaker and seminar events:

05/21/2013 *Domestic Airline Pilot Needs for the Next 10 to 20 Years*; Brant Harrison, First Officer, Skywest Airlines; Owner, Audries Aircraft Analysis, LLC

04/10/2013 *U.S. Airlines Mergers: The Modern Era*; George Hamlin, President, Hamlin Transportation Consulting

12/11/2012 *Right-Sizing: The Right Move in the Airline Business*; George W. Hamlin, President, Hamlin Transportation Consulting

11/29/2012 *Airline Capacity Discipline: Where and to what Extent?*; Aaron J. Gellman, Professor of Transportation, NUTC, and Kellogg School of Management



Education

NUTCs Fall 2013 Executive Education Program, attended by 22 executives from manufacturing, shipping, and logistics—experienced 3 days of presentations, Q&As, and discussions.

NUTC EXECUTIVE EDUCATION PROGRAMS

Freight Transportation and Logistics: Delivering Results in a Volatile Environment

During a period of economic uncertainty, operators and their customers (those who buy freight) face a volatile business landscape and shifting opportunities and expectations. Variability must be managed in freight transportation and logistics decisions with regard to pricing, service, access, mode selection, and contractual arrangements. Strategies for success for both the transportation buyers and sellers must continually adapt in this environment.

To address these challenges, the Northwestern University Transportation Center developed and conducted, on September 9-11, 2013, a customized program for transportation and logistics executives and those who invest, raise capital, and provide services for the sector. This executive program provided insight into the rapidly changing domestic and international transportation industry, including air, rail, truck, marine, package, third party logistics, and other non-asset sectors such as brokerage.

Subject matter covered:

- How is the volatile business environment and economic uncertainty impacting domestic/international freight transport?
- How have customers' logistics expectations changed?
- What are the relative competitive factors among the various modes in terms of access/availability, price and service?
- What regulatory changes can be expected that will impact relationships?
- What changes are needed in mode and carrier selection?
- What forces are driving these changes and how can you better anticipate and take advantage of them going forward?
- What new services and solutions are emerging from third party logistics providers? How applicable are these?
- What are the roles of freight intermediaries and how can they be used to a shipper's advantage?
- How is technology being leveraged to improve operational performance and service quality?
- How can carriers gain advantage in the new environment?
- What do those changes mean to logistics strategies? How do shippers achieve leverage?

At right: program faculty members Hani Mahmassani and Justine Zubrod conduct a Q & A session at the end of the course.

Far right: Joel Sitak, CEO, BirdDog Solutions.



The Northwestern University Transportation Center (NUTC) offers rigorous, non-degree executive program courses for transportation and logistics professionals, as it has done throughout most of its history. Developed for professionals engaged in and committed to the transportation and logistics fields, the courses provide exposure to a full range of management techniques and decision-making skills. These programs provide industry participants with the skills to excel in the complex business realm of global transportation and logistics. All of the Executive Programs are taught by leading authorities in their fields.



Participants listen and discuss during the Fall 2013 Executive Education Program..

Faculty for the program were:

Hani Mahmassani, William A. Patterson Distinguished Professor of Transportation and Director, NUTC; **Justin Zubrod**, Managing Partner, Justin Zubrod & Co., LLC; **Farrukh Bezar**, Partner, The Clarendon Group, LLC; **Mike Brennan**, Chief Operating Officer, Peapod; **Michael Burton**, Chief Executive Officer, C&K Trucking, LLC; **Lee Clair**, Partner, Norbridge, Inc.; **Shawn McWhorter**, President – Americas Region, Nippon Cargo Airlines, Inc.; **Ian Savage**, Associate Chair of Economics and Distinguished Senior Lecturer, Northwestern; **Karen Smilowitz**, Professor of Industrial Engineering, Northwestern; **Jan Van Mieghem**, Harold L. Stuart Professor of Managerial Economics; Kellogg School of Management, Northwestern; **Steven Rothberg**, Founding Partner, Mercator International, LLC; **Joel Sitak**, CEO, BirdDog Solutions; **Jeff Starecheski**, Vice President, Logistics Services, Sears Holding Company; and **Doug Waggoner**, Chief Executive Officer, Echo Global Logistics.

