

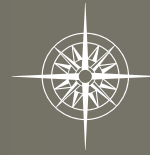
McCormick

Northwestern Engineering



**Northwestern University
Transportation Center**

2014 Progress Report



Northwestern University
Transportation Center

About the Northwestern University Transportation Center

For more than 60 years, the Northwestern University Transportation Center has been one of the world's leading interdisciplinary education and research institutions, serving industry, government, and the public. Founded in 1954 to make substantive and enduring contributions to the movement of materials, people, energy, and information, the NUTC stands at the forefront of transportation research and education, bringing together academic researchers, students, and business affiliates in open exploration of transportation and supply chain operations. In so doing, the Center aims to influence national and international transportation policy, management, operations, and technological developments, with the goal of making transportation and supply chain operations more productive, efficient, safe, secure, environmentally friendly, and socially beneficial.

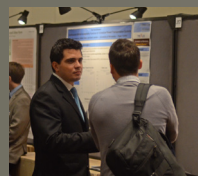
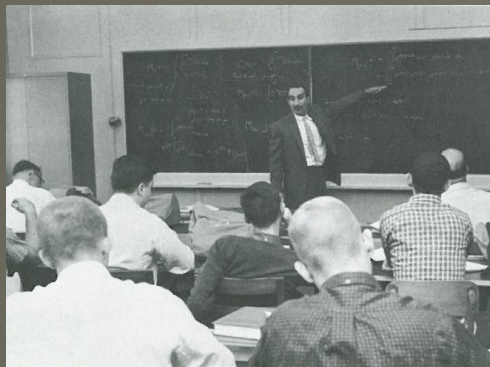




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Director's Message



For the last sixty years, the Northwestern University Transportation Center has been a lynchpin of the intersection between vigorous research and industry innovation. From its inception in 1954, the Transportation Center has striven to provide a place in which business leaders, academics, students, and policy decision-makers can come together to discuss and improve all sectors of transportation. Its core strengths—the quality and productivity of its faculty; its focus on both scholarly and applied research; its awareness of and responsiveness to the continual changes in the transportation and logistics industries—have helped to shape local, national, and international views of transportation for six decades.



Since I arrived at the Transportation Center in 2007, the Center has continued its longstanding tradition of cultivating and sharing an improved understanding of the economics and science of transportation and logistics systems. From our educational programs and extensive research projects to our social groups and community events, the NUTC has worked hard to create a fully interdisciplinary, truly community-oriented organization dedicated to furthering the Center's mission.

The last year has brought us many successes. In addition to our 60th Anniversary Celebration (p. 36), we have seen an expansion of our Business Advisory Council (p. 28), new faculty members and researchers (p. 11), and a wide variety of projects that have contributed greatly to our understanding of transportation and logistics (p. 18). In addition, we continue to have strong ties to our community with our events (p. 40), seminar series, and industry groups (p. 44). I could not be more pleased with our progress.



When the Center was founded in 1954, it is unlikely that even the most visionary among our faculty at that time could have foreseen the momentous changes in transportation technology and the sharing of information that would take place over the following six decades. What excites me most about the NUTC's future is the prospect of all the ideas and technologies that we have not even begun to develop. We at the Transportation Center look forward to the next sixty years of educational and research excellence.

A handwritten signature in black ink, appearing to read "HSM".

Hani S. Mahmassani

*William A. Patterson Distinguished Chair in Transportation
Director, Northwestern University Transportation Center*

Highlights | Numbers

- 15 New graduate students in transportation-related fields
- 13 Graduate students supported via research projects
- 4 Dissertation year fellows
- 12 Current Transportation & Logistics Minor students
- 10 Current proposals in review
- 9 Active funded research projects
- 7 Conferences, symposia, and distinguished lectures
- 7 New Business Advisory Council companies
- 75 Business Advisory Council companies
- 9 New Business Advisory Council members
- 92 Business Advisory Council membership
- 60 Years the Northwestern University Transportation Center has been supporting transportation and logistics research



Business Advisory Council Members Andrew Boyle and Farrukh Bezar share a light-hearted moment during the NUTC 60th Anniversary Transportation Summit (p. 39)

Highlights | Collaboration and Outreach



Regional & National

Schneider CEO Chris Lofgren delivered the **33rd Annual William A. Patterson Transportation Lecture** (p. 41)

Researchers, academics, and industry leaders came together for the **NUTC 60th Anniversary Technical Symposium** (p. 37), **Gala Dinner** (p. 38), and **Transportation Summit** (p. 39)

NUTC faculty affiliate Ian Savage delivered the **Leon N. Moses Transportation Lecture** (p. 41)

NUTC faculty and students were active participants in the **Transportation Research Board's 93rd Annual Meeting**

NUTC faculty affiliate Joseph Schofer gave the **2014 Deen Lecture** at the **Transportation Research Board's 93rd Annual Meeting** (p. 15)

NUTC faculty affiliate Joseph Schofer chaired a Transportation Research Board workshop **Development of Freight Fluidity Performance Measurements** in Washington, DC

Aaron Gellman received the **2014 McKelvey Award** at the **Transportation Research Board's 93rd Annual Meeting** (p. 15)

The NUTC hosted industry workshops: **The Fight for the Last Mile**; and **Autonomous Vehicle Technologies for Passenger and Freight Mobility** (p. 40)

NUTC faculty affiliate Ian Savage served on the organizing committee for the **Global Level Crossing and Trespass Prevention Symposium**

SYMPOSIA, CONFERENCES, & COMMITTEES

The Transportation Center has partnered with the **Leveraging, Integrating, Networking, Coordinating Supplies (LINCS) in Supply Chain Management (SCM)** consortium that was selected as a grant awardee for the Department of Labor's Trade Adjustment Assistance Community College and Career Training (TAACCCT) grant program (p. 27)

The Center participated in the two-day **UILabs CitySmart Workshop** to develop and advance a collaborative smart cities research program with the City of Chicago

RESEARCH COLLABORATION

NUTC Associate Director Bret Johnson participated on the **Alliance for Regional Development Transportation and Logistics Committee**

The NUTC joined the **Illinois Tollway** in a discussion of operational challenges and research needs for smart highways

The Center worked with the **Chicago Metropolitan Agency for Planning (CMAP)** to develop a multimodal network microsimulation platform (p. 18)

GOVERNMENTS AND AGENCIES

NUTC Associate Director Bret Johnson moderated a public-private **HNTB Think Forum** discussion entitled **The Roadway of the Future**

2014 North American Travel Monitoring Exposition and Conference (NATMEC) in Chicago

ongoing research (p. 26), including **BNSF Railway**, **Boeing**, **Booz Allen Hamilton**, **Echo Global Logistics**, **SAIC**, **Sejel Technologies**, and **U.S. Bank**, as well as various small businesses

INDUSTRY RESEARCH

The Center co-sponsored the

The NUTC is working with industry partners to foster



International

SYMPOSIA, CONFERENCES, & COMMITTEES

Hani S. Mahmassani presented the keynote address on autonomous vehicles and connected vehicle systems at the **1st National Congress and Exhibition on Intelligent Transport Systems for Highways** in Istanbul

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

- Amsterdam, The Netherlands
- Athens, Greece
- Beijing, China
- Beirut, Lebanon
- Berlin, Germany

- Dubai, UAE
- Guangzhou, China
- Hong Kong, China
- Istanbul, Turkey
- Lausanne, Switzerland
- Riyadh, Saudi Arabia
- Santiago, Chile
- Sydney, Australia
- Toronto, Canada

The NUTC will host the **22nd International Symposium on Traffic and Transportation Theory (ISTTT)** in 2017

RESEARCH COLLABORATION

Hani S. Mahmassani has provided expert assistance to a development consortium in Indonesia, mapping out subjects for future training and research:

- Infrastructure Development
- Economic Development
- Transportation and Land Use
- Planning and Development
- Sustainable Design and Practices
- Communication and Public Policy

GOVERNMENTS AND AGENCIES

The Transportation Center provided continuing technical assistance to the **Kingdom of Saudi Arabia's Ministry of Transportation** as they develop a national Roads & Transportation Research Center

The NUTC hosted a group of 60 Indonesian city mayors, district leaders, and government officials in Chicago for two days as the culmination of a customized

executive education program, **Transportation Policy Development, Planning and Management**, conducted in Jakarta, Indonesia, in partnership with the **Ministry of Home Affairs of the Republic of Indonesia** and the **Rajawali Foundation** (p. 42)

NUTC Faculty Affiliate Aaron Gellman serves on the **Panama Canal Advisory Board**

Synergistic Institutes and Centers

The 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. 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.

Infrastructure Technology Institute

The Infrastructure Technology Institute (ITI)'s goal 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.

Center for Operations & Supply Chain Management

The Center for Operations and Supply Chain Management was established in 2004 to organize the Kellogg School's research and pedagogical activities in these essential subject areas. The Kellogg School's Operations and Supply Chain Management programs, led by an accomplished group of nine faculty members, have historically ranked among the nation's best.

Initiative for Sustainability and Energy

The Institute for Sustainability and Energy at Northwestern (ISEN) was established in 2008 as an umbrella organization whose unique mission is to advance global energy and sustainability solutions through transformational research, interdisciplinary education, and public engagement. 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

The Northwestern Institute on Complex Systems (NICO) was founded in 2004 with the goals of uncovering fundamental principles governing complex systems in science, technology, and human behavior and applying these principles to solve societally relevant problems through the analysis, design, and control of complex systems. Based on the belief that breakthroughs in complex systems require collaboration across boundaries of traditional domains, NICO brings together faculty in business, engineering, education, medicine, natural sciences, and social sciences. Cross-disciplinary collaborations break down barriers due to disciplinary knowledge silos and domain-specific terminology, accelerating the development of the new science of complex systems.

The 2014 ISEN Futures Summit, "Resilient Futures: Ecosystem and Infrastructure Risk," brought together more than 200 participants.



The Center for the Commercialization of Innovative Transportation Technology (CCITT) promotes and fosters research and technology implementation collaborations among transportation researchers at Northwestern, industry and public sector agencies. Notable research partnerships have recently involved Echo Global Logistics, U.S. Bank, Boeing, BNSF Railway, CenterPoint, and the Chicago Transit Authority.

This year, the CCITT coordinated two industry workshops, **The Fight for the Last Mile** and **Autonomous Vehicle Technologies for Passenger and Freight Mobility** (p. 40), respectively highlighting transformative changes underway in last mile package delivery and vehicle mobility.



CCITT Key Numbers

- Projects funded: 15
- Faculty principal investigators: 15
- Academic departments engaged: 6
- Students supported: 25
- CCITT funding committed: \$1,273,300

Transportation Library

The Northwestern University Transportation Library was founded in 1958 to support the curricula and research programs of the Transportation Center and the Center for Public Safety. With more than 500,000 items, the Library is one of the largest information centers of its kind in the world, encompassing information on all transportation modalities, including air, rail, highway, pipeline, water, urban transport, and logistics. In addition, its collection of environmental impact statements is one of the most complete in the world.



*Roberto Sarmiento
Head, Transportation Library*

The Transportation Library's staff produces TRANweb, a web-based periodical index of transportation and law enforcement articles and proceedings. Its collections are available to the general public and are used by researchers worldwide.

Emerging Challenges

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.

Building on the core strengths of its faculty researchers, enhanced through collaboration with other research centers and entities, the Transportation Center has identified seven emerging challenge areas:

- Reinventing the User Experience
 - Freight and Passenger Transportation
 - Business Intelligence
 - Marketing and Operational Efficiency
 - Urban and Facility Design
- Smart Cities
 - Driverless Vehicles
 - Connected Systems
- Freight Mobility and Intermodalism
 - “Last Mile” Delivery
 - Economic Competitiveness
- Leveraging Big Data for Transportation Agencies
- Transportation Energy and Sustainability
- Recognizing the Growing Role of Bicycles in the 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. They form the focus of efforts both inside Northwestern as well as with our industry and agency partners. Four of these are currently under intensive study at the NUTC: Humanitarian Logistics and Disaster Relief; Smart Cities; Reinventing the User Experience; and Freight Mobility and Intermodalism.

Humanitarian Logistics

The Humanitarian Logistics Initiative at Northwestern University, spearheaded by NUTC faculty affiliates Karen Smilowitz and Irina Dolinskaya, concerns itself with research that applies a broad range of engineering sciences and tools to solving the critical problems that arise in the chaotic arena of disaster relief distribution operations. Advances in geographic information systems (GIS) technologies, mobile communications platforms with social media features, optimization techniques networking power, and the decision sciences are now being brought to bear on challenges such as relief supply vehicle routing in uncertain, rapidly changing settings; search and rescue that takes into account real-time information on access road networks and infrastructure conditions; and enhanced tools and methods for locating and setting up mobile health clinics in relief zones.

The Initiative encompasses three interrelated fields: (1) humanitarian logistics involves the coordination of people, organizations, and materials to deliver goods and services to people in need; (2) evacuation logistics and management entails moving affected populations out of harm's way and providing for their needs during and after the process; and (3) nonprofit logistics focuses on the operations of nonprofit organizations at local, regional and national levels.

In all categories the research aims to provide the data necessary for reliable decision-making by integrating relief routing models with new streams of

imagery, mapping, and crowd-sourced real-time data into tools usable by aid practitioners in real settings. In addition, understanding the psychological and sociological aspects of human response in these situations is essential.

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, can 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

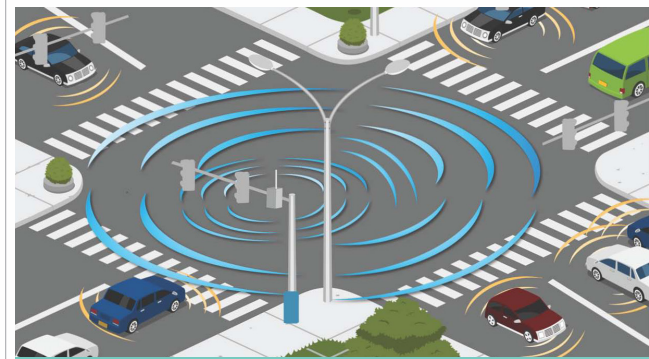
In many realms of personal products and services, new technologies and devices continue to please and delight consumers. Through focus on the user experience, personal communication devices have become virtual hubs for social interaction, instant connectivity and context-specific information, creating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

Drawing upon the lessons of highly successful consumer product 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 Hani S. Mahmasani. Key BAC industry partners include Tera-data and Echo Global Logistics. Agency collaborators include the Chicago Transit Authority and PACE Transit.



