McCormick

Northwestern Engineering

CCITT

Center for the Commercialization of Innovative Transportation Technology

2010 Annual Report

CCITT is operated within the Northwestern University Transportation Center

Welcome

This past October at the Northwestern University Transportation Center semi-annual Business Advisory Committee meeting I was presented with a Northwestern service award (pin) in recognition of my ten years of service at the University by Dr. Hani Mahmassani, Director of the Transportation Center (pictured with me below). What an interesting road it has been for me on the Evanston campus. I am humbled by the opportunity given to me to apply my knowledge of the commercialization of technology to the transportation research community and to lead the Center for the Commercialization of Innovative Transportation Technology (CCITT) for the past four years.

Just as I have navigated an emerging path at the University, transportation researchers, and USDOT funded University Transportation Centers, face an uncertain and ever-evolving road ahead as we deal with budget uncertainties and diverging political realities. Likewise, the users and implementers of our research outcomes, who are frequently saddled with diminishing budgets and personnel resources, are continually forced to do more with less. I have no doubt the solution to this challenge is applied innovation – innovation that can be successfully translated to near and long term problems.

One broad solution to doing more with less is optimization. A majority of the CCITT funded projects involve some aspect of optimization – for example: optimization of the deployment of alternative fueling infrastructure for future vehicles, optimization of video compression algorithms to support intelligent traffic systems, optimization of steel properties for rail tank car reliability, optimization of rail maintenance worker scheduling, and optimization of traffic routing algorithms for travel time reliability predictions.

To translate innovations into practice, CCITT encourages its investigators to collaborate with end-users and to build metrics into research proposals and plans that enable the measurement of outcomes and potential impact. Of course the easiest measurement of our success is the adoption and actual use of our innovations. We are steadily getting there but the process of commercialization is not a straight forward task. We would like to thank our many partners for accepting this challenge, including the Chicago Transit Authority, Ingenient Technologies (acquired by Sasken Communication Technologies), LogicBox, Norfolk Southern Railroad, and Union Tank Car Company (UTLX). But most importantly, we commend our researchers for their undying energy and desire to improve our transportation system.

Sincerely,

Bret Johnson

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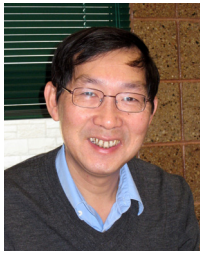
Investigators

Oluwaseyi Balogun
Assistant Professor
Mechanical Engineering
& Civil Engineering



Yip-Wah Chung
Professor
Materials Science and
Engineering

Irina Dolinskaya
Assistant Professor
Industrial Engineering and
Management Sciences

Sridhar Krishnaswamy
Professor
Mechanical Engineering

Yu Nie
Assistant Professor
Civil Engineering

Sotirios Tsaftaris
Research Professor
Electrical and Computer
Engineering

CCITT Principal Investigator

Hani S. Mahmassani is CCITT's Principal Investigator. Dr. Mahmassani holds the William A. Patterson Distinguished Chair in Transportation and serves as Director of the Northwestern University Transportation Center, which he joined in 2007 from the University of Maryland and previously the University of Texas at Austin. His research focuses on the role of information and communication in the operation of transportation systems, and the interaction between user decisions and system performance. He has developed simulation and optimization platforms for large-scale transportation networks that support operation and planning of these systems, including vehicular traffic, pedestrians and crowds, as well as intermodal freight and logistics systems.

Hani Mahmassani

Morris Fine
Professor Emeritus in Service
Materials Science and
Engineering

Aggelos Katsaggelos
Professor
Electrical and Computer
Engineering

Diego Klabjan
Associate Professor
Industrial Engineering and
Management Sciences

Semyon Vaynman
Research Professor
Materials Science and
Engineering

Karen Smilowitz
Junior Patterson Professor
of Transportation
Associate Professor
Industrial Engineering and
Management Sciences

Post-Doctoral Researchers

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Post-Doctoral Fellow
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Management Sciences

Brad Regez
Post-Doctoral Fellow
Mechanical Engineering

Dengfeng Yang
Post-Doctoral Fellow
Industrial Engineering and
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Clinical Associate Professor
Center for Entrepreneurship and Innovation
Northwestern University

Michael J. Shiffer
Vice President for Planning
Translink - South Coast British Columbia
Transportation Authority

Research

New Projects

Decision-Making Tools for Distribution Networks in Disaster Relief

Principal Investigator: Karen Smilowitz, Industrial Engineering and Management Sciences

Co-PI: Irina Dolinskaya, Industrial Engineering and Management Sciences

Problem: Lack of appropriate tools to manage supply chains and distribution in disaster relief settings.