Academic Programs in Transportation and Logistics

Northwestern University is recognized throughout the world as one of the premier institutions for transportation and logistics education and for the quality of its graduates. NUTC's interdisciplinary transportation programs at both the graduate and undergraduate level prepare students for careers in diverse fields such as transportation operations, planning, engineering, and management—in the private and public sectors, government, consulting, and academia.

Academic programs are specialized and thorough. The program structure balances highly technical and quantitative training in the engineering and mathematical fields with theories and applications drawn from the relevant disciplines of economics, management, finance, marketing, energy, and the social sciences. Each of these programs involves rigorous coursework, opportunities for involvement in research, and exposure to real-world learning experiences in industry.

Undergraduate *Interdisciplinary Minor in Transportation and Logistics*

The minor is available to all Northwestern students. Students involved in the program benefit from an interdisciplinary approach to transportation and logistics education. Core courses come from the departments of Economics, Civil and Environmental Engineering, and Industrial Engineering and Management Sciences.

MS / PhD

- MS and PhD in Transportation Systems Analysis and Planning
- MS and PhD in Industrial Engineering and Management Sciences
- MMM Program — joint Master of Engineering Management and Masters of Business Administration
- MS in Analytics, McCormick School of Engineering & Applied Science



Students filled the seating for a seminar by Illinois Secretary of Transportation Ann Schneider in September 2013.



Paul Vilter, Assistant Vice President, Amtrak, shared lunch and conversation with transportation students in April 2013.

Student Comments

Education (continued)

Jiwon Kim

"My research area is transportation network modeling and simulation, with applications in traffic management and operations. Currently, I am interested in applying advanced data mining and analytics techniques to develop intelligent decision support systems for real-time traffic management.

"Along with the high-quality educational system, research programs and academic advising, what I think the most valuable aspect of NUTC is its atmosphere where every student is individually cared for and supported by the department and University. It is also very valuable that students are offered ample opportunities to learn and interact/network with faculty and professionals from various disciplines."

Charlotte Anne Frei

"The most valuable thing is the opportunities we have to work with industry and the public sector to solve practical, meaningful problems. I'm motivated by the idea that cities and transportation can be healthier and more sustainable if designed well; and I think people's mobility and access shouldn't be limited by poor infrastructure or eligibility (e.g. driver's license).

"In 3-5 years, I would like to be in a position that allows me to do research and implementation."

Meead Saberi

"My main research areas include traffic flow theory, network modeling, travel demand and behavior modeling, complex systems in transportation, and urban transportation data and information systems.



"The NU's transportation program provides diverse opportunities of research and coursework. The wide variety of research projects that faculty members are supervising help students to gain a broad perspective of the transportation field.

"The rapidly growing urban population in the world and the increasing challenge in large cities to satisfy needs for mobility and accessibility motivated me to conduct research in the general topic of congestion mitigation and smart cities.

"I will start as an assistant professor at Monash University, Melbourne, Australia in January 2014. In the next 5 years, I would like to establish my own research group and start a multidisciplinary research center focusing on "Smart Cities."

Christopher Lindsey

"I research freight and logistics systems and how these systems can be more efficiently run and better modeled for transportation planning.

"Most valuable at Northwestern are the University's library resources and the "flat" nature of departmental bureaucracy. Northwestern University has an excellent Transportation Library with a wealth of resources that you don't find at other institutions."



Madison Fitzpatrick

"My research focuses on modeling urban passenger travel behavior. Specifically, I am interested in the effects of attitudes and social interactions on travel choices.

"NU provides many opportunities for graduate students to enrich their experience beyond the typical coursework and research. For instance, last year I participated in the Graduate Teaching Certificate Program, which prepares grad students and post-docs to teach at the undergraduate level. Through this program, I had the opportunity to design and co-teach an undergraduate course and build a teaching portfolio that will help me market my skills in the future."



Dissertation Year Fellowships

A primary goal of the Northwestern University Transportation Center is to promote academic excellence and quality research among its transportation students involved in graduate programs across campus. In support of this commitment, each year NUTC offers a number of Dissertation Year Fellowships to outstanding PhD candidates conducting thesis research on transportation, logistics, or supply-chain topics.