Connected vehicles are helping make the vision of smart cities a reality. See a related story on autonomous vehicles on page 40.

Freight Mobility and Intermodalism

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 consist 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:

- 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;
- Harmonizing infrastructure, technology and policy for seamless and secure border crossings that support trade and economic activity;
- Meeting capacity needs and alleviating congestion at critical urban hubs to eliminate bottlenecks through judicious combination of technological innovation, infrastructure investment, and policy initiatives;
- Channeling global logistics chains to drive local economic renewal and employment;
- Assuring reliability, resilience and consumer responsiveness of freight and logistics networks;
- Defining models for public-private partnering in infrastructure development, financing, and operation to achieve national objectives regarding multimodal freight corridors;
- 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 industry as well as state and national-level agencies.

Faculty Affiliates and Researchers

■ Feinberg School of Medicine ■ Kellogg School of Management ■ McCormick School of Engineering and Applied Science
■ Medill School of Journalism, Media, and Marketing Communications ■ Northwestern University Library ■ School of Communications
■ School of Law ■ Weinberg College of Arts and Sciences ■ Loyola University Chicago ■ University of Iceland / Chalmers University

■ Jan D. Achenbach

Walter P. Murphy and Distinguished McCormick School Professor Emeritus of Civil and Environmental Engineering, Engineering Sciences and Applied Mathematics, and Mechanical Engineering • Airworthiness assurance of aircraft structures; ultrasonic methods in quantitative nondestructive evaluation; fracture mechanics

■ Zdeněk Bažant

McCormick Institute Professor; Walter P. Murphy Professor of Civil and Environmental Engineering, Mechanical Engineering and Material Science, and Engineering • Mechanics of materials and structures and structural safety; nanomechanics; hygrothermal effects; applications to concrete, fiber composites, tough ceramics, rocks, soils, bone, snow, and sea ice

■ Henry Binford

Associate Professor, History and Urban Affairs • Evolution of subcommunities within cities; redevelopment of cities; history of transportation relating to growth of cities

■ David E. Boyce

Adjunct Professor, Civil and Environmental Engineering • Urban travel and location forecasting models; transportation network analysis and modeling; history of urban travel forecasting methods

■ Ronald R. Braeutigam

Associate Provost, Undergraduate Education; Harvey Kapnick Professor of Business Institutions; Professor of Economics • Applied microeconomic theory and industrial organization; regulatory economics

■ Fabián E. Bustamante

Associate Professor of Electrical Engineering and Computer Science • Design, deployment, and evaluation of large-scale distributed systems in both wide-area and mobile networks; experimental systems, particularly operating systems and distributed computing

■ Clarke L. Caywood

Professor of Integrated Marketing Communications • Marketing and communications; crisis management and communications; humanitarian logistics, stakeholder relationship management; political and deceptive messages and advertising; China management education and training

■ Wei Chen

Wilson-Cook Professor in Engineering Design; Professor of Mechanical Engineering • Multidisciplinary design optimization; design under uncertainty; simulation-based design; design theory and methodology

■ Sunil Chopra

IBM Distinguished Professor of Operations Management and Information Systems, Department of Managerial Economics & Decision Sciences • Supply chain management and operations; design of communication and distribution networks; supply chain risk

■ J. Edward Colgate

Allen K. and Johnnie Breed Senior Professor in Design; Professor, Mechanical Engineering; Director, Master of Science in Engineering Design & Innovation Program; Research Council Member, Segal Design Institute • Human/machine interface; haptics; mechatronic systems

■ James G. Conley

Clinical Professor of Technology; Professor of Industrial Engineering & Management Sciences • 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 and Management Science; Professor of Communications Studies • Social and knowledge networks; statistical and computational methods; organizational theory

■ David Corr

Clinical Associate Professor of Civil and Environmental Engineering • Structural engineering and mechanics; structural sensing and diagnostics; failure analysis and forensic engineering; performance of civil engineering materials; stochastic methods and structural reliability

■ Anne Coughlan

John L. & Helen Kellogg Professor of Marketing • Distribution channel management and design; pricing strategy; reverse channels for product returns; competitive strategy

■ Gianluca Cusatis

Associate Professor of Civil and Environmental Engineering • Mechanics of infrastructure materials and constitutive modeling of concrete and cementitious composites

■ **David A. Dana**

Kirkland & Ellis Professor of Law • Environmental and land use law, regulation, and policy, particularly methods of allocating carbon credits; regulation and technological change in the automobile industry; eminent domain reform and urban sprawl

■ **Irina S. Dolinskaya**

William A. Patterson Junior Chair in Transportation; Assistant Professor, Industrial Engineering and Management Sciences • Transportation science and logistics; adaptive modeling and solutions; humanitarian logistics; optimal vessel performance; electric vehicle routing

■ **Charles H. Dowding**

Associate Chair and Professor of Civil and Environmental Engineering • Construction vibrations; structural health monitoring; subsurface exploration decisions

■ **David Dunand**

James N. and Margie M. Krebs Professor of Materials Science and Engineering; Co-Director, Initiative for Sustainability and Energy at Northwestern • Lightweight metallic materials for energy-efficient transportation; high-temperature alloys for energy-efficient internal-combustion and jet engines

■ **Pablo Durango-Cohen**

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

■ **Steven Franconeri**

Assistant Professor, Cognitive Psychology • Visual cognition; guidance, capture, and tracking of visual attention and awareness; effective visual design

■ **Aaron J. Gellman**

Former Director, Northwestern University Transportation Center • Transportation management, economics, and policy; aviation management; regulation; financial analysis; the management of technology and innovation; technology forecasting

■ **Robert J. Gordon**

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

■ **Kimberly A. Gray**

Professor of Civil and Environmental Engineering • Urban sustainability; brownfield and urban redevelopment; environmental impacts of transportation on ecological and human health; energy-efficient technology

■ **Brian Hanson**

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

■ **Mike Hewitt**

Assistant Professor of Information Systems and Operations Management, Quinlan School of Business • Quantitative models for decision-making; solutions for transportation and supply chain management domains, particularly in freight transportation and home delivery

■ **Paul M. Hirsch**

James L. Allen Distinguished Professor of Strategy & Organizations; Chair, Management and Organizations Department • Organizational change; human resources and mass media

■ **Joel Horowitz**

Charles and Emma Morrison Professor of Market Economics • Econometrics; travel demand modeling; urban transportation; air quality

■ **Thomas N. Hubbard**

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



■ **John C. Hudson**

Professor of Anthropology; Director, Geography Program; Associate Director, Environmental Sciences Program • Cultural and physical geography of North America; biogeography; economic geography; cartography and mapping; geographic information systems

■ **Albert Hunter**

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

■ **Arthur P. Hurter**

Professor Emeritus of Industrial Engineering and Management Sciences • Logistics; applied microeconomic analysis; routing and risk analysis; facility locations; plant and equipment investment and replacement

■ **Seyed M.R. Iravani**

Professor of Industrial Engineering and Management Sciences • Stochastic modeling and analysis; production and logistics; optimization of queuing systems; manufacturing and supply chain management; white collar work and service operations systems; analysis of integrated production and maintenance policies

■ **Breton Johnson**

Associate Director, Northwestern University Transportation Center (NUTC); Director, Center for the Commercialization of Innovative Transportation Technology • Technology transfer and commercialization; technology-based economic development; space and technology innovation policy; homeland security

■ **Richard Joseph**

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

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

■ ■ **William L. Kath**

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

■ **Leon M. Keer**

Walter P. Murphy Emeritus Professor of Civil and Environmental Engineering and Mechanical Engineering • **Engineering mechanics; tribology**

■ **Diego Klabjan**

Professor of Industrial Engineering and Management Sciences; Director, Master of Science in Analytics Program • **Business intelligence and analytics in air transportation, logistics, rail, retail, and supply chain management**

■ **Frank S. Koppelman**

Professor Emeritus of Civil and Environmental Engineering • **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 Pepper Professor of Civil and Environmental Engineering; Director, Master of Project Management Program • **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**

William A. Patterson Distinguished Chair in Transportation; Professor of Civil and Environmental Engineering; Director, Northwestern University Transportation Center (NUTC); Professor, Managerial Economics and Decision Sciences • **Dynamic traffic system management; network modeling and optimization; dynamics of user behavior and telematics; intermodal freight and logistics**

■ **Therese McGuire**

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



Ph.D. candidate Christopher Lindsey (center) with NUTC faculty members (from left) Diego Klabjan, Karen Smilowitz, Hani S. Mahmassani, and Joseph L. Schofer

■ **David Morton**

Professor of Industrial Engineering and Management Sciences • **Stochastic optimization and its application to energy, security, and health problems**

■ **Barry L. Nelson**

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

■ **Yu (Marco) Nie**

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

■ **Maciek Nowak**

Associate Professor of Information Systems and Operations Management, Quinlin School of Business; Director, Master of Science in Supply Chain Management Program • **Vehicle routing and tracking; supply-chain management; operations management and research; logistics and data analysis; quantitative methods; heuristic search**

■ **John C. Panzar**

Louis W. Menk Professor Emeritus of Economics • **Theoretical and policy issues relating to network industries (telecommunication, electric transport, air transport and postal services); industrial organization; regulatory economics; applied microeconomic theory**

■ ■ ■ **Kalyan Raman**

Professor of Integrated Marketing Communications; Professor of Psychiatry and Behavioral Sciences; Affiliated Professor of Marketing • **Integrated marketing communications; marketing mix optimization issues; sales force compensation; brand name recall and implications for advertising and market structure; pricing; diffusion models; supply chain management**

■ **Mark A. Ratner**

Professor of Chemistry; Co-Director, Institute for Sustainability and Energy at Northwestern • **Organic electronics and photovoltaics; energy storage materials, particularly electrochemical; energy concentration routes, including exciton fission; agent-based modeling of complex systems**

■ **Kathryn Reid**

Research Associate Professor, Neurology • **Impact of sleep loss and circadian disruption on human performance; health and safety with emphasis on the impact of shiftwork**

■ **Roberto Sarmiento**

Head, Transportation Library • **Management issues for the digitization of transportation collections; analysis of transportation library's collection at the national level; the role of journal article indexing in a full-text world**

■ **Ian Savage**

Associate Chair, Department of Economics; Assistant Professor of Instruction • **Transportation safety; transportation economics; urban transit**

■ **Joseph L. Schofer**

Associate Dean, Faculty Affairs; Professor of Civil and Environmental Engineering • **Transportation policy analysis and planning; uses of data and information in decision making; issues and factors in investment decisions; traveler behavior and market research**

■ **Karen Smilowitz**

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

■ **Richard Sobel**

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

■ **Amanda Stathopoulos**

Assistant Professor of Civil & Environmental Engineering • **Transportation choice modeling and forecasting**

■ **Gunnar Stefánsson**

Professor, Industrial Engineering, Mechanical Engineering, and Computer Science; Associate Professor, Technology Management and Economics • **Logistics and transportation management; collaboration management; information and communication systems; management of technology and economics**

■ **Fred W. Turek**

Charles E. and Emma H. Morrison Professor of Biology, Department of Neurobiology & Physiology; Director, Center for Sleep and Circadian Biology • **Investigation of circadian rhythms and their importance to human health, safety, performance, and productivity; relationship between abnormal sleep-wake cycles on fatigue and alertness in the workplace and the transportation industry**

■ **Jan A. Van Mieghem**

Harold L. Stuart Distinguished Professor of Managerial Economics; Professor of Operations Management, Department of Managerial Economics & Decision Science • **Operations management and strategy; supply chain management and analysis; management and investment under uncertainty**

■ **Ismail Ömer Verbas**

Post-Doctoral Research Fellow, Northwestern University Transportation Center (NUTC) • **Transportation network modeling; multi-modal assignment and simulation; transit network design; transit scheduling; time-dependent origin-destination estimation; energy and sustainability; emergency evacuation**

■ **Michael Watson**

Adjunct Professor, Department of Industrial Engineering and Management Sciences, Master of Engineering Management Program, and Master of Science in Analytics Program • **Supply chain network design; facility location; analytics**

NUTC faculty member Ian Savage (left) with Business Advisory Council Member Joshua L. Schank of the Eno Center for Transportation



Faculty Affiliates and Researchers | Recognition

Zdeněk Bažant

Elected as Foreign Member of Academia Europaea

David E. Boyce

Published historical overview book *Forecasting Urban Travel: Past, Present and Future* (with Huw C.W.L. Williams)

Clarke Caywood

Named the first recipient of the Ofield Dukes Education Award by the Black Public Relations Society



NUTC faculty affiliate Clarke Caywood

Irina Dolinskaya

Presented national address on industrial engineering to middle schoolers for The Jason Project; received the 2014 Cole-Higgins Award for Excellence in Advising from Northwestern University

Aaron Gellman

Received the 2014 Francis X. McKelvey Award at the Transportation Research Board's Annual Meeting in Washington, DC during the Aviation Group Executive Board meeting



NUTC faculty affiliate Aaron Gellman (center) receiving the Francis X. McKelvey Award

Michael Hewitt

Awarded National Science Foundation grant for supply chain project *Efficient Algorithms for Continuous Time Service Network Design Models That Accurately Estimate Consolidation Opportunities in Time*

Paul Hirsch

Elected to the board of the Western Academy of Management

Joel L. Horowitz

Received honorary doctoral degree from Humboldt University (Berlin, Germany)



NUTC faculty affiliate Joel L. Horowitz

Hani S. Mahmassani

Awarded the Transportation Research Board Transportation Network Modeling Committee's Best Paper honor for 2014 and the 2014 Ryuichi Kitamura Paper Award for *How Many Runs? Analytical Method for Optimal Scenario Sampling to Estimate the Variance of Travel Time Distributions in Vehicular Traffic Network* (with NUTC researcher Jiwon Kim); presented keynote address at the 1st National Congress and Exhibition on Intelligent Transport Systems for Highways in Istanbul, Turkey

Roberto A. Sarmiento

Named Chair, Transportation Research Board Library and Information Science for Transportation (ABG40) Committee; named Chair, Special Libraries Association (SLA) Bylaws Committee

Ian Savage

Awarded Best Academic Paper, 2014 Global Level Crossing and Trespass Prevention Symposium, University of Illinois at Urbana-Champaign, for "Analysis of Fatal Train-Pedestrian Collisions in Metropolitan Chicago 2004-2012"; received the 2015 Herbert O. Whitten Service Award from the Transportation Research Forum

Joseph L. Schofer

Gave the 2014 Thomas B. Deen Distinguished Lecture at the Transportation Research Board's Annual Meeting in Washington, DC; chaired Transportation Research Board workshop *Development of Freight Fluidity Performance Measurements* in Washington, DC

Richard Sobel

Authored book, *The Politics of Joint University and Community Housing Development, Cambridge, Boston, and Beyond*

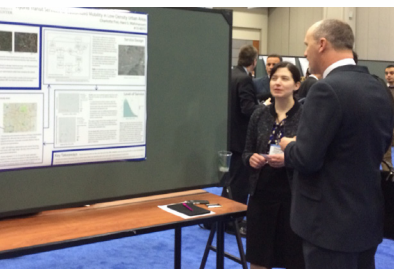
.....
One of the Center's greatest strengths lies in the indelible contributions of its faculty and researchers to the understanding of transportation and logistics.
.....