Solution: Easy-to-use decision-making tools tailored for relief agencies operating with incomplete information.

Impact: More timely and efficient delivery of food, supplies and medical equipment to save lives in disaster scenarios.

The devastation caused by the 2010 earthquake in Haiti was compounded by the significant logistical challenges of distributing relief to those-in-need. Unfortunately this is the case with many disasters. Rapid and efficient distribution of water, food, medicine and other essential supplies is crucial to saving lives and rebuilding the region. The investigators are leveraging their expertise in supply chain management and vehicle navigation under uncertainty to study design and operational improvements for humanitarian relief chains.

Distribution in commercial delivery services share some features with disaster relief; however, several critical attributes are not present. First, models and solution must be accessible and easy to implement by relief workers operating in extreme conditions. These end users often lack the technical background and support during their operations, and cannot implement complex optimization software used in industry. Second, information about the environment can be very limited following a disaster, to a degree not often encountered in commercial settings. Third, the objectives in disaster relief have not been extensively studied in other sectors. The team will analyze relief systems with multiple (often conflicting) objectives to ensure efficient and effective distribution of relief supplies.

This research project has three key activities: learning from agencies about their current relief operations; developing prototype logistics models to improve operations; and transitioning this research to Northwestern engineers, trained through this initiative. These engineers will adapt the prototype models to create and deploy decision-making tools for agencies to improve relief distribution.

Information System for Infrastructure Deployment in Support of Future Vehicles

Principal Investigator: Diego Klabjan, Industrial Engineering and Management Sciences

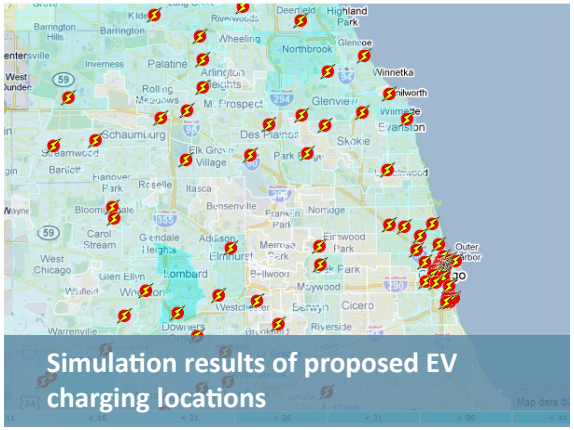
Problem: The public sector must optimize scarce dollars to purchase and deploy the initial phase of electric vehicle (EV) charging infrastructure. In time, the private sector will seek an efficient model to do the same.

Solution: Develop a location decision-making software tool that employs optimization and agent-based modeling techniques to pinpoint optimal locations of EV charging stations.

Impact: Enable the efficient deployment of a sustainable, alternative energy infrastructure for the mass roll-out of EVs.

Mass production electric vehicles (EVs) will be coming on the market en masse during the next few years. Their adoption will depend on the availability of charging stations. A few cities have started deploying such stations and many are in the planning stage. The decision makers, being city governments, utilities, or private entities such as mall and fast-food restaurant operators, are in need of information systems that will assist them in deploying such an infrastructure, including (1) EV demand consideration, (2) the actual location of stations, (3) the implied service time on car owners, and (4) power grid implications. All of these aspects should be addressed through analytical methodologies, such as discrete choice modeling to capture the demand, optimization

for actual location recommendations, and comprehensive simulations to estimate the overall impact on the system. While some of these questions have already been addressed at the macro level, thorough research is required to conduct assessments at the micro level, which is required to actually build the infrastructure.