Dissertation Year Fellowships include full or partial funding to cover three quarters of tuition and a stipend for selected students during their final year of study.

2013-14 NUTC Dissertation Year Fellowships

Charlotte Frei

PhD Candidate in Civil & Environmental Engineering
Dissertation Year Topic: *Travel, Communication and Activity Behavior: Improving the Customer Experience and Service Allocation*;
Faculty Advisor: Hani Mahmassani

Joseph Warfel

PhD Candidate in Industrial Engineering & Management Science; Dissertation Topic: *Operations Management of Retail Donation Programs*
Faculty Advisors: Karen Smilowitz & Seyed M.R. Iravani

Weizeng Zhang

PhD Candidate in Civil & Environmental Engineering
Dissertation Year Topic: *Segmentation Modeling: Applications of Finite Mixture Regression Models to Management of Transportation Infrastructure*
Faculty Advisor: Pablo Durango-Cohen

2012-13 NUTC Dissertation Year Fellowships

Yikai Chen

PhD Candidate in Civil & Environmental Engineering
Dissertation Topic: *Statistical Health-Monitoring for Transportation Infrastructure*;
Faculty Advisor: Pablo Durango-Cohen

Luis de la Torre

PhD Candidate in Industrial Engineering & Management Science; Dissertation Topic: *Models and Algorithms for Coordination in Humanitarian Logistics*;
Faculty Advisors: Irina Dolinskaya and Karen Smilowitz

Jiwon Kim

PhD Candidate in Civil & Environmental Engineering
Dissertation Topic: *Reliability in Traffic Simulation Models*; Faculty Advisor: Hani Mahmassani

Tim Sweda

PhD Candidate in Industrial Engineering & Management Science; Dissertation Topic: *Decision Making for Electric Vehicles*; Faculty Advisor: Diego Klabjan

Student Awards, 2012–13

Madison Fitzpatrick, PhD Candidate in CEE – Transportation Systems Analysis and Planning

- Eisenhower Transportation Fellowship awarded by USDOT Federal Highway Administration
- Selected to serve as one of six Graduate Teaching mentors in the Teaching Certificate program by the Searle Center for Teaching Excellence

Jonathan Hall, Dan Searle Post-Doctoral Research Fellow in Economics

- Best paper award at the ITEA International Conference on Transportation Economics: *Pareto Improvements from Lexus Lanes: The Case For Pricing a Portion of the Lanes on Congested Highways*

Jiwon Kim, PhD Candidate in CEE – Transportation Systems Analysis and Planning

- 2013 Best Presentation Award at the Doctoral Student Research in Transportation Modeling Workshop, TRB Annual Meeting
- Best Poster Award (in Transportation Systems) at the 2nd International Transportation PhD Student Symposium, September 2013, University of Illinois at Urbana-Champaign, Champaign, IL.

NuMat Technologies, a Northwestern University graduate student-based start-up company — comprised of three NU graduate students and a research professor — was part of the NU research team awarded \$1.5 million in research funding by the U.S. Department of Energy Advanced Research Project Agency – Energy (ARPA-E) to support natural gas vehicle technologies. Pictured at right are NU Graduate students (joint JD-MBA candidates) **Ben Hernandez**, and **Tabrez Ebrahim**, making one of many NuMat presentations. The team also won the first-ever U.S. Department of Energy (DOE) National Clean Energy Business Plan Competition. NuMat Technologies swept the 2012 Rice Business Plan Competition winning the grand prize and three major awards.

CCITT Student of the Year,

Charlotte Anne Frei, PhD Candidate in Transportation Systems Analysis and Planning, is shown at right with NUTC Associate Director Bret Johnson, after receiving her award at the banquet of the Council of University Transportation Centers, held in D.C. during the TRB Annual Meeting.





Since its inception in 1954, the Northwestern University Transportation Center has maintained strong ties with industry through its Business Advisory Council (BAC). The BAC consists of industry executives from a wide variety of firms and organizations involved in providing, procuring and/or supporting

transportation, logistics, and supply chain operations. Membership includes senior-level executives from shipper and carrier firms, freight-forwarders, equipment and technology suppliers, trade associations, financial organizations, and management consulting firms. The Center's industry connections link the

Northwestern community to challenging problems as well as to opportunities to learn and test solutions in real world settings. Members serve as advisors to the Center, providing important insights into the transportation-related issues and problems they face in their businesses.