Education

Northwestern University is recognized throughout the world as one of the premier institutions for transportation and logistics education. The NUTC's interdisciplinary programs prepare students for careers in such diverse fields as transportation operations, planning, engineering, and management. NUTC graduates go on to serve in a wide array of sectors—public and private, including government, business, independent consulting, and academia.



The NUTC's academic programs are specialized and thorough, with a program structure that balances highly technical quantitative training in engineering and mathematics with theories and applications drawn from relevant disciplines such as economics, management, finance, marketing, energy, and the social sciences. Each section involves rigorous coursework, opportunities to become involved in research, and exposure to real-world learning experiences in industry.



Undergraduate students may become involved with the Transportation Center through the **Transportation and Logistics Minor**. Available to all Northwestern undergraduates, this interdisciplinary program draws from a wide variety of disciplines and includes courses from the McCormick School of Engineering and Applied Sciences and the Weinberg College of Arts and Sciences. It samples coursework from departments as varied as Civil & Environmental Engineering, Economics, Geography, Industrial Engineering & Management Sciences, History, Political Science, and Sociology.



At the graduate level, the NUTC offers a number of different avenues for students. Master of Science and Doctoral degrees are available in **Transportation Systems Analysis and Planning** as well as **Industrial Engineering and Management Sciences**, both offered through the McCormick School of Engineering and Applied Sciences. In addition, students may become involved with the NUTC through the **Master of Science in Analytics**, also offered through McCormick, or the specialized **MMM Program**, a joint degree offering a Master of Engineering Management through McCormick and a Master of Business Administration through the Kellogg School of Management. All graduate students affiliated with the Transportation Center have the opportunity to take advantage of the Center's wide array of faculty affiliates, business contacts, and academic advising.

“The Center provides many opportunities for graduate students to enrich their experiences beyond typical coursework and research.”
— Madison Fitzpatrick, Ph.D. Candidate

Education | Student Awards

Dissertation Year Fellowships

One of the NUTC's primary goals is to promote academic excellence and quality research among its transportation students. In support of this commitment, the Center offers a number of annual Dissertation Year Fellowships to outstanding Ph.D. candidates conducting thesis research on transportation, logistics, or supply chain topics. Dissertation Year Fellowships include full or partial funding to cover tuition and a stipend for students' final year of study.

2014-2015 NUTC Dissertation Year Fellows



Madison Fitzpatrick

Ph.D. Candidate in Civil & Environmental Engineering

Dissertation Topic: *Dynamic Attitudes and Social Networks in Travel Behavior Modeling*

Faculty Advisor: Pablo Durango-Cohen



Mehrnaz Ghamami

Ph.D. Candidate in Civil & Environmental Engineering

Dissertation Topic: *Planning Infrastructure for Electric Vehicles*

Faculty Advisor: Yu (Marco) Nie



Alireza Talebpour

Ph.D. Candidate in Civil & Environmental Engineering

Dissertation Topic: *Modeling Driver Behavior in a Connected Environment*

Faculty Advisor: Hani S. Mahmassani



Ali Zockaie

Ph.D. Candidate in Civil & Environmental Engineering

Dissertation Topic: *Path Finding and Traffic Equilibrium in Stochastic Networks Considering Link Travel Time Correlations*

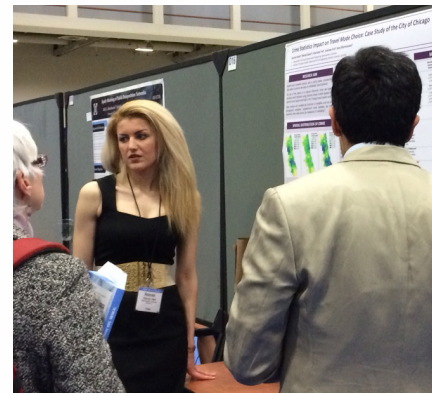
Faculty Advisor: Hani S. Mahmassani

Student Awards



Charlotte Frei

Named an Eno Fellow at the 22nd Annual Eno Center for Transportation Leadership Development Conference in Washington, DC



The NUTC's primary objective is to discover new insights, concepts, and tools that can be utilized by industry, business, and government to support decision-making. The ultimate end of the Center's intensive research agenda is to help all these sectors move towards more efficient and responsive services and systems. The Transportation Center's core research areas reflect this goal.

- 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

Easing Large-Scale Network Planning Into the 21st Century

Project Title: *Development of Multimodal Network Microsimulation Platform and Integration with Activity-based Travel Demand Model for the Chicago Metropolitan Agency for Planning (CMAP)*

NUTC PI: Hani S. Mahmassani

The primary purpose of this project is to extend application of the Activity-Based Model of travel demand to include dynamic sensitivity to multi-modal network conditions, with a focus on incorporating suitably advanced methods of integration between the demand and network-supply side, at a level of complexity that is commensurate with the systems modeled and the questions the models are intended to address. The NUTC team led by Hani S. Mahmassani has developed and implemented an integrated multimodal transportation system operations model that consider individual travelers' experience throughout the system as they perform their daily activity chains. NUTC has primary responsibility for the multimodal network microsimulation aspect of the work, while Parsons Brinckerhoff, Inc. has developed the activity-based demand modeling system. Integration of the two is advancing the state of the art as well as the state of the practice in significant and far-reaching ways.

Methodologically, the project is covering new ground in terms of defining and operationalizing concepts, formulations and solution algorithms for integrating user choices in an agent-based simulation framework over the short-term, medium-term and long-term, by implementing different notions of mutual consistency between

agent choices and multimodal network performance.

Another important innovation is the development of NU-TRANS, a multimodal transit simulation-assignment platform that operates in tandem with the highway traffic mesosimulation procedures, intended for integrated operation for large-scale networks. This tool finds least cost hyperpaths, assign travelers and simulate them along with vehicles in a multimodal transit network. Modeling the multi-modal, multi-pattern, time and approach-dependent features of a transit network enables finding strategies that reflect the real-world behavior of travelers. A gap-based solution approach for assignment, which evaluates the individual experience of every traveler in the network provides convergent behavior even for large-scale applications. These individual experiences are obtained via the multi-agent particle simulation platform, which is able to capture the heterogeneities and the discontinuities in travel such as seating/standing, boarding/getting rejected, transferring/missing connection, etc.

The CMAP multimodal regional network is one of the largest used in practice; successful integration of these tools with activity-based models would be the first such accomplishment on a network of this size.



How Well Do Crew Members Sleep on Long Barge Trips?

Project Title: *Enhancing Sleep Efficiency on Vessels in the Tug/Towboat/Barge Industry*

NUTC PIs: Kathryn Reid and Fred Turek

The overall objective of this project is to develop a compendium of best practices for enhancing sleep efficiency on towboats in the U.S. inland waterway industry.

For the last 5 years, investigators at Northwestern University, led by Reid and Turek, have carried out research on towboats, interacting with hundreds of crew members on towboats from more than 30 inland



waterway companies to assess and quantify the amount of sleep the crews are obtaining on a two-watch system, as well as their levels of fatigue and overall health. This research has enabled us to collect an unprecedented amount of data about the sleep habits and strategies of crew members attempting to obtain sufficient sleep while on the “square-watch” schedule for prolonged periods of time (e.g. 14-28 days) as well as their sleep and wake habits when off-duty.

The researchers have also collected “real world” data on fatigue, stress, health indices and barriers to good sleep while on the vessel. Researchers have also distributed educational material to 163 wheel house crew members. Taken together these data enables the investigators to determine the behaviors and characteristics of individuals that make up the “best practices” used by the “good sleepers,” as well as the compendium of behaviors and characteristics of crew members who are not obtaining adequate sleep. The study will also

analyze the environmental factors that impact sleep-wake behaviors of crew members on board the vessel and in their home environment. This will form the basis for developing models that will enable towboat operators and their crews to implement “best practices” onboard vessels in the U.S. inland waterway industry, as well as in other industries (e.g. trucking) where sleep is often split into “anchor sleep/nap sleep” over a twenty-four hour period.

When Do Carriers Accept a Load on the Spot Market?

Project Title: *Carrier Reservation Prices for Truckload Capacity on the Spot Market*

NUTC PI: Hani S. Mahmassani

The transportation spot market is an important element of the U.S. motor carrier industry. The transportation spot market consists of shipments handled on a one time load-by-load basis, and exists to facilitate urgent or unfulfilled demand. It is characterized by price volatility and uncertainty in the availability of capacity. These aspects of the spot market make it very challenging for shippers who rely on it. Because of the severe shortage of spot market capacity and its relatively high and volatile prices, shippers must actively as opposed to passively (i.e. conduct traditional transportation auctions) seek carrier capacity. This has created an important role for third party logistics providers, known as non-asset based



carriers, who can efficiently match loads to capacity on a real-time basis.

This research, conducted by NUTC doctoral candidate Christopher Lindsey, under the supervision of Mahmassani, yields insight into carrier behavior



underlying their acceptance of shipper loads tendered on the spot market by presenting results of a hypothetical field experiment on spot market transactions for truckload shipments in which truckload carriers evaluated spot market shipment offers. Following an in-depth study of carrier and industry practices, carefully designed computer-assisted stated choice experiments were conducted and administered to a large number of carrier representatives. Participating carriers’ responses are analyzed using advanced econometric techniques (mixed logit model for panel data) that can capture the heterogeneity of the respondents’ preferences, reflecting their individual situations, as well as the serial correlation present in panel data. The discrete choice analysis results were used to estimate carrier reservation prices for the presented truckload spot market shipments.

Furthermore, the study explores the practice of sourcing multiple spot market loads simultaneously, also known as bundling. Offering bundled shipments in hope of securing capacity for those shipments more quickly and at better rates is a common industry practice. However, estimating reservation prices in the case of bundled shipments is more complicated than for single shipments. The study developed an approach for that problem.

The results reflect the fact that reservation prices can vary over carriers in the same lane in a measurable fashion. The speculative nature of the spot market introduces to it considerable behavioral dynamics. Accounting for these dynamics in operational and revenue management strategies can lead to better decision-making, particularly for shippers

and their representatives.

Monitoring Transportation Infrastructure: A Statistical Approach

Project Title: *Analysis of Common-cause and Special-cause Variation in the Deterioration of Transportation Infrastructure: A Field Application of Statistical Process Control for Structural Health Monitoring*

NUTC PIs: David J. Corr and Pablo Durango-Cohen

This study has developed a statistical process control framework to support structural health monitoring of transportation infrastructure. It presents an integrated, generally-applicable (to various types of structural response data) statistical approach that links the literatures on statistical performance modeling and on structural health monitoring. The framework consists of two parts: The first, estimation of statistical models to explain, predict, and control for common-cause variation in the data (i.e. changes), including serial dependence, that can be attributed to usual operating conditions. The ensuing standardized innovation series are analyzed in the second part of the framework, which consists of using Shewhart and Memory Control Charts to detect special-cause or unusual



events.

The framework is applied to analyze strain and displacement data from the monitoring system on the Hurley Bridge (Wisconsin Structure B-26-7). Data analysis reveals that, after controlling for seasonal effects, linear trends are significant components of the response measurements. Persistent displacement may be an indication of deterioration of the bridge supports. Trends in the strain data may indicate changes in the material properties (i.e. fatigue), sensor calibration, or traffic loading. The results also show that autocorrelation and conditional heteroscedasticity are significant sources of common-cause variation. Use of the control charts detected forty-three possible special-cause events, with approximately 50% displaying persisting effects, and 25% lasting longer than one week. Analysis of traffic data shows that unusually heavy loading is a possible cause of the longest special-cause event, which lasted eleven days.

The use of the methodology developed in this study can help monitor and predict the structural performance of critical transportation infrastructure elements, enabling timely intervention to avoid costly failures that endanger the safety of the public.

Learn more about this project at <http://j.mp/MonitoringInfrastructure>

Towards a Strategic Plan for Rail Research

Project Title: *A Potential Strategic Plan and Research Agenda for the National Cooperative Rail Research Program*

NUTC PIs: Joseph Schofer, Bret Johnson, Norm Carlson

This study has developed a potential strategic plan and research agenda for the National Cooperative Rail Research Program (NCRPP) should the program continue beyond currently available funding. NCRPP is one of a number of active rail research programs, including work of the Federal Railroad Administration (FRA), the Association of American Railroads (AAR), individual

railroads, their suppliers, and research institutions.

While other rail research programs have been addressing technology, materials, and safety issues, NCRPP has focused on matters of policy, economics, and institutions. This report assumes that the focus going forward would continue to be primarily in these areas. That focus should not be interpreted to diminish the value of other rail research.

The potential plan and agenda provided here are based on a review of recent rail research and primarily on the results of interviews with more than sixty railroad stakeholders who were asked to identify key opportunities and problems facing the industry. The plan identifies eight areas where rail research is both needed and expected to produce cost-effective results. These are:

1. Assuring safe and efficient management of railroad capacity, particularly in the case of shared rights-of-way;
2. Facilitating and accelerating railroad project delivery;
3. Developing the railroad workforce;
4. Promoting innovation in funding and financing rail projects and operations;
5. Growing ridership on regional and commuter passenger services;
6. Promoting and facilitating freight rail services to reduce highway congestion, save energy, and reduce environmental impacts;
7. Developing and deploying strategies and technologies for enhancing safety; and
8. Developing and deploying advanced methods and materials for railroad design, rehabilitation, and maintenance: faster, cheaper, and better methods.