Simulation results of proposed EV charging locations

The developed decision support system and service will be subscription-based with a broad market spreading from city governments and municipalities (installing charging stations in public parking spaces, curbside charging), utilities, and private entities (retailers, mall operators, fast-food and restaurant chains, garage owners, etc.). While the actual savings of using analytics for deployment vs. more judgmental approaches are hard to estimate, the proposed system will drastically reduce labor needs, and it will open the door to easily conduct what-if analyses.

The initial phase of the project will be focused on developing such a system for the EVs, however the underlying concepts and methodologies are also applicable to deploying the infrastructure of other possible alternative fuel vehicles, such as compressed natural gas (CNG), hydrogen, or biofuel stations.

Ongoing Projects

Evaluation and Application of Super-Tough Steel for Use in Tank Cars Transporting Cryogenic Liquids

Principal Investigator: Semyon Vayman, Materials Science and Engineering

Co-PIs: Morris Fine, Materials Science and Engineering
Yip-Wah Chung, Materials Science and Engineering

Problem: Railroad tank cars carrying hazardous materials, including cryogenic liquids, are at risk of fracture and puncture failures.

Solution: Design steels for tank cars that retain high-fracture toughness in cryogenic operating conditions, yet remain weldable and cost effective.

Impact: Next Generation Tank Cars will increase the safety of transporting high risk material

The goal of the proposed project is to further develop and market advanced 60-ksiyield strength super-tough cryogenic steel (designated as NUCu60ST) for use in tank cars transporting cryogenic liquids. This is a joint project with Union Tank Car Company (UTLX). Developed at Northwestern University, this super-tough cryogenic steel was included into the “Next-Generation Rail Tank Car Project”, an innovative joint initiative of the three companies (Dow, Union Pacific and UTLX), Association of American Railroads (AAR), and US and Canada Departments of Transportation focused on the design and implementation of a next-generation rail tank car with enhanced ability to safely transport hazardous chemicals.

The team has completed extensive testing with UTLX on the project. The “super-tough” steel has outperformed all other steels, including A709 HPS100, in fracture tests at low temperatures and in straight-punch tests, where no cracks of any kind were formed in “super-tough” steel. Exhaustive welding studies were completed on an Initial sample “heat” (production run) of steel at the Edison Welding

Institute and the ArcelorMittal Research Center. As a result of the testing among the investigators, UTLX, and the steel company, the Ti-modified A710B “super-tough” steel is a leading candidate for the outer shell of a double-hulled tank car design for

Punctured “super-tough” steel (left) and A709 HPS100 (right) steel plates

cryogenic liquids. The Department of Homeland security has also expressed interest in the steel for railroad applications because of its high fracture toughness; the steel's blast resistance will be tested at US DoD facilities.

Completed Projects

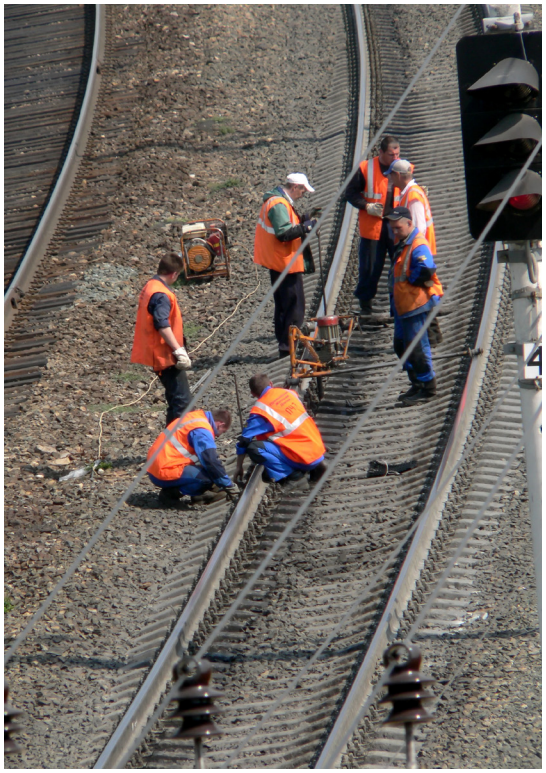
Business Intelligence for Gang Scheduling

Principal Investigator: Diego Klabjan, Industrial Engineering and Management Science

Problem: Inefficient scheduling of rail maintenance workers creates unnecessary expenses

Solution: A web-based software system using business intelligence and state-of-the-art analytics to streamline maintenance scheduling.