Business Advisory Council



Business Advisory Council (continued)

The BAC has long been a major force behind the Transportation Center's success, providing interactions and collaborations that benefit industry and the University alike.

There are two primary levels of membership: Leadership, and Sustaining. Each category carries with it a set of membership benefits, as well as a suggested level of commitment and financial support for NUTC's research, education, and outreach activities.

Benefits to all members include access to Northwestern's world-class faculty, opportunities for networking with peers, invitations and involvement in special programs and events, insights into cutting-edge research and trends, discounted tuition fees for NUTC's executive programs, and access to Northwestern's Transportation Library and bright students.

The BAC meets twice yearly on the Evanston campus to foster an exchange of ideas among its members and the Center faculty, staff, and students. The meetings are designed to explore areas of interest and relevance to the BAC member companies. Each meeting features working sessions, panel discussions, and speaker presentations, as well as opportunities for more informal networking and exchange.

Fall 2012 Meeting, October 30–31, 2012

The Fall BAC meeting began with a Tuesday afternoon workshop in the form of two successive panels of presenters on the topic: *Data-Driven Business: Challenges and Best Practices in the Transportation Industry*. (See article on page 36)

Tuesday evening, NUTC held a reception for attending BAC members, graduate students, faculty, and university officials. Dinner followed the reception, after which Jim Carey, NU Adjunct Professor of Integrated Marketing Communications (and Data Driven Marketing Consultant) mixed humor, common sense, and marketing wisdom to illustrate that significant benefits await those who extract knowledge from existing, often overlooked data.



Wednesday morning, Director Mahmassani provided the *State of the Center* report to BAC members, highlighting the initiatives and programs sponsored by the Center during the 2010-2011 academic year. He noted that there were 27 research projects underway at the Center during 2012 and that BAC membership grew with the addition of several companies.

Three panels offered introductions and perspectives on developments of interest to members: **(1) Transportation & Logistics Implications of Unconventional Oil and Gas Production & Delivery;** Charles H. Dowding, Associate Chair, Civil and Environmental Engineering, NU; Graham Brisben, CEO and Founder, Professional Logistics Group; Carol Orndorff, Director, Chemicals, Norfolk Southern Railroad; and Doug Allen, Executive Vice President, Kenan Advantage; **(2) Opportunities for Leveraging Social & Knowledge Networks in the Business Environment;** Mohanbir Sawhney, Professor of Marketing, Kellogg School of Management; and Director, Center for Research in Technology & Innovation; and Jodi Navta, VP Marketing and Communications, Coyote Logistics; **(3) Aviation Game Changers? How the B787 and A380 Aircraft Transform Airline Operations;** Ron Baur, Vice President - Fleet, United Airlines; and Perry Cantarutti, Senior Vice President - Europe, Middle East and Africa, Delta Airlines; Aaron Gellman, Professor of Transportation, NU.

Finally, engineering graduate students and business start-up executives Ben Hernandez, CEO, and Tabrez Ebrahim, COO, of NuMat Technologies gave a concise "elevator pitch" of their innovative natural gas storage products. Immediately following this, NUTC's transportation students were introduced to the members, and the meeting adjourned to a luncheon.



Spring 2013 Meeting, April 24–25, 2013

Wednesday's start to the Spring meeting was the afternoon workshop: *Smarter Cities / Smarter Mobility*. Forming a glimpse of the technologies and the business expectations driving progress toward more connected urban transportation solutions, this BAC workshop continues to reverberate in the Center's activities and planning. (See article on page 37).

In the evening, Dr. Irwin M. Jacobs, Founding Chairman & CEO Emeritus, Qualcomm Inc., delivered the 32nd Annual William A. Patterson Transportation Lecture. (See article on page 38).