This potential strategic plan describes each of these areas and presents several specific research topics under each. These topics reflect problems and opportunities raised by stakeholders, and they build on work that is currently underway. These broad topics are narrowed to a five-point potential research agenda based on the scale and scope of NCRRP and the work underway in other programs:

- **Assuring safe and sufficient railroad capacity.** The focus is on making safe and efficient use of limited physical infrastructure. Work in this area includes development of models and tools to guide the safe, shared use of rights-of-way by freight, passenger, high-speed rail (HSR), and maintenance operations; institutional arrangements and valuations for right-of-way sharing; and strategies and methods for managing unexpected rail service disruptions such as severe weather events.
- **Defining the rail value proposition.** This area aims to facilitate rail project implementation by helping communities understand the value of existing and proposed rail facilities and services. The work covers methods to build community support for passenger and freight facilities and services based on the value of community outcomes; demonstrating the value of maintaining rail systems and facilities in a state of good repair (SGR); and conceptual and case-based studies of the public benefits and costs of investing in freight rail connectivity to support public investment decisions.
- **Developing the future rail workforce.** Research and development in this category is targeted to assuring sufficient and well-prepared personnel for passenger and freight rail services. Work in this area includes market studies and programs to attract workers to rail employment, ranging from operating and maintenance personnel to technical, engineering, and management professionals.
- **Sustaining funding for rail facilities and services.** Here the tasks are to show the value of rail services, particularly those requiring some level

of public investment; to educate policy makers dealing with rail services about passenger rail economics and finance; and to explore innovative and effective financial strategies, including public-private partnerships.

- **Expanding the markets for passenger and freight rail services.** This research area looks for ways to attract demand for both passenger and freight services, and therefore to produce efficiency, environmental, and safety benefits for society. Specific actions would include market tracking studies using current and emerging big data sources; assessing promising strategies and best practices for growing markets; and identifying cost-effective approaches to delivering seamless services.

Why Are Pedestrian Rail Deaths On the Rise?

Project Title: *Analysis of Fatal Train-Pedestrian Collisions in Metropolitan Chicago 2004-2012*

NUTC PI: Ian Savage

This study analyses the 338 pedestrian fatalities on railroads that occurred in the Chicago metropolitan area between 2004 and 2012. On average there was one such fatality every ten days, and they comprised the vast majority (84%) of all deaths on the railroad. Almost half (47%) of the pedestrian fatalities are apparent suicides.

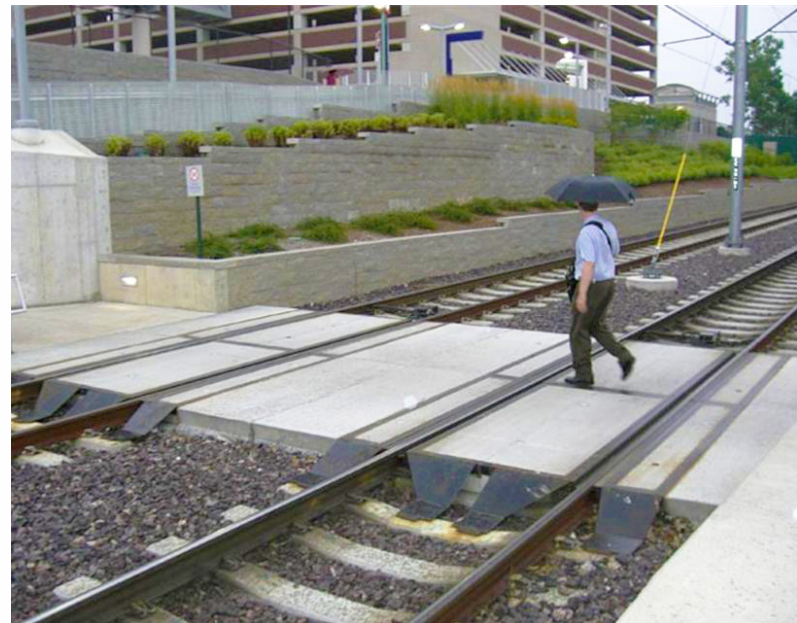
Non-suicidal fatalities at stations and crossings represent 21% of the total, while the remaining 32% are non-suicidal incidents at other places along the right of way.

The decedents are predominantly male (72%) and of working age (83% between the ages of 18 and 65). There are very few minors or senior citizens. Chicago has harsh winters, so incidents are much more common during the warmer

months. There does not seem to be any pattern to how fatalities are distributed across the days of the week, but they are concentrated during peak travel times of day, with an additional spike late at night.

A spatial analysis shows that while there is a general randomness in incident location, there are some common patterns, and also some notable outliers or “hot spots.” The frequency of fatalities at stations and crossings and from trespassing in different municipalities within the region is strongly related to the density of public access points to the right of way. Consequently, grade separation is effective in reducing fatalities. But fatalities of these types do not increase with train volume suggesting that pedestrians may exercise more care around busier lines.

The distribution of apparent suicides is less strongly related to the density of public access points suggesting that those intending self-harm will seek out a point of access. Apparent suicides are



also more prevalent where there is a higher train frequency and a greater proportion of passenger trains that run to a published schedule. They are also more prevalent in municipalities with higher incomes and lower population density. While most of the apparent suicides (70%) are not associated with any copycat activities, the dataset contains 20 clusters of suicides. These

clusters contain incidents that are proximate in both time and space and are unlikely to have occurred randomly.

Getting Users to Their Destinations On Time

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

NUTC PI: *Hani S. Mahmassani*

The broader goal of the reliability focus area within the Strategic Highway Research Program 2 (SHRP 2) is to address unexpected traffic congestion and improve travel time reliability. This project (L04), funded by the SHRP2 program, is aimed at improving planning and operations models in order to create suitable tools for the evaluation of projects and policies that are expected to improve reliability. This recently completed three-year project was undertaken through a collaborative effort between NUTC, Delcan, and PB Americas.

The L04 project has addressed the need for a comprehensive framework and conceptually coherent set of methodologies to (1) better characterize reliability, and the manner in which the various sources of variability operate individually and in interaction with each other in determining overall reliability performance of a network; (2) assess its impacts on users and the system; and (3) determine the effectiveness and value of proposed counter measures. In doing so, this project has closed an important gap in the underlying conceptual foundations of travel modeling and traffic simulation, and provided practical means of generating realistic reliability measures using network simulation models in a variety of application contexts. A principal accomplishment of the project is a unifying framework for reliability analysis using essentially any particle-based micro- or meso- simulation model that produces vehicle travel trajectories.

The framework developed in this study is built on a taxonomy that recognizes demand- vs. supply-side, exogenous vs. endogenous, and systematic vs. random variability. The framework features three components:

1. A Scenario Manager, which captures exogenous sources of unreliability such as special events, adverse weather, work zone and travel demand variation;
2. Reliability-integrated simulation models that model sources of unreliability endogenously, including user heterogeneity, flow breakdown, accidents and so forth; and
3. A vehicle Trajectory Processor, which extracts reliability information



from the simulation output, namely vehicle trajectories.

The primary role of the Scenario Manager is to prepare input scenarios for the traffic simulation models; these scenarios represent mutually consistent combinations of demand- and supply-side random factors and are intended to capture exogenous sources of variation. Endogenous variation sources are captured in the traffic simulation model, depending on the modeling capability of the selected platform and the intended purpose of the analysis. The framework may be used with any “particle-based” simulation model, namely micro- and mesoscopic simulation models that produce individual vehicle (or particle) trajectories. These trajectories enable construction of any level of travel time distributions of interest (e.g., network-wide, origin-destination pair, path, and link), and subsequent extraction of any desired reliability metric. These tasks are performed by the Trajectory Processor, which produces and helps visualize reliability performance measures (travel time distributions and indicators) from observed or simulated trajectories.

Prototypes of a Scenario Manager and a Trajectory Processor have been developed as project-specific deliverables

during this research. The tools are conceptually generic and (simulation) software-neutral. The prototypes were demonstrated for a micro-simulation modeling platform (Aimsun) and meso-simulation Dynamic Traffic Assignment platform (DYNASMART-P), both of which are representative of other available options in their respective categories to enable rapid cross-platform adaptation.

The prototypes and the overall reliability-analysis framework were demonstrated using the above micro- and meso-simulation models applied to networks extracted from the New York City regional network. Detailed calibration and validation steps were described using available data sources in addition to a specially acquired sample of actual vehicle trajectories based on GPS traces—highlighting and demonstrating the role and potential of such vehicle trajectories in traffic simulation model development and application, especially for reliability-oriented analysis purposes.

In summary, this project has 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.

Learn more about this project at <http://bit.ly/ReliabilityPerformance>

Keeping Large Events Safe and Secure

Project Title: *Improving Medical Preparedness, Public Safety and Security at Mass Events*

NUTC PI: *Karen Smilowitz*

The objective of this Grant Opportunity for Academic Liaison with Industry (GOALI) award is to improve medical preparedness, public safety, and security at mass gathering events through the use of optimization methodologies. The nation engages in over 500 mass gathering events, such as marathons, each year. Such events are subject to medical emergencies for the participants, and other security related

events. This GOALI project brings together engineering and medical faculty at Northwestern University and the organizers of the Bank of America Chicago Marathon to study approaches for the mitigation of hazards and risks through course design. In the case of a marathon, course design decisions are related to the route to be followed and the locations of aid stations, medical tents and volunteers on the course. Multi-objective models and solution approaches will be developed for course design, coupled with data analytics and field observations to identify a safe and medically accessible course. The research plan is based on active integration across the areas of modeling, algorithms, data analysis and decision maker engagement.

The results of this research will lead to advances in medical preparedness and response for a variety of mass gathering events. This project provides a test bed to advance the science and practice of mass event planning and preparedness, through repeated field observations at the Chicago Marathon, conducted by faculty, students, and practitioners. Given connections across the city of Chicago and within the marathon community, the research team will host seminars to disseminate best practices from this research to other mass events in the Chicago region and worldwide. This GOALI project represents a unique application of operations research that will expose students to a new type of planning problems. The operations research modeling will lead to new developments in multi-objective arc routing models, by introducing new classes of arc routing problems and creating solution methods for these prob-



lems. Further, this work will lead to new approaches to multi-objective optimization based on the iterative generation of promising solutions with input from decision makers.

Better Road Weather Management through Integrated Predictive Analytics



Project Title: *Integrated Modeling for Road Condition Prediction*

NUTC PI: Hani S. Mahmassani

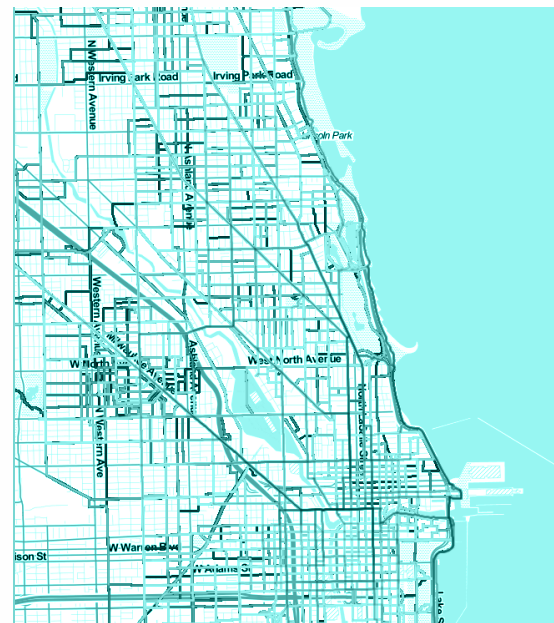
Transportation Systems Management and Operations (TSMO) are at the cusp of a revolution spurred by the explosion in data from different sources, and the sophistication of models utilizing the data. New approaches in road weather management are bringing together meteorology, traffic management, law enforcement, maintenance and traveler information to support agency decision-making and influence travel behavior. Through these operational efforts and private sector innovations, travelers today have higher expectations for their travel experience. Travelers will now participate in generating and validating information as well as consuming it. This trend will accelerate with deployment of Connected Vehicle systems. Within this context, the role of prediction and forecasting will become more important to the travel and activity choices made by travelers, as well as to agency decisions in transportation operations. Freight carriers and logistics providers will also benefit in planning routes, times and delivery schedules.

Development and adoption of traffic prediction approaches by operating agencies have been limited even with a growing body of research. While part of

the reason has been limited data, available predictive tools have been narrowly focused and have not taken full advantage of developments in related disciplines and domains. As a result, the use of predictive strategies in support of operational decisions continues to be limited.

Recent developments incorporating forecast weather conditions in traffic predictions in the USDOT Traffic Estimation and Prediction System (TrEPS) project have shown considerable promise. The utility of traffic predictions can however be further enhanced by augmenting the forecast weather conditions with known and likely capacity constraints like work-zones and incidents. Factoring in reported conditions from environmental sensing stations, vehicle fleets, and citizen reported conditions will further enhance predictions. Current and planned road treatment approaches, snowplow routing, parking restrictions and maintenance decisions may be included as well.

This project, funded by the US Department of Transportation and conducted by the NUTC in collaboration with Leidos, Inc. and Synesis, is intended to provide the foundational systems engineering concepts and designs to create a methodological framework that incorporates real-time along with archived data to predict the current and future overall road/travel conditions for travelers, transportation operators, and mainte-



nance providers. This predictive capability forms the basis of an array of operational interventions, including information provision, in connection with anticipated inclement weather conditions, to ultimately provide decision support in a manner useful to operators and travelers.

The Effectiveness of Using Cap-and-Trade to Manage Congestion and Pollution



Project Title: *From Pricing to Cap-and-Trade: Analysis and Design of Quantity-based Approach to Congestion Management*

NUTC PI: Yu (Marco) Nie

Traffic congestion continues to threaten economic prosperity and quality of life around the world. Demand management is an indispensable ingredient in the recipe for solving the traffic congestion puzzle, and likely to be one of the more effective and cost-efficient if properly implemented. This research explores a new and promising travel demand management strategy, inspired by various cap-and-trade schemes aiming to reduce greenhouse gas and air pollutant emissions. The cap-and-trade schemes considered in this research seek to couple direct travel demand restriction with a trading mechanism. Because such a scheme typically involves creating mobility credits and trading them in a market, it is also known as a tradable credit scheme.

The project complements the current paradigm in travel demand management with the idea of tradable credit schemes, and thus integrates ideas from two fields, namely transportation systems and economics, on the subject of travel demand management in general and tradable credit scheme in particular.