Impact: Increase the labor efficiency and reduce costs of rail companies and maintain good state of repair of railroad corridors.



Railway tracks wear down and thus need to be constantly maintained. Groups of maintenance workers, called gangs, are responsible for such maintenance tasks. Throughout a year, a gang works for a few days in a particular track section and then reallocates to another section. Railways incur significant expenses related to gangs. They range from the direct costs such as salary and travel allowance to indirect costs consisting primarily of the impact to operational disruptions. It is thus of vital importance to railways to schedule the gangs as efficiently as possible. For the majority of railroads, the development of a gang schedule is a tedious and labor intensive process.

To solve this problem, Klabjan and his research team, in conjunction with support from Norfolk Southern Corporation (NS), developed a gang scheduling information software application based on business intelligence and state-of-the-art analytics. At the core of the software is a sophisticated optimization algorithm that constructs a schedule and then iteratively refines the schedule based on state-of-the-art mathematical programming techniques and large "neighborhood local search" strategies. The software allows the master scheduler to visually compare alternative scheduling solutions on a web-based map that displays the geographical flow of gangs from the first maintenance job to the last. The software has been demonstrated to produce schedules that reduce overall cost, reduce the over distance traveled by workers, reduce train schedule interferences, and enable other strategic business requirements. After completing a roll-out of the scheduling software at NS, Klabjan plans to offer it over the Internet as software-as-a-service to other railways.

Intelligent Structural Health Monitoring of Vehicular Bridges

Principal Investigator: Sridhar Krishnaswamy, Mechanical Engineering

Co-PI: Oluwaseyi Balogun, Mechanical Engineering and Civil and Environmental Engineering

Problem: Piezoelectric sensors used for structural health monitoring (SHM) of bridges and other infrastructure have inherent performance and cost limitations.

Solution: A field-deployable optical Fiber Bragg Grating (FBG) Acoustic Emission (AE) sensor system for SHM of infrastructure.

Impact: Improve the integrity of structural health monitoring by implementing more accurate, more reliable and more cost-effective sensor technologies, thus enhancing safety.

After the catastrophic I-35W bridge collapse, engineers have been seeking and pursuing alternative inspection techniques to monitor a bridge's structural health. The purpose of this project was to develop a prototype AE sensor system that uses optical FBG in place of piezoelectric sensors (the current standard) to "listen" to the structure and monitor potential damage. FBG sensors offer numerous advantages compared to piezoelectric sensors for AE monitoring. FBG sensors are low cost and readily available, light-weight, immune to electromagnetic noise sources, and are multiplexable. It is possible to set up a FBG array at great distances from the control box with minimal

signal loss because the FBG are connected to the control box by fiber optic and not a cable. Having a significantly smaller footprint than the piezoelectric sensors, the FBG can also be mounted in areas with small tolerances. Since they are small, the FBG can be installed permanently to the structure and its fiber runs to each sensor can be concealed easily. This allows for an inspector to leave the sensor in place to do real-time SHM of the structure or to leave the sensors in place and simply hook up the demodulator box when a scheduled inspection is required. With this sensing approach, inspectors are not required to set up local sensors, apply coupling fluids for ultrasound transmission, and recalibrate the sensors prior to each use, all of which are necessary for the commonly used piezoelectric SHM sensors. FBG sensors also exhibit long-term stability and optical sensitivity, which is suitable for SHM applications.