On Thursday, after the *Director's Report* given by Hani Mahmassani, a full morning of presentations followed. Three panels of experts provided case studies and insights on topics ranging from port and rail facility integration to battery storage technologies, to the role of private equity in transportation:

(1) Global Logistics Strategies: Integrating Port and Rail Development; Thanasis Ziliaskopoulos, President and CEO, TRAINOSE; James Hertwig, President and CEO, Florida East Coast Railway; **(2) Battery Storage Technology: The 787 Dreamliner Case and a Roadmap for Next Generation Technologies through the Joint Center for Energy Storage Research;** George Hamlin, President, Hamlin Transportation Consulting; Kenneth Poeppelmeier, Charles E. & Emma H. Morrison Professor of Chemistry, NU; **(3) The Changing Role of Private Equity in Transportation;** John Anderson, Managing Partner, Greenbriar Equity Group LLC; Price Blackford, Senior Advisor, Sagent Advisors Inc.; Ed Feeley, Managing Director, Littlejohn & Co. LLC; Heidi Hornung-Scherr, Partner, Scudder Law Firm; Kathleen Ross, SVP, Global Commercial Banking, Bank of America Merrill Lynch.

The Spring BAC Meeting ended with an introduction of the current NUTC students and a wrap-up luncheon.



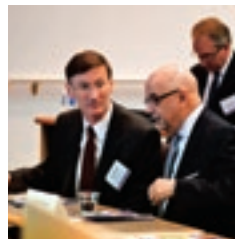
BAC workshop programs and expert presentations can be accessed at our Web site: <http://www.transportation.northwestern.edu/industry/bac.html>



New BAC member, Mike Brennan, COO of Peapod, LLC., introduces himself during the Spring meeting.



The third panel presentation on Wednesday offered an in-depth look at the role of private equity in the transportation industry. Among several topics, the five panelists spoke about: the perspectives of potential private investors, legal considerations in equity firm ownership, and banking relationships and strategies.



Jay Walsh, Vice President of Research, Office for Research, and Dean Julio Ottino, McCormick School of Engineering and Applied Science, were on hand to welcome BAC members to the Spring meeting.

New Members

Leadership Level



Pam Stec
Director, North America
Material Planning
& Logistics,
Ford Motor Company.



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Vice President,
Portfolio Planning &
Program Management;
Vice President, Defense
Engineering, Navistar

Sustaining Level



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Peapod, LLC.



Mr. Martin Hollander
Chief Operating
Officer,
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Mr. James R. Hertwig
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Coast Railway, LLC



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Matson



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Nokia Location &
Commerce



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Logistics Solutions,
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Global Rail Innovation
Center, IBM



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Mr. Reggie Dupré
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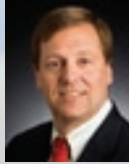
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Continuing Members

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Teradata



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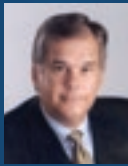
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& Co., LLC
*Chair, Business
Advisory Committee*



NUTC Community

A few of the graduate students socialize during NUTC's end-of-the-year grill and picnic on the lawn behind Chalmers Hall, June 6, 2013.

A number of social activities punctuate the steady flow of learning, fostering an academic and research environment conducive to collegiality, creativity, and balance.

New Academic Year Welcome Dinner

Each Fall, NUTC hosts a dinner to welcome students to the starting academic year. New transportation students are introduced and network with NUTC ongoing students and faculty.

End-of-the-Year Grill for Students, Faculty, Friends

The Transportation Center hosts an annual get-together in June to celebrate the end of another successful academic year. This tradition gathers the NUTC family of students, faculty, alumni, colleagues, and friends for a relaxed picnic and visit.

NUTC receptions associated with conferences, lectures and BAC meetings provide an essential aspect of building community. Left to right: faculty members Pablo Durango-Cohen and Karen Smilowitz with an NUTC affiliate from Loyola University, Maciek Nowak.



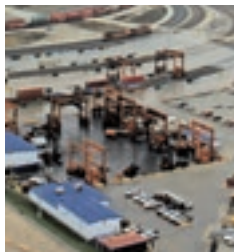
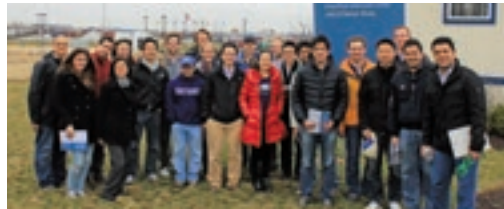
TRB Reception for Alumni, Associates, Faculty, Students in Washington D.C.