In this study, NUTC researchers are developing analytical tools to address several critical design and implementation questions regarding tradable credit schemes. The main results include:

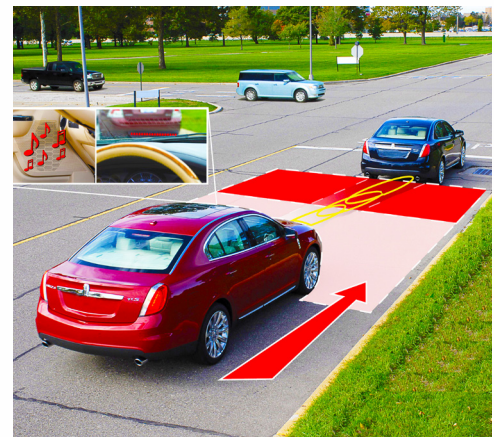
- A new tradable credit scheme that rewards only those who contribute to congestion relief (e.g. by choosing transit or traveling during off-peak time) with mobility credits. The analysis indicates that very simple designs of the scheme could reduce congestion significantly, and properly distribute the benefits among all the commuters through credit trading.
- New numerical methods for solving both descriptive and prescriptive models of the morning commute problem with heterogeneous users. These tools can be used to evaluate how a given travel demand management scheme might impact the welfare of individual users, and to design optimal congestion pricing or tradable credit schemes.
- A hypothetical case study that uses empirical data from Florida to compare socioeconomic impacts of gasoline tax, mileage fee and tradable mobility credits or permits for regulating the vehicle miles traveled. It also compares congestion pricing and tradable credit schemes in managing network mobility under demand or supply uncertainty.
- Analysis of tradable credit schemes on networks with two types of players, namely, a finite number of Cournot-Nash players and an infinite number of (infinitesimal) Wardrop-equilibrium players. The former are transportation and logistics companies while the latter are individual travelers. Both types of players exist in the real world and hence should be considered in designing a tradable credit scheme.
- Exploration of applications of tradable credit schemes, including replacing congestion pricing with parking permits reservation, and implementation of staggered work times (in which firms receive mobility credits to trade-off their workers' travel delays and productivity losses).

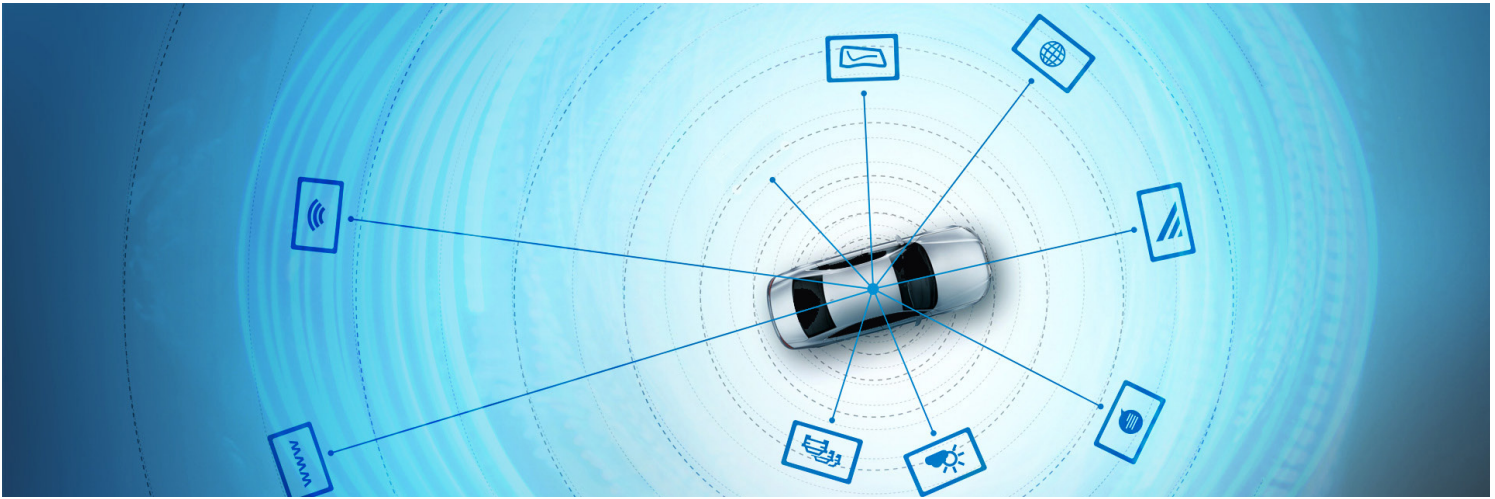
Improving Traffic Flow with Autonomous Vehicles and Connectivity

Project Title: *Flow Characteristics of Autonomous Vehicles and Connected Vehicle Systems in Mixed Traffic Streams*

NUTC PIs: Hani S. Mahmassani and Fabián Bustamante

The driving environment is expected to change by the introduction of connected and autonomous vehicles. These technologies are intended to improve safety and mobility in transportation systems. Autonomous vehicles





that rely on advances in sensing technologies and artificial intelligence to enhance and partially or completely replace human driving are nearing market introduction with varying degrees of automation. Wireless communication technologies provide the opportunity to create an internet of vehicles where individual vehicles can communicate with other vehicles (vehicle-to-vehicle) and traffic management center (vehicle-to-infrastructure communications). Connected Vehicle technology provides real-time information about surrounding traffic condition as well as guidance from the traffic management center. This additional information is expected to improve drivers' efficiency, response, and comfort while improving safety and mobility. Connected Vehicle technology can also improve the efficiency and reliability of operating autonomous vehicles, even though the latter could operate with their on-board sensors and without communication.

This exploratory study, conducted with doctoral candidate Alireza Talebpour under the supervision of Mahmassani and Bustamante, is examining the traffic flow implications of different autonomous vehicle adoption rates. NUTC investigators have developed a microscopic modeling framework to examine mixed traffic streams in which certain fractions of the vehicles are respectively autonomous, connected or both. A novel feature of the approach is the joint modeling of the traffic system along with the properties of the peer-to-peer communication systems for different levels of message content. The framework is used in an exploratory analysis of the flow characteristics of the resulting mixed traffic stream, with particular attention to throughput and stability.

The stability analysis reveals that connected and autonomous vehicles can improve string stability. Moreover, automation can be expected to be more effective in preventing shockwave formation and propagation.

Promoting an Experimental Culture in Transportation

Project Title: *We Can Learn Something from That! Promoting an Experimental Culture in Transportation*

NUTC PI: Joseph Schofer

Decision makers need to know what works and what doesn't in order to make informed choices about transportation investments. Hard evidence, rather than opinions, should be the source of this information. Making use of hard evidence, though, can be challenging when transportation proposals come from policy makers who have already made a public commitment to an idea, such as building a high-speed rail system. Presenting new information on such vision-driven projects may mean confronting, and perhaps contradicting, established political positions. Nonetheless, evidence on what works is vital to making wise transportation decisions. Experiments are the most effective way to show what works—or might work—in a given setting, especially when the experimental conditions are close to the decision situation at hand. Experiments vary in validity and transferability, but opportunities to experiment with transportation are all around us.

Research | Industry Research

In addition to a scholarly emphasis on its core research areas, the Transportation Center devotes a significant portion of its resources to assisting industry with research on a wide variety of topics. These partnerships help the Center implement real-world solutions to complex issues in transportation and logistics, deepening the connection between industry and research.

- Network Modeling
- Data Analytics
- City Logistics



An In-Depth Exploration of Freight Payment Transactional Data

The project, a partnership with U.S. Bank's Freight Payment Group, explored novel techniques for leveraging presently available payment data to provide the Bank's clients with new business intelligence capabilities. Although U.S. Bank offers an extensive suite of business intelligence capabilities for its customers, primarily involving financial and accounting information and performance metrics, The NUTC defined and demonstrated several new tools for both client-level and market-level performance benchmarking to ultimately support the optimization of their clients' service planning and operational decisions.

More specially, the NUTC investigated the determinants of line-haul rates for TL and LTL shipments. A methodology was developed to process and mine historical shipment data for patterns and trends. The NUTC examined the transactional data as a panel (longitudinal) data set by aggregating transactions at the lane level. In doing so, a broad view of the spatial dynamics of TL and LTL rates was taken into account, yielding insights into overall market behavior.

As a leading provider of transportation payment systems, and thus in possession of a large set of transactional data, the NUTC concluded that U.S. Bank is in a unique position to both provide overall market performance benchmark for the U.S. freight market and help its clients make better data driven decisions at the company level.



Expanding Alternative Air Transportation in Supply Chain and Logistics Networks

Through support from Boeing, the NUTC is investigating the application and integration of alternative air transportation capabilities into supply chain and logistics networks to augment, to enhance or to enable the movement and distribution of materials, supplies and final products. The Center's approach is to examine the opportunity from the perspective of the choice of transport mode for given moves, and more generally from the standpoint of the design of logistics strategy and logistics networks intended to meet certain production or service objectives or requirements. In both cases, critical attributes of the mode considered include time (of transit), reliability, and cost (generally per unit weight of delivered commodity), given the properties of the commodity to be delivered (e.g. shelf life, odd shape and size), and the characteristics of the particular move and use requirements (e.g. time-sensitivity, time windows).

The NUTC is evaluating the trade-offs between these attributes, in comparison with existing alternatives and capabilities, to assess the viability of alternative air transport vehicles for various logistical challenges. The study is directed by Professors Hani S. Mahmassani and Karen Smilowitz, along with NUTC associate director Bret Johnson.

Exploring and Supporting Supply Chain Management

The NUTC is a contributing member of the Leveraging, Integrating, Networking, Coordinating Supplies (LINCS) in Supply Chain Management (SCM) consortium that was selected as a grant awardee for the Department of Labor's Trade Adjustment Assistance Community College and Career Training (TAACCCT) grant program. The LINCS SCM consortium, led by Broward College (Broward) 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.

In the first year of the program, Broward convened its geographically diverse consortium of colleges and universities, including Columbus State Community College, Essex County College, Florida State College at Jacksonville, Georgia Institute of Technology, Harper College (Illinois), Long Beach City College, Rutgers University, San Jacinto Community College, St. Petersburg College, and Union County College, in two multi-day planning sessions, and also launched several smaller teams to develop the first of four certification tracks.

The NUTC lent support to the development of two of the four certification tracks, Transportation Operations and Supply Chain Principles. The other two tracks were Warehousing and Customer Service.

In addition to assisting with course development, the NUTC, along with the consortium university partners, launched an outreach campaign to supply chain practitioners to assess and identify required workplace competencies, as a follow up to a national survey conducted in August 2014. The NUTC is working with Harper College and local Council of Supply Chain Management Professionals (CSCMP) industry roundtables to solicit feedback from industry in Illinois.

Also of note, CSCMP joined the project as the LINCS national industry partner, and Mathematica Policy Research as the third-party evaluator for the consortium.

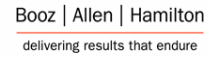


Crafting a Comprehensive Framework for Truckload Pricing and Load Matching

In a collaboration with Echo Global Logistics, NUTC researchers developed a comprehensive framework and decision support system for truckload pricing and carrier load matching by modeling the transactional behavior of shippers and carriers with offline and online predictive analytics. The tool generated prices for sales agents 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. Through extensive research and testing, three primary models were used to provide the desired pricing intelligence: discrete choice models from both shipper and carrier perspectives, and a pricing engine that operates in real time. This project demonstrated 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.

Through this intense research engagement with Echo, a leading provider of technology-enabled transportation and supply chain management services, the research team produced several scholarly outputs. These included "Predictive Analytics to Improve Pricing and Sourcing in Third-Party Logistics Operations," by Christopher Lindsay, Andreas Frei, Hani S. Mahmassani, Young W. Park, Diego Klabjan from Northwestern, and Michael Reed, Gregory Langheim, and Todd Keating of Echo.

Business Advisory Council





Unequaled by any academic transportation advisory board in the country, the NUTC Business Advisory Council has long been a major force behind the transportation center's success. The BAC is structured through four distinct levels of membership: Leadership, Sustaining, Individual, and Association. Each category carries with it a set of membership benefits, as well as a suggested level of commitment and financial support for the NUTC's research, education, and outreach initiatives.



All BAC members enjoy access to Northwestern's world-class faculty, opportunities for networking with industry peers, invitations to and involvement in special programs and events, insights into cutting-edge research and industry trends, discounted tuition fees for the NUTC's executive programs, and access to Northwestern's bright student population and renowned Transportation Library.



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.

Business Advisory Council | Membership

Leadership Level



Susan Bee
Managing Partner
Teradata



Robert Martínez
Vice President, Business
Development
Norfolk Southern Corp.



Gene Seroka
Executive Director
Port of Los Angeles



Jim Compton
Vice Chairman & Chief
Revenue Officer
*United Continental
Holdings*



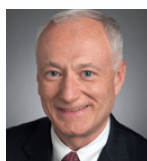
Dennis Mooney
Group Vice President
Navistar



Jeff Silver
CEO
Coyote Logistics



Doug Cook
Vice President, Opera-
tions Planning &
Engineering
FedEx Express



Paul Nowicki
Assistant Vice President,
Government & Public
Policy
BNSF Railway



Russell Stokes
President & CEO
GE Transportation



Edward Jenkins
Assistant Vice President,
Market Strategy
E-Business
CSX Corp.



Will Ris
Senior Vice President,
Government Affairs
American Airlines Group



Burt Wallace
President, Corporate
Transportation
UPS



Robert M. Knight, Jr.
Chief Financial Officer
Union Pacific Corp.



Matthew K. Rose
Executive Chairman
BNSF Railway

Sustaining Level



Allen Adler
Vice President of Enter-
prise Technology Strategy
Engineering, Operations &
Technology
Boeing



David Arganbright
Vice President of Gov-
ernment Affairs
OmniTRAX



Andrew Boyle
Executive Vice President
& CFO
Boyle Transportation



William P. Ainsworth
Chief Executive Officer
Progress Rail Services



Farrukh Bezar
Partner
Clarendon Group



Mike Brennan
Chief Operating Officer
Peapod

Sustaining Level (cont'd)



Michael Broaders
Vice President Transportation, Supply Planning & Warehouse
Coca-Cola Refreshments



Keith Dierkx
Global Industry Leader, Rail and Director, Global Rail Innovation Center
IBM



Robert Hart
Vice President & Managing Director, Surface Transportation
Fifth Third Bank



Michael Burton
President & CEO
C&K Holdings Acquisition



Ann Drake
Chairman & CEO
DSC Logistics



Jack Hellmann
President & CEO
Genesee & Wyoming



Perry Cantarutti
Senior Vice President – Europe, Middle East & Africa
Delta Air Lines



Reggie Dupré
CEO
Dupré Logistics



James R. Hertwig
President & CEO
Florida East Coast Railway



Robert M. Chapman
CEO
CenterPoint



Edmund J. Feeley
Managing Director
Littlejohn & Co.