FBG acoustic emission sensor prototype in aluminum chassis

At the core of the AE prototype is a two wave mixing (TWM) interferometer developed by the PI's team that allows for wavelength demodulation of FBG sensor responses in a photorefractive crystal. A FBG sensor responds to mechanical or thermal strains imposed by the environment, by a modulation in the phase of the light. The prototype system was fabricated in a compact form using laboratory components and free space optics housed in a rack-mounted enclosure that is suitable for field testing applications. Through another funding source, a set of pilot field tests were conducted in collaboration with research partners at the Hong Kong Polytechnic University in Hong Kong, and the Dalian University of Technology in China. During the testing, the demodulator successfully detected vibration energy waves generated by fractures that occurred under loading. The experimental study demonstrated the potential application of the demodulator device in structural and civil engineering applications, particularly in the scenario of sudden change of infrastructure stiffness during earthquakes. The results obtained demonstrate a high sensitivity of FBG sensors to local damage evolution in component parts. The research team is currently investigating potential field testing of local damage at vehicular bridge sites within the United States.

Providing Reliable Route Guidance - Part 2

Principal Investigator: Yu "Marco" Nie, Civil and Environmental Engineering

Problem: Travel time estimation tools for personal travelers, shippers, and others provide average times without consideration of variability (or reliability).

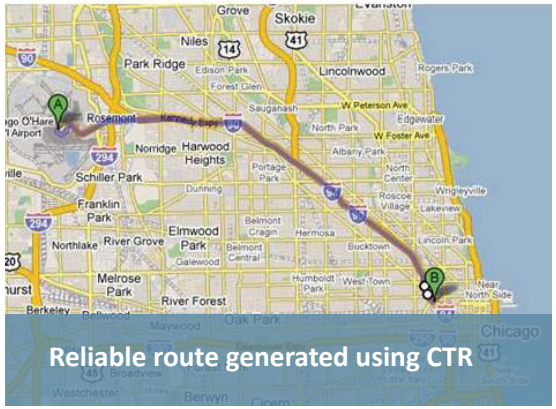
Solution: A web-based software prototype using novel routing algorithms and archived traffic data to create a travel reliability inventory of Northeastern Illinois.

Impact: The ability to provide reliable future and real-time travel times in an urban area and enhance mobility.

The overarching goal of the project was to enhance travel reliability of highway users by providing them with reliable route guidance produced from newly developed routing algorithms that were validated and implemented with real traffic data. The project involved three primary activities: further developing and refining the reliable routing algorithms from Phase I of the project; evaluating the use of Chicago Transit Authority (CTA) bus data to estimate travel times on arterial and local roads; and conducting a survey to understand travelers' reaction and attitude to travel reliability and their opinions about reliable route guidance products.

Several meaningful observations and research results were uncovered from the bus data. The investigation suggests that: on freeways and expressways, the bus travel time data have strong correlations with those obtained from loop detectors; the data on arterial and locals streets typically contain larger noises; the arterial data quality is better on longer streets than shorter streets, and better on streets located in suburbs than those in the downtown area; and the bus data tend to overestimate travel time under free flow or light congestion conditions, but better represent the reality in the presence of heavy congestion. The survey results indicate that travel time reliability is the second most important decision making variable in route choice decisions by travelers, next only to travel time.

For more information on the CTR software tool, visit Professor Nie's NU-TREND (Transportation - Reliability - Equilibrium - Network – Dynamics) website at: http://translab.civil.northwestern.edu/Nutrend/homepage.aspx.



Reliable route generated using CTR

iTRAC: Intelligent Compression of Traffic Video

Principal Investigators: Aggelos K. Katsaggelos, Electrical and Computer Engineering
Sotirios A. Tsaftaris, Electrical and Computer Engineering