Reception, Sixth William O. Lipinski Symposium



Lakefront Skyline Boat Cruise, ITEA Conference



Kellogg Transportation and NU Transportation Clubs Tour Centerpoint Properties, United Operations

Student awareness and interest in transportation-related career opportunities are stimulated by a variety of events throughout the year sponsored by the Kellogg and NUTC Transportation Clubs, including presentations by industry managers and field trips to local transportation operations. During the 2012-13 academic year, students toured: the CenterPoint Intermodal Center in Elwood/Joliet, IL, which included helicopter views of the 2,500-acre operation; the United Airlines Network Operations Center in Chicago's Willis Tower hosted by Kellogg alum Noam Alon, Director of the Operations Control Center (with presentations by six of the Center's top managers); the CTA's Communications and Power Control Center; and O'Hare Airport to view the multi-million dollar O'Hare Expansion Project.

SOCIAL MEDIA:

To join: transportation.northwestern.edu



Facebook NUTC has two forums: an NUTC Fan page, which everyone can "Like" in order to receive information on upcoming events and news of interest; and the NUTC Community Group page which is a special member-only forum for those closely tied to the NUTC community.

LinkedIn's NUTC group, with over 300 members, is a dynamic medium to engage the NUTC community. Along with showcasing upcoming NUTC events of interest, the NUTC LinkedIn Group members engage in transportation and logistics discussions.



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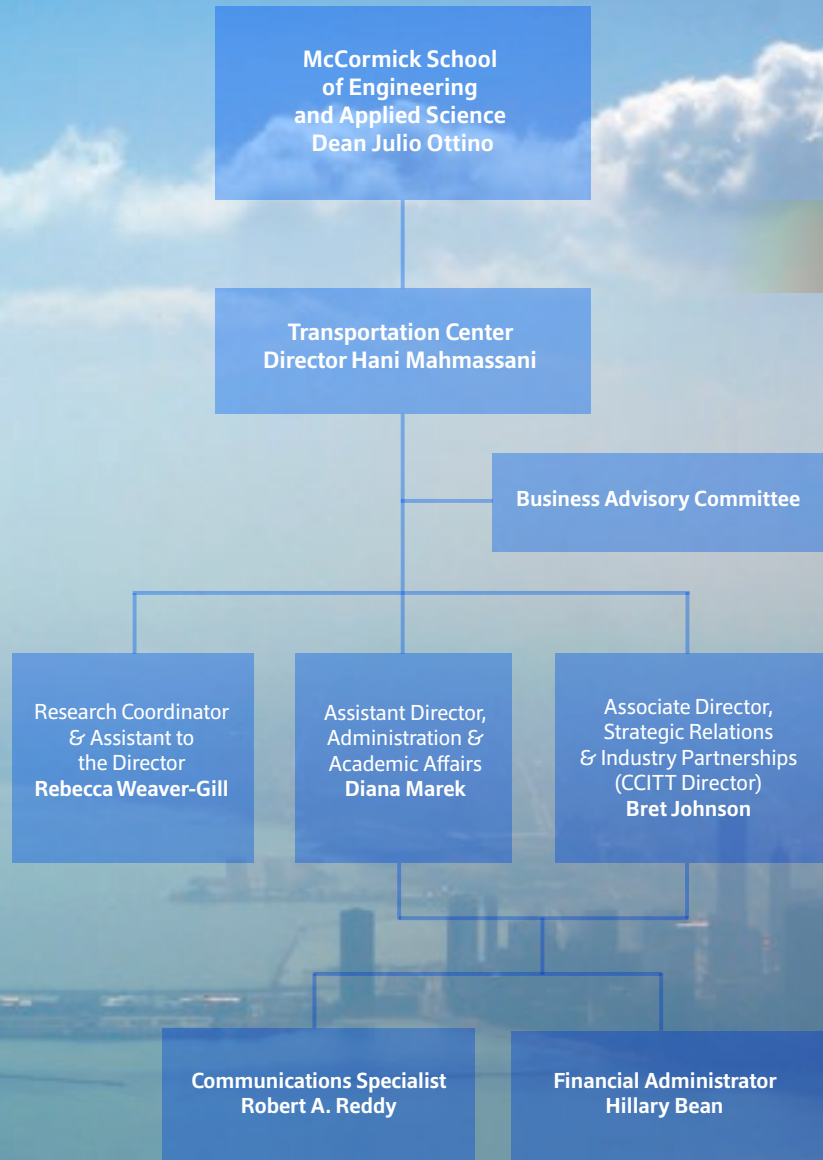