Dave Hoppes
Senior Vice President, Ocean Services
Matson



Lee Clair
Partner
Zubrod/Clair & Co.



Ken Fleming
CEO
Eyefreight



Heidi Hornung-Scherr
Partner
Scudder Law Firm



Neil Collins
Senior Client Partner; Global Sector Leader, Logistics & Transportation Services
Korn Ferry



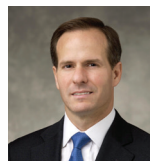
Andrew Fox
President
Chicago South Shore & South Bend Railroad



David Horowitz
Vice President and Executive Director, Fleet Portfolio Management
GATX Corporation



William A. Cook
Director, Logistics and Customs
FCA US, LLC



Eli Gross
Managing Director
Morgan Stanley



Regg Jones
Founder & Managing Partner
Greenbriar Equity Group



Jim Davis
CEO
AccuFleet



James Hamilton
Managing Director, Transportation Investment Banking
J.P. Morgan



H. Merritt Lane, III
President & CEO
Canal Barge Co.

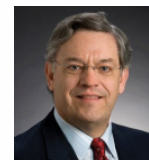
Sustaining Level (cont'd)



Stefan Loeb
Senior Vice President,
Marketing & Strategic
Development
Watco



Cliff Porzenheim
President & COO
Milestone Equipment Co.



Dan Spellman
President & COO
Neovia



Robert Maidman
Senior Product Manager,
Corporate Payments Systems,
Freight Audit, and Payment
U.S. Bank



James P. Rankin
President & CEO
Columbia Helicopters



Jeff Starecheski
Vice President of
Logistics Services
Sears Holdings Corp.



Ben McLean
Chief Executive Officer
Ruan



Ogi Redzic
Vice President, Connect-
ed Driving
HERE



Richard H. Thompson
Managing Director,
Supply Chain &
Logistics Solutions
Jones Lang LaSalle



Shawn McWhorter
President, Americas
Region
Nippon Cargo Airlines



Jean Regan
President, CEO & Chair-
man of the Board
TranzAct



Tom Tisa
Director of Corporate
Development
CN



D. Stephen Menzies
Senior Vice President;
Group President,
TrinityRail
Trinity Industries



Kathleen L. Ross
Senior Vice President,
Midwest Corporate Banking
Bank of America Merrill Lynch



Douglas Waggoner
CEO
Echo Global Logistics



Alfred Messina
Vice President
Booz Allen Hamilton



Steven Rothberg
Founding Partner
Mercator International



Thomas F. Wells
President & CEO
TTX



Dennis Nash
Chairman & CEO
Kenan Advantage Group



Gilles Roucolle
Partner, Global Transpor-
tation Practice
Oliver Wyman



Robert Nathan
Chief Executive Officer
Load Delivered Logistics



Paul Schneider
Director
Schneider



Seth Wilson
Founder & Managing Partner
Headhaul Capital Partners



Aurelio Pérez Alonso
Associate Director & CFO
Grupo ADO



John M. Smith
Chairman of the Board
CRST International



Justin Zubrod
Managing Partner
Zubrod/Clair & Co.

Association Level



Rick D. Blasgen
President & CEO
*Council of Supply Chain
Management Professionals*



Bill Graves
President & CEO
*American Trucking
Associations*



Joshua L. Schank
President & CEO
*Eno Center for
Transportation*



Bruce Carlton
President & CEO
*National Industrial Trans-
portation League*



Ed Hamberger
President & CEO
*Association of American
Railroads*

Individual Level



Phil Bakes
Co-Managing Partner
BBX Capital Partners



Norman Carlson
Chairman
*Carlson Consulting
International*



Eugene McCormick
Partner
*McCormick Jahncke
Group*



L. Price Blackford
Managing Director and
Group Head – Transpor-
tation & Logistics
Scott-Macon, Ltd.



Brendan Hickman
Managing Partner
*Transportation Manage-
ment Group*



Linda Morgan
Partner
Nossaman LLP



John Bowe
Principal
American Maritime Group



Adam Inselbuch
Managing Director
South Street Ventures



Craig Philip
Former CEO
Ingram Barge



Vicki Bretthauer
Independent Consultant



Timothy Krauskopf
Principal
Round Lake Designs



David Rohal
Managing Partner
Rohal & Associates



Edward Burkhardt
Founder & President
Rail World



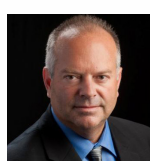
Charles Lounsbury
Former Senior Vice
President
Ryder System



James Runde
Special Advisor
Morgan Stanley



James H. Burnley IV Esq.
Partner
Venable LLP



Regis Luther
President
Regis Luther LLC



Ande Sze
Founder and Principal
Fastraxx

Business Advisory Council | Meetings

Fall Meeting

October 29-30, 2013



The Fall 2013 BAC meeting kicked off with *The Fight for the Last Mile*, a workshop highlighting the competitive landscape surrounding the continual rise of e-commerce and direct delivery of goods to consumers and businesses alike. The program emphasized that the “Fight for the Last Mile” (p. 40) is not only about the last mile itself, but the complete design of the supply chain and the technology that enables a first-in-class user experience.



On Tuesday evening, dinner at the James L. Allen Center followed a cocktail reception. Afterwards, the **Leon N. Moses Distinguished Lecture** (p. 41) was presented by Professor Ian Savage, Associate Chair & Distinguished Senior Lecturer, Northwestern University Department of Economics. In *The Economics of Transportation Safety*, Dr. Savage described the connection between unintentional deaths and transportation safety, highlighting the considerable limitations of our knowledge, and the extensive potential for further research.



On Wednesday morning, NUTC Director Hani S. Mahmassani presented his Director’s Report, followed by a Membership Committee Report from BAC Chair Justin Zubrod. This was followed by a series of panel discussions and presentations: **(1) “Trends in Global Trade and Manufacturing,”** featuring Evan A. Feigenbaum, Vice Chairman, The Paulson Institute; Scott N. Paul, President, Alliance for American Manufacturing;



Former NUTC Director Leon N. Moses (right) with current NUTC Director Hani S. Mahmassani. Dr. Moses passed away shortly before the 2013 Leon N. Moses Distinguished Lecture (p. 41).

and Farrukh Bezar, Partner, Clarendon Group; **(2) “Research Challenges in Humanitarian Logistics,”** presented by Karen Smilowitz, Associate Professor of Industrial Engineering and Management Sciences, McCormick School of Engineering and Applied Science, Northwestern University; and Irina Dolinskaya, William A. Patterson Junior Chair in Transportation, McCormick School of Engineering and Applied Science, Northwestern University; **(3) “Regulation, Compliance, Data, and Technology,”** with Andrew Boyle, Executive Vice President & CFO, Boyle Transportation; Mike Regan, Chief of Relationship Development, TranzAct Technologies, Inc.; and Fred Turek, Director, Center for Sleep and Circadian Biology, Feinberg School of Medicine, Northwestern University; **(4) “Social Networks and Organizational Behavior,”** featuring Noshir Contractor, Jane S. & William J. White Professor of Behavioral Sciences, Weinberg College of Arts and Sciences, Northwestern University; and **(5) Director Mahmassani’s presentation** on the NUTC 60th Anniversary Celebration and Campaign.

Finally, students currently studying transportation were introduced to the BAC members, followed by a networking luncheon.



Spring Meeting

June 10-11, 2014



Justin Zubrod
Chair, NUTC Business Advisory Council

The Spring 2014 meeting of the Business Advisory Council began with a look into the not-too-distant future. “Autonomous Vehicle Technologies for Passenger and Freight Mobility” (p. 40) explained in detail the advances in and future of self-driving vehicles.

That evening, the 33rd Annual William A. Patterson Transportation Lecture (p. 41) detailed a more pressing concern. In “Funding the Future, Lessons from the Past: How Underinvestment in Highway Infrastructure Threatens Transportation and Sustainable Economic Health,” Schneider President & CEO Christopher B. Lofgren detailed the degradation of the Highway Trust Fund and the general underinvestment in infrastructure.

Wednesday’s official meeting of the Business Advisory Council opened with comments from BAC Chair Justin Zubrod. Associate Provost Ronald Braeutigam walked through Northwestern’s “We Will” capital campaign and student experience, and NUTC Director Hani S. Mahmassani presented his Director’s Report.

Finally, NUTC Associate Director Bret Johnson reviewed Center committees, including the new 60th Anniversary Committee, which was established to plan for the 60th Anniversary Celebration (p. 36).

After an introduction of the new BAC members, the meeting’s sessions included (1) **“Shale Oil – Long-Term Economic Impacts and Opportunities,”** featuring Louis Fenyvesi, Director of Markets & Supply, TransCanada; Stefan Loeb, Senior Vice President – Marketing & Strategic Development, Watco Companies; and Pat Moynihan, Director Marketing, Chemicals and Petroleum, BNSF; (2) **“Adoption and Perceived Risks of Web-based Software for Transportation Management,”** which featured presentations from Chris Pickett, Chief Strategy Officer, Coyote Logistics; Steve Hunt, CPP CISSP, Hunt Business Intelligence; and Shawn Clark, President, Clark Consulting



Group, LLC; and

(3) **“Financing Growth in Transportation,”** including lectures from Rob Hart, Vice President and Managing Director, Fifth Third Bank; Adam Inselbuch, Managing Partner, South Street Ventures; and Michael Weiss of Greenbriar Equity Group. The final presentation, from Schneider Director Paul Schneider and Jean Regan, President, CEO & Chairman of the Board, TranzAct Technologies Inc., discussed the plans for the November 2014 60th Anniversary Celebration and fundraising campaign.



To close the 2014 Spring Meeting, the current students in the transportation program were introduced, followed by a networking luncheon.

60th Anniversary | History

In 2014, the Transportation Center celebrated its 60th anniversary. To honor this special occasion, the **Northwestern University Transportation Center 60th Anniversary Celebration** was held November 13-14, 2014. The two-day event included a Technical Symposium for researchers and academics, a Gala Reception and Dinner, and a Transportation Summit for industry leaders.

The Northwestern University Transportation Center (NUTC) was established in 1954 by Northwestern University president J. Roscoe Miller to fill the growing need for a broad and imaginative program of transportation education and research at the university level. A joint undertaking of the Northwestern School of Commerce, the Technological Institute, and the Traffic Institute, the Transportation Center at Northwestern University—the first of its kind in the nation—was expected to offer an expanded program of research to help solve major problems in the highway, rail, air, pipeline, and water divisions of the national transportation industry. “It seems desirable to expand the work of the university in this field,” Dr. Miller told the Chicago Tribune upon the Center’s founding. “Because of rapid developments, transportation has become increasingly complex and has created many unsolved problems—economic, technical, and social.”



*Franklin M. Kreml
1955-1963*



*Leon N. Moses
1974-1979*

From the outset, the Transportation Center’s leadership included some of the finest and most influential minds in the industry. **Franklin M. Kreml**, then the director of the Traffic Institute and a principal architect of the Center’s establishment, was named the Transportation Center’s first director in 1955. Fred G. Gurley, President of the Atchison, Topeka & Santa Fe Railroad, was named chair of the Center’s first Advisory Committee; he was joined by other influential executives such as United Airlines president William A. “Pat” Patterson, Standard Oil president Alonzo Peake, and Lockheed Aircraft Corporation chairman Robert E. Gross.

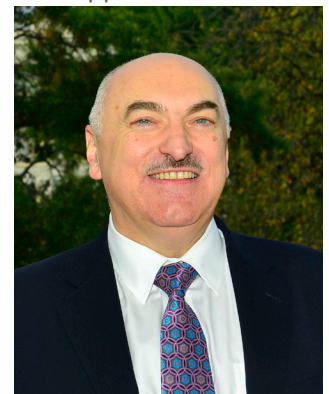
In 1963, with the Transportation Center’s influence growing, director **William C. Flaherty** helped establish the master of science in Transportation program. In 1964, recent Northwestern doctoral graduate **William L. Garrison** was appointed director, a position in which he served with distinction for three years. Following his tenure, the next director, **John A. Bailey**, helped secure funding from the Urban Mass Transit Administration (UMTA, now the Federal Transit Administration) for a fellowship program. Graduates of this program went on to leadership roles in both industry and government.

In 1974, **Leon N. Moses** was appointed as the Center’s director. He secured support from the university for a number of joint faculty appointments, helping strengthen the Center’s multidisciplinary character. He also helped establish the William A. Patterson Distinguished Chair in Transportation, named after one of the TC’s most prominent early proponents; this would prove a transformative milestone in the University’s ability to attract and foster world-class scholarship in Transportation.

Named director in 1979, **Robert P. Neuschel** oversaw a restructuring to the master of science in Transportation program, which included the addition of an internship as well as a refinement of the curriculum. A year later, the Center established one of its most lasting institutions, the annual William A. Patterson Transportation Lecture.

In 1998, under the leadership of director **Aaron Gellman**, construction began on a permanent home for the Transportation Center. Opened in 1999, Chambers Hall was named after Jerry Chambers, founder of the firm that became Clipper Exxpress in 1938. Three years later, NUTC director **Robert E. Gallamore** helped establish a new undergraduate minor in Transportation.

Following Gallamore’s departure, Interim Director **Joseph Schofer** helped reposition the NUTC administratively with the McCormick School of Engineering and Applied Science, reflecting its close connection to engineering faculty while still maintaining the Center’s university-wide mission and dedication to multidisciplinary research. To this end, **Hani S. Mahmassani**, who joined Northwestern as the Patterson Chair holder in 2007, became the Center’s director in 2008. Along with more than 60 faculty affiliates and 80 members of the Business Advisory Council, Mahmassani oversees one of the world’s leading interdisciplinary education and research institutions dedicated to influencing national and international transportation policy, management, operations, and technological developments.



*Hani S. Mahmassani
2008-Present*

60th Anniversary | Technical Symposium



The NUTC 60th Anniversary Technical Symposium was held on Thursday, November 13, 2014 at the Hilton Orrington/Evanston Hotel. The symposium identified the future of transportation, particularly from a researcher's point of view, focusing on sectors in which the Center has had, and will continue to have, a notable impact: Travel Demand and Behavior; Logistics and Supply Chain Management; Economics, Regional Science, and Policy; and Networks and Operations. Each session featured leading authorities and researchers in their fields.

NUTC faculty affiliate **Frank Koppelman** led the session on Travel Demand and Behavior, joined by **Pat Mokhtarian** '81, **Chandra Bhat** '91, and **Kimon Prousaloglou** '87/'92. In a unified presentation, they described how to model and forecast demand through conceptualization of relationships among variables, data collection, model estimation and validation, changes in

socioeconomic characteristics, and integration with transportation services. Koppelman quipped, "We're still not that good at representing multiple relationships simultaneously—but we're getting better!"