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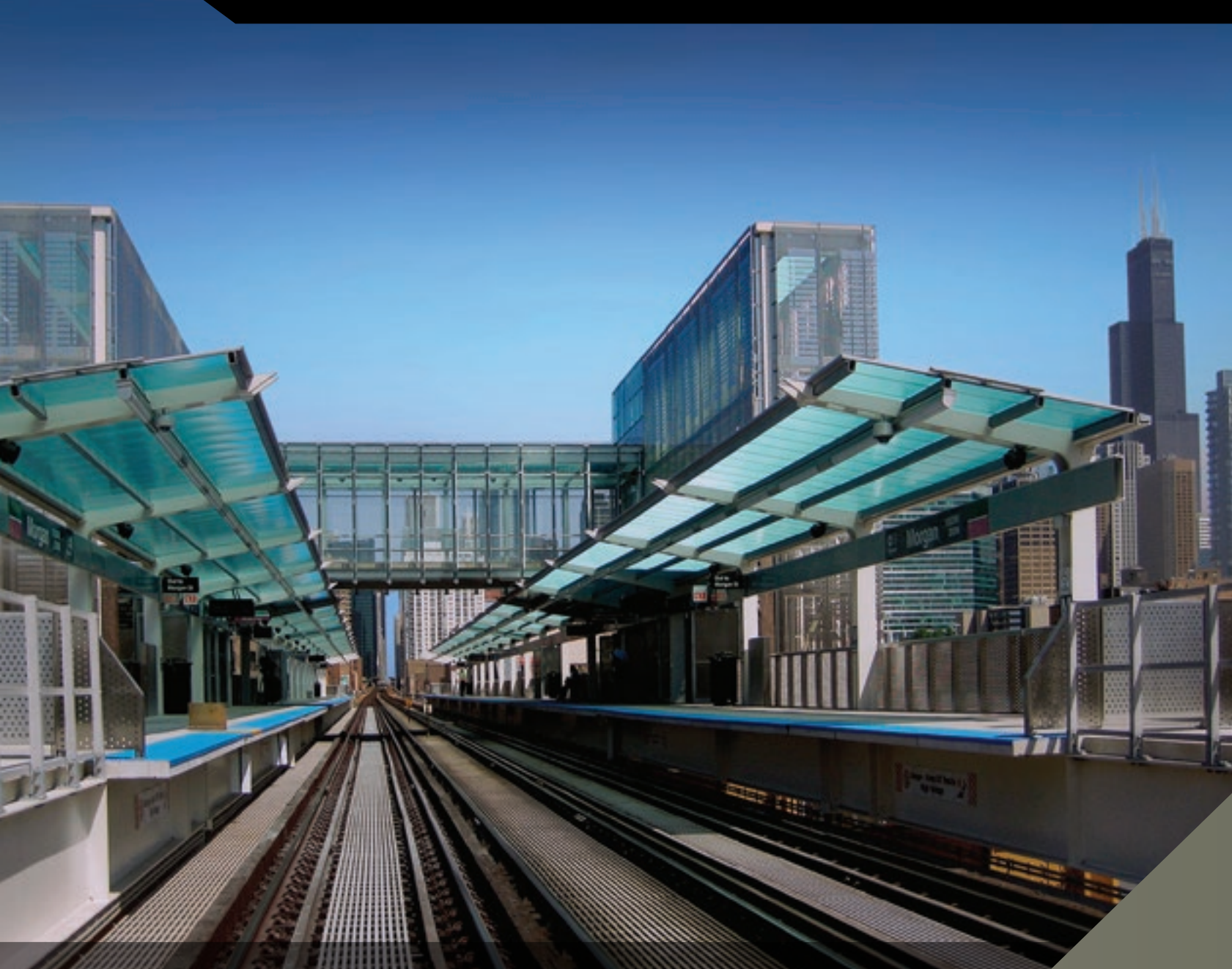
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