Leading the second session, Logistics and Supply Chain Management—Resiliency and Robustness, was former Northwestern professor **Mark Daskin**, now of the University of Michigan. Daskin outlined changes to the supply chain industry over the past three decades, looking towards a future that will make use of "big data" and analytics to determine the location and status of vehicles, potential disruptions, and methods to anticipate demand. Former Ingram Barge CEO **Craig Philip**, a member of the NUTC Business Advisory Council, seconded Daskin's view of change, noting that we may not even be able to anticipate how things like climate anomalies might affect shipping down the road.



Craig Philip
Former CEO, Ingram Barge



Susan Hanson
Distinguished Professor Emerita,
Clark University

The post-lunch keynote address, delivered by Clark University Distinguished Professor Emerita **Susan Hanson** '69/'73, outlined the Transportation Center's own contributions to research, as well as methods of encouraging federal investment in transformative research. She particularly noted that, while the desire to "discover" transformative research *a priori* sometimes drives decisions in funding, the truth is, "It's not as easy as all that." She went on to describe why people should care about research investment, as well as how such research can be nurtured.

In the third session, Economics, Regional Science and Policy, University of California, Irvine professor Kenneth A. Small and Iowa State professor **Jing Dong** '08 each detailed how alternative-fuel vehicles are progressing, while NUTC faculty affiliate **John Panzar** spoke on deregulation and DePaul University Chaddick Institute for Metropolitan Development director **Joseph Schwieterman** '83 discussed intercity bus services in the United States.

Rounding out the afternoon session was **Hani S. Mahmassani**, director of the Transportation Center, who led a comprehensive discussion on transportation networks and operations in a connected world. Supplementing Mahmassani's talk were experts such as **Kuilin Zhang** '10, professor of civil and environmental engineering from the Michigan Technological University, who explained how to plug the implementation gap between activity-based modeling of travel demand and simulation-based dynamic traffic assignment modeling of transportation networks; and **Hediye Tuydes** '05 of the Middle East Technical University in Ankara, Turkey, who detailed the difficulty of assessing disaster traffic management for engineers—and how they can best define problems like evacuation, emergency response, and logistics operations.

Finally, the Symposium was closed out by **Joseph Schofer**, associate dean of the Northwestern University McCormick School of Engineering and Applied Science, who detailed the many changes since the Transportation Center's founding in 1954. "We are not done developing theories and models in the field of transportation," Schofer said. "It's a learning model... at the Transportation Center, isn't learning what we're all about?"



Joseph Schofer
Associate Dean, Northwestern University
McCormick School of Engineering
and Applied Science

60th Anniversary | Gala Reception & Dinner

Faculty, alumni, and friends gathered for a gala dinner at the Woman's Club of Evanston on November 13, 2014. The celebration featured keynote speaker McCormick School of Engineering & Applied Science alumna Gwynne Shotwell, president and COO of SpaceX. Shotwell shared videos of the company's rocket launches and discussed plans to put the first people on Mars, a feat that she predicts will happen within 15 years.

"It will be important to be able to move humanity to another location in case something terrible happens on Earth," she said. "And something terrible will happen; it's just a matter of when."



SpaceX President and COO Gwynne Shotwell (right) with McCormick School of Engineering & Applied Science Dean Julio Ottino at the Northwestern University Transportation Center 60th Anniversary Gala Dinner

She told the audience to think about the trip to Mars like the Westward Expansion of the 19th century: it will take many months to reach the destination, but it will be worth it. "It will take a village to get to Mars," she said. "The effort and logistics will be huge."

NUTC BAC Chair Justin Zubrod toasts to the 60th anniversary of the Northwestern University Transportation Center



*"It will take a village to get to Mars; the effort and logistics will be huge."
– Gwynne Shotwell*



NUTC Faculty Affiliate Robert Gordon greets former NUTC Director Aaron Gellman at the Northwestern University Transportation Center 60th Anniversary Gala Dinner

60th Anniversary | Transportation Summit

On November 14, 2014, transportation experts from around the world gathered to explore the future of transportation in the United States. In addition to a detailed presentation from Qantas Airways Head of Group Strategy Reed Tanger, who shared his Australian-based firm's intense \$1 billion turnaround story, the NUTC Transportation Summit included four dynamic panels delivering varied perspectives on supply chain, sustainability, finance and innovation.

In a transforming field rife with headline-grabbing news of driverless vehicles, drones, 3D printing, and same-day delivery, **Ken Heller**, vice president of supply chain excellence at DSC Logistics, urged attendees to think of supply chain as a strategic advantage, not a necessary evil. By using technology to increase productivity and accessibility and blending the experience and know-how of Baby Boomers with the data-savvy ways of Millennials, enterprises can capture results. "Manufacturing made us great in the 20th century, but supply chains will make us great in the 21st century," he said.

To counter the price volatility and price discovery issues that continue to plague supply chains, Echo Global Logistics CEO **Douglas Waggoner** floated the idea of a futures market for truckload capacity. That concept, he acknowledged, would require the industry to see truckload capacity as a commodity, a notion many have struggled to accept. "But if we don't look at these types of opportunities, we might miss an opportunity," he explained.

The Summit next assembled a panel of leaders from the trucking, air, and barge industries to discuss a omnipresent buzzword in today's transportation world: sustainability. **Angela Foster-Rice**, United Airlines managing director of environmental affairs and sustainability, spoke of United's push for fuel-efficient aircraft, winglet installations, and electric or alternative-fueled ground equipment. Sharing United's goal of cutting its aviation carbon dioxide in half by 2050, Foster-Rice said the Chicago-based airline could not secure those results alone. She called for continued R&D to improve feedstock innovation and production technology, the acceleration of certifications for new jet fuels, and stable government policies to incentivize industry. "We need to have a long-term vision and to do the work now," she said.

In corporations' rush to champion sustainability, however, Schneider President and CEO **Chris Lofgren** warned against taking one dimension of a problem and optimizing it, a process often littered with unintended consequences. He noted how environmental sustainability is only viable alongside economic sustainability. "Sustainability and profitability can go hand-in-hand when done right and done thoughtfully," Lofgren said. "It's not *either/or*, but *and*."

During the next panel, former U.S. Deputy Secretary of Transportation **Mortimer Downey** called the freight system "a matter of national concern," particularly given a growing national population, freight's continued expansion, and weakening road and rail infrastructure. In addition to an influx of capital, he said the transportation sector must bring four million people on board over the next decade.

Public-private partnerships and private equity were two solutions introduced by Norfolk Southern Corporation Vice President **Robert Martínez** and Scott-Macon Managing Director **L. Price Blackford**, respectively, while **Martin Wachs**, former director of the Institute for Transportation Studies at the University of California, touted the strategic plays of state and local governments. Rather than the industry wringing its hands about federal inaction, Wachs urged transportation leaders to investigate measures at the state, county, and local level to assess what's working.

The daylong summit concluded with a look ahead, specifically exploring the ways that innovation could propel the industry despite hurdles ranging from the long life of assets undermining the adoption of new developments to the time-consuming approach necessary to ensure safety. **Allen Adler**, vice president of Enterprise Technology Strategy for The Boeing Company, noted that

innovation often comes in great leaps, while Coyote Logistics chief executive officer **Jeff Silver** noted that though they will force companies to change their way of thinking, such leaps will undoubtedly lead to better service for customers. "I'm more excited today than I've ever been about our industry and what we're able to do," Silver concluded, stating his strong belief that improvements in technology truly benefit all segments of the transportation and logistics industries.



Ken Heller
President, Supply Chain Excellence,
DSC Logistics



L. Price Blackford
Managing Director, Scott-Macon Ltd.

Events | Industry Workshops

The Fight for the Last Mile

In October 2013, the NUTC was pleased to have **Lee Clair**, one of the Center's Business Advisory Council members, chair *The Fight for the Last Mile*, an industry workshop centered around internet commerce. Global e-commerce, a driving force behind the competition to capture "the last mile" of goods' delivery to customers, has both traditional and online retailers working to optimize supply chains for omni-channel retailing.

To begin, NUTC Director **Hani S. Mahmassani** showcased the value of predictive analytics in urban routing for time-sensitive pick-up and delivery, and the ability to change routing in real-time based on congestion, disruptions, weather, and changing customer demands. The potential benefits of predictive, real-time routing include improving information utilization, reducing operation cost, and increasing customer satisfaction. By contrast, **John Fitzgerald**, Head of Global Business Development for GTNexus, pointed out that a majority of supply chain management is not yet real-time, but rather is based in spreadsheets, emails, and phone calls. He described GTNexus' web-based information platform, which enables communication among warehouses, distribution centers, and stores among different companies, thus providing visibility further back into the supply chain. Getting to the last mile, he said, will require "flexibility using real-time information."



Jeff Starecheski, Vice President of Logistics, Sears Holding Corporation next explained that the time for delivery is less important than free- or low-cost delivery. Buy-online-pick-up-anywhere, tablet and smartphone shopping, faster delivery, and blurred lines between social and commercial experiences are trending. Rather than following "shiny objects" such as same-day delivery Starecheski advised focusing on customer service and process improvement strategies like online order fulfillment speed.

Garrick Pohl, CEO of Zipments, described how his company is using crowdsourcing to re-invent the courier delivery business in urban areas. The company's technology platform connects couriers with customers, enabling direct point-to-point delivery that relies on the ingenuity of the couriers themselves to find the optimal paths. Pohl claimed that this is more efficient and cost-effective than traditional parcel carriers.

Finally, **Maciek Nowak**, Associate Professor, Loyola University Quinlan School of Business, explained that service quality and driver efficiency in the delivery industry may be enhanced by increasing the regularity with which a driver visits the same set of customers. Nowak showed that multi-objective routing models can achieve a balance between workforce management and travel distance goals.

Autonomous Vehicle Technologies for Passenger and Freight Mobility

In June 2014, the NUTC, along with the Center for the Commercialization of Innovative Transportation Technology, presented *Autonomous Vehicle Technologies for Passenger and Freight Mobility*, an industry technical workshop co-chaired by NUTC Director **Hani S. Mahmassani** and Associate Director **Breton Johnson** and moderated by **Fabián Bustamante**. It brought together speakers from the automobile, trucking, and technology communities to discuss technology readiness, innovations on the horizon, target markets, and insights into near- and long-term rollout of autonomous vehicle and mobility enhancing technologies.



Automated vehicles are coming. While estimates vary as to when the technological, legal, and infrastructure elements necessary to put such vehicles on the road will be ready, most experts agree that innovations like the Google driverless car have shown that self-driving vehicles are closer to reality than science-fiction.

Many executives, like **Brian Droessler**, **Roger Berg**, and **Ogi Redzic**, are currently leading teams dedicated to developing such technologies. Berg, R&D Vice President for Denso International America, sees many applications to safety concerns, particularly as vehicle-to-vehicle communications improve. Droessler, Continental Automotive's VP of Software and Connected Solutions, sees cloud-based synergy as the missing ingredient in full automation and is working on ways to fully integrate systems like global positioning systems, in-vehicle cameras, and brakes. For Redzic, who heads the Connected Driving division for HERE, there is also an element of "humanization" that must occur: programmable profiles that would increase the comfort levels both of vehicle occupants and other drivers on the road.

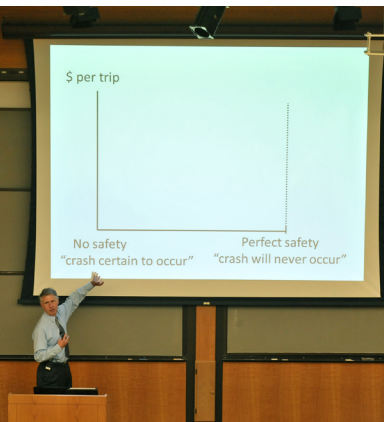
There are many applications for these types of automobiles, too. Dr. Mahmassani believes there is a wide market for transporting non-drivers like children and senior citizens. **Josh Switkes**, Founder and CEO of Peloton Technology, Inc., foresees benefits for the trucking industry through the incorporation of automated tools to help prevent accidents and improve fuel economy. His assertion is backed up by Navistar Project Manager **Leo Danielides**, who adds that automation and connected systems may be able to help reduce downtime for truck breakdowns.

Even as legal and regulatory frameworks change and evolve, still greater, unforeseen challenges may arise. Yet the speakers shared a consensus that technologies are advancing at such a rapid rate and autonomous vehicles will be seen on roads in some form within the next decade or so. The automated vehicle industry is an emergent and potentially lucrative industry that will undoubtedly reshape and reimagine our strategies and plans to transport passengers and freight.

Events | Lectures

Distinguished Leon N. Moses Lecture: The Economics of Transportation Safety

On October 29, 2013, NUTC Faculty Affiliate Ian Savage, Associate Chair, Northwestern University Department of Economics, delivered the Leon N. Moses Distinguished Lecture in Transportation. Savage, Moses' longtime collaborator, began by outlining the life of the noted Economics professor, who had passed away two weeks earlier at the age of 88. Following this personal history, Savage delved into the basics of terminology used in describing transportation safety. In particular, he noted that safety professionals prefer the word "crashes" to "accidents" because the latter word suggests that the occurrences are due to fate and cannot be influenced by human decisions.



Savage explained that the highway fatality risk per vehicle driven has fallen by 70% since 1975. This trend has also been seen in rail and aviation: collisions and derailments per train mile have fallen by 85% since the late 1970s, while the fatality risk per passenger enplanement has fallen to close to zero since the late 1990s. In contrast, on-the-job transportation sector fatality risks are comparatively high: trucking and maritime employee fatality rates are twice as high as those in the mining and construction industries. Even in the railroad and aviation industries,

employee fatality rates are still twice those of working in manufacturing. Further, the general population faces spillover risks from collisions between trains and cars/pedestrians, between trucks and automobiles, and from the release of hazardous materials as a result of transportation crashes. This led Savage to question, "How safe is 'safe enough?'"

Obviously, increased safety comes at a cost, and consumers may not be willing to pay the price to reach the mythical "perfect safety," even if such a low level of risk was physically possible. Transportation sectors must find the best way to decrease the risk to consumers and the public while recognizing that there is an upper bound to the price that users and taxpayers are willing to pay.

Savage concluded that the difficulty in defining "optimal safety" means that it is difficult to say whether or not there is "too little" safety in a particular mode. As a result, economists try to observe breakdowns in the market process by which carriers and their customers determine their preferences for safety. He also noted that when customers have differing tastes for safety, both higher- and lower-safety carriers may coexist in the market. Customers placing a greater value on safety will be willing to pay a premium price to obtain lower-risk transportation.

33rd Annual William A. Patterson Lecture: Funding the Future, Lessons from the Past

On June 10, 2014, **Christopher B. Lofgren**, President & CEO of Schneider, detailed the importance of the Highway Trust Fund (HTF) in a lecture entitled *Funding the Future, Lessons from the Past: How Underinvestment in Highway Infrastructure Threatens Transportation Efficiency and Sustainable Economic Health*.

According to Lofgren, the HTF was created in 1956 to "eliminate unsafe roads, inefficient routes, traffic jams, and all the other things that get in the way of speedy, safe transcontinental travel." In recent years, expenditures from the HTF have expanded from highway construction and maintenance to items such as transit, bike paths, and recreational trails, while the fuel tax has become more like any other tax. The political consensus that had existed to allow periodic increases in the fuel tax rate has been lost, and the HTF has become a political football, with neither major political party willing to make the changes necessary to fund it properly. Without major changes, the HTF will go bankrupt by 2015. This, Lofgren said, is a mistake.



Lofgren outlined a few different ideas on how to strengthen the HTF. First, he mentioned that the best way to secure the future of the fund is to "tax petroleum at the wellhead." This would involve a direct tax on oil producers of approximately \$2.61 per barrel prior to gasoline refinement. He also proposed returning the HTF to exclusively funding highway construction and maintenance.

One proposal Lofgren had that he believes will elicit criticism from all political sides is to raise taxes at the pump \$0.16 per gallon of gasoline and \$0.21 per gallon of diesel in order to improve infrastructure and prevent catastrophic events like bridge collapses. However, Lofgren also noted that even with indexing, such a tax structure is likely not sustainable because revenues fall as fuel economies improve. Therefore, the best way to use such a tax would be to phase out taxes at the pump and move towards a VMT tax, which charges riders based on the usage of roads and can be adjusted or targeted to address high-traffic times in urban centers. In cities such as London, adding VMT tax has significantly reduced congestion in central urban areas. Lofgren believes adopting similar measures in urban centers around the United States could be a step towards insuring the sustainability of the Highway Trust Fund.

Lofgren stressed that there are "lots of questions, but not a lot of definitive answers." But he emphasized the need to enhance the Highway Trust Fund both to repair current infrastructure and to expand into new areas as necessary in order to help the United States put itself back on the path that made it one of the most economically powerful countries of the last century.

Events | Executive Education

Freight Transportation and Logistics

During a period of economic uncertainty, operators and their customers (those who buy freight) face a volatile business landscape with shifting opportunities and expectations. Variability must be managed in all decisions—pricing, service, access, mode selection, contractual arrangements, etc. In such an environment, both sides must continually adapt their strategies for success.

To address these challenges, the Northwestern University Transportation Center has developed and conducted a rigorous curriculum customized for transportation and logistics executives, those who invest and raise capital for the industry, and those who provide services for the sector. This executive education program, part of the NUTC Executive Education Series, provides 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.

Topics covered in a typical program include how the volatile business environment and economic uncertainty impact both domestic and international freight transport; regulatory changes that can be expected and how they can impact relationships; how technology is being leveraged to improve operational performance and service quality; and ways carriers can gain advantages in the new environment. Program content is thoroughly integrated by the course faculty so that participants emerge with a comprehensive understanding and perspective of both domestic and international transportation sectors. Both Northwestern faculty and outside lecturers lead the Center's executive education programs.



NUTC faculty affiliate Joseph Schofer discusses policy implications during the Transportation Center-affiliated course, "Transportation Policy Development, Planning and Management"

Transportation Policy Development, Planning and Management

NUTC hosted more than forty elected-government officials and public sector policy professionals from the Republic of Indonesia in Chicago, Illinois on October 17-18, 2013, as the culmination of a customized NUTC-developed executive education course, Transportation Policy Development, Planning and Management. The participants had responsibility for District-level governance, including the provision of transportation infrastructure and services in Indonesia. In August 2013, following a weeklong course that was developed in partnership with the Ministry of Home Affairs (MOHA) of the Republic of Indonesia and the Rajawali Foundation, officials and professionals in attendance were given a final assignment: apply their newly acquired skills learned to a transportation problem in their region of the country.

In Chicago, the "students," who had assembled into groups by region, presented case studies and action plans for their regions and received guidance from NUTC faculty Hani S. Mahmassani, Joseph Schofer, and Pablo Durango-Cohen. The program included a field visit to Willis Tower for presentations by the Chicago Metropolitan Agency for Planning and United Airlines (as well as sightseeing at the observation deck), and a tour of United Airlines Operations Control Center. Following the field visit, NUTC faculty, Indonesian officials and professionals, and MOHA administrators convened for a closing dinner and award certification ceremony. 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, delivered a keynote address to our guests, and charged them to take active steps to implement their new skills toward challenges and opportunities in Indonesia.

The 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; alternatives analysis using; sustainable transportation systems; freight transportation and economic competitiveness; and strategic policy making and examples from the perspective of U.S. state government.

Other faculty who participated in Jakarta included Ralph Gakenheimer, Professor Emeritus of Urban Planning, MIT; Martin Wachs, Professor Emeritus of Civil & Environmental Engineering and City & Regional Planning, University of California, Berkeley; Debra Miller, Senior Consultant, Cambridge Systematics and former Secretary, Kansas Department of Transportation; and Breton Johnson, Associate Director, Northwestern University Transportation Center.

Community | Events

NUTC students (from left) Archak Mittal, Michael Hyland, Lama Bou Mjahed, and Xiang "Alex" Xu at a meeting of the Transportation Research Board in Washington, D.C.



NUTC Welcome Dinner

Each Fall, the NUTC hosts a dinner to welcome students to the opening of the academic year. New transportation students are introduced, and they network both with continuing students and NUTC faculty.

Annual TRB Reception

In conjunction with the annual meeting of the Transportation Research Board in Washington, D.C, the Transportation Center hosts a well-attended reception for current students, alumni, faculty, and friends of the Center.

End-of-the-Year BBQ

In June, the Center hosts an annual get-together to celebrate the end of a successful academic year. This tradition gathers current students together with faculty, staff, alumni, and friends for an informal picnic and conversation.



The Center's social activities punctuate the steady flow of learning, fostering an academic and research environment conducive to collegiality, creativity, and balance.

Community | Groups



NUTC Seminar Series

The NUTC Seminar Series allows students, faculty, and the community to learn from the real-world experiences of seasoned industry professionals and researchers in the field.

5/22/2014 *Analysis of Highway-Safety Data: Current and Future Methodological Challenges*; Fred Mannering, Charles Pankow Professor of Civil Engineering, Purdue University

5/1/2014 *Life-Cycle Analysis of Transportation Fuels and Vehicle Technologies*; Michael Wang, Systems Assessment Group, Energy Systems Division, Argonne National Laboratory

4/10/2014 *Vehicle Routing Problems: Applications in Service and Entertainment Environments*; Grisselle Centeno, Associate Professor, Department of Industrial and Management Systems Engineering, University of South Florida

4/4/2014 *Vehicle Routing Problems: Applications in Service and Entertainment Environments*; Christina Drouet, Manager, Chicago Area Modernization Program Office, Federal Aviation Administration

4/1/2014 *The Science of Sleep: Aviation Rest and Fatigue Regulations for Pilots*; Noam Alon, Director, Network Operations Center, United Airlines, and Kathryn Reid, Associate Director, Circadian Rhythms & Sleep Research Program, Northwestern University

2/27/2014 *Distributed Coordinated in-Vehicle Online Routing Using Mixed-Strategy Congestion Game*; Lili Du, Assistant Professor, Civil, Architectural & Environmental Engineering, Armour College of Engineering, Illinois Institute of Technology

2/20/2014 *Envisioning Autonomous Vehicle Pathways through the Lens of Air Transportation Planning*; Megan S. Ryerson, Assistant Professor, City & Regional Planning, Department of Electrical and Systems Engineering, University of Pennsylvania

1/9/2014 *Harvesting Complexity to Build Smarter Cities*; Sybil Derrible, Director, Complex and Sustainable Urban Networks Lab, University of Illinois at Chicago

12/5/2013 *Overview of Power Grid Research at Argonne National Laboratory*; Jianhui Wang, Energy Systems Engineer, Argonne National Laboratory

11/07/2013 *Transit Service Reliability, Hidden Waiting Time, and Optimal Holding Control*; Peter Furth, Professor, Civil & Environmental Engineering, Northeastern University

10/31/2013 *High-speed Railroad Passenger Services: Ridership Projections for the USA's Northeast Corridor*; David Boyce, Adjunct Professor of Civil & Environmental Engineering, Northwestern University

10/24/2013 *Adaptive Routing in Stochastic Time-Dependent Networks with Real-Time Information*; Song Gao, Associate Professor of Civil & Environmental Engineering, University of Massachusetts Amherst

10/15/2013 *Enhanced Econometric Model Structures: Application to Travel Behavior and Transportation Modeling*; Naveen Eluru, Assistant Professor, Department of Civil Engineering and Applied Mechanics, McGill University

09/27/2013 *Transforming Transportation for Tomorrow*; Ann L. Schneider, Secretary, Illinois Department of Transportation

09/26/2013 *Modeling Individual Choices for Sustainable Mobility: Understanding the Role of the Environment*; Elisabetta Cherchi, Associate Professor, Department of Transport, Technique University of Denmark

09/23/2013 *Modeling Heterogeneous Decision Processes and Joint Decision-Making in Travel Demand Models*; Amanda Stathopoulos, Research Fellow, Transportation and Mobility Laboratory, School of Architecture, Civil and Environmental Engineering, École Polytechnique Fédérale de Lausanne



Hagestad Sandhouse Gang

The Hagestad Sandhouse Gang is a railroad discussion group that aims to explore rail-related issues and link active practitioners with students and academics at Northwestern.

12/9/2014 *The Race Is One! Service, Capacity, Capex, and the Railroad Renaissance*; Anthony B. Hatch, Consultant, ABH Consulting

10/16/2014 *American Railroads: Decline & Renaissance in the Twentieth Century*; Robert E. Gallamore, Principal, The Gallamore Group

5/15/2014 *A Personal Look at 50 Years of Railroad History*; George W. Hamlin, President, Hamlin Transportation Consulting

4/17/2014 *Building Consensus for CTA's Red Line South Reconstruction Project*; Graham Garfield, General Manager of Customer Information Chicago Transit Authority

3/20/2014 *Freight Rail Economic Development*; Libby Ogard, Consultant, Prime Focus, LLC

1/14/2014 *A Conversation with Don Orseno*; Donald A. Orseno, Interim Executive Director, Metra



Icarus Society

The Icarus Society provides a forum for the discussion and dissemination of issues impacting the worldwide aviation industry.

05/14/2014 *Airline Hubs: Blessing, Bane...or Both?*; George W. Hamlin, President, Hamlin Transportation Consulting

05/06/2014 *The Flight Plan: Vision, Leadership and Culture*; Howard Putnam, Former President & CEO, Southwest Airlines, and Former CEO, Braniff Airlines

04/04/2014 *The O'Hare Modernization and Chicago Airspace Project*; Christina Drouet, Manager, Chicago Area Modernization Program Office, Federal Aviation Administration

04/01/2014 *The Science of Sleep: Aviation Rest and Fatigue Regulations for Pilots*; Noam Alon, Director Operations Control Center, United Airlines, and Kathryn Reid, Associate Director, Circadian Rhythms and Sleep Research Program



Kellogg Transportation Club

The Kellogg Transportation Club engages Kellogg students in the airline, aerospace, railroad, ocean shipping and logistics industries. The Club aims to raise student awareness and provide resources related to management opportunities with companies in these industries. The Club informs students about employment and recruiting opportunities and plans student events throughout the academic year.

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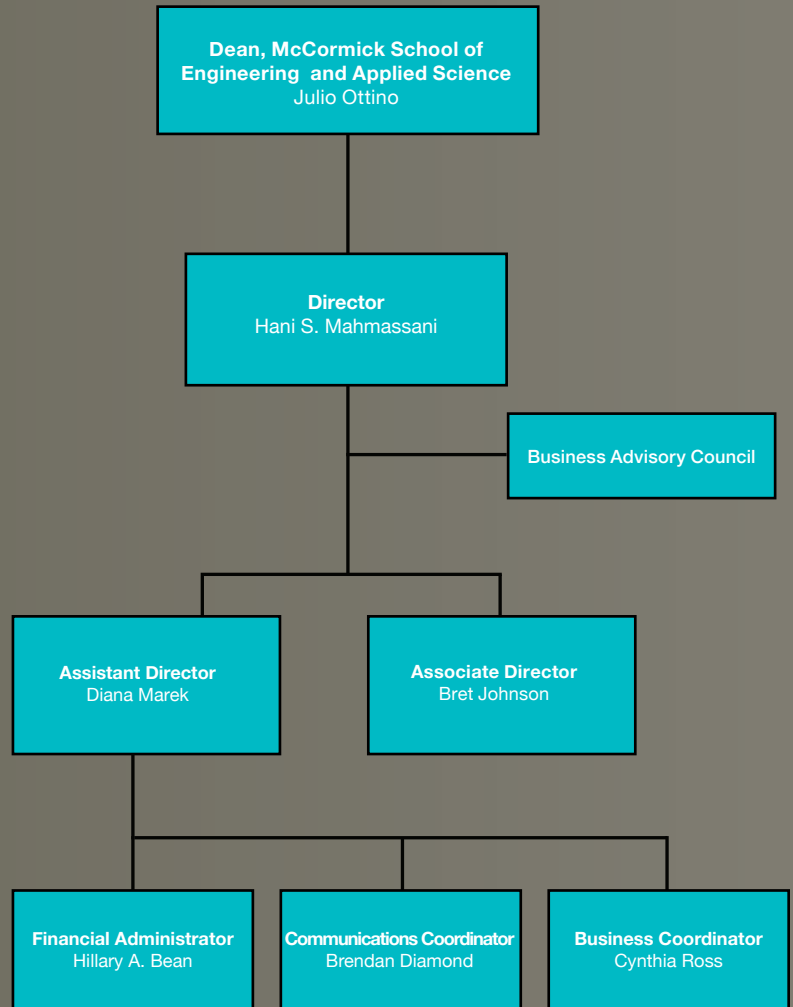
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