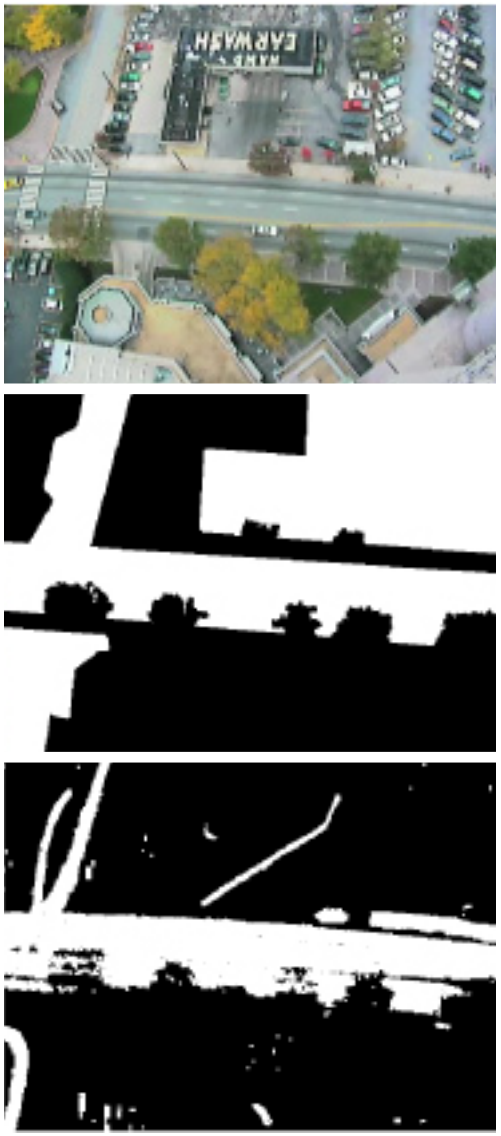
Problem: Widespread adoption of video surveillance for intelligent traffic monitoring and object tracking is limited by installation (labor) and infrastructure (high bandwidth, power) costs.

Solution: iTRAC, an intelligent algorithmic module, to be used in conjunction with the H.264 video encoding standard that achieves a 75% savings in video bitrate requirements yet maintains comparable tracking quality to existing systems.

Impact: Enable the wide-scale deployment of video-based traffic monitoring applications for traffic management and public safety.

Non-intrusive video imaging sensors are commonly used in traffic monitoring and surveillance. The goal of this research project was to develop a portable, easy to deploy, low cost, low power, wireless video imaging sensor that generates compressed, yet robust, video images for traffic surveillance and tracking. The enabling of higher quality streaming video (or increased video bitrate) for video analytics requires the deployment of expensive wired communication infrastructure (i.e. high labor costs to deploy) or heavy compression of the video data to pass through a majority of existing networks. Through investigations of the existing compression techniques, the researchers determined that the visual quality of the data is not only low, but more important, the tracking accuracy and efficiency is severely affected.

In their search for a better method, the researchers pursued the integration of newer video encoding standard (H.264) with state of the art video compression algorithms specifically designed for transportation (traffic) applications. The result is the iTRAC system, a novel method of optimizing object tracking quality in compressed video through quantization tables, which injects highway content-awareness in the H.264 standard. In this project the investigators report providing up to 75% savings in bitrate required to transmit traffic surveillance video with comparable automated tracking quality, using common tracking algorithms. Therefore for real-world track surveillance applications featuring automated tracking, the bitrates required by systems using iTRAC could be deployed over existing 3G or WiMAX wireless links, allowing ubiquitous coverage at reasonable cost.



Right: Sample video frame from FHWA licensed traffic sequence (top), and comparison of manually segmented Region of Interest (ROI) for analysis (center) with iTRAC automatically extracted ROI for encoding (bottom).

Education

Partnering with NUvention

NUvention, led by Farley Center for Entrepreneurship and Innovation (FCEI) Director and CCITT Advisory Board member Michael Marasco, is a visionary academic partnership created by FCEI in the McCormick School of Engineering and Applied Science that expands upon Northwestern University's excellence in interdisciplinary study. During 2010, CCITT steered two faculty research projects toward NUvention: Energy, one of NUvention's three focus areas. The goals of NUvention: Energy are strongly compatible with the Northwestern University Transportation Center's emerging research area in transportation energy and sustainability

Nicholas Switanek, visiting assistant professor of management & organizations at the Kellogg Graduate School of Management, leads the NUvention: Energy graduate course. In his class, students from engineering, business, arts and sciences, law and other graduate schools across campus come together in interdisciplinary teams to develop a product or service, and a business plan, in the sustainable energy industry.

In Spring 2010, an interdisciplinary student team of four graduate students developed strategic plans to make use of an analytical framework to support sustainable decision-making in the purchasing and operation of transportation infrastructure. This effort was catalyzed by the efforts of Pablo Durango-Cohen, professor of civil and environmental engineering, and PhD student Elaine Croft McKenzie and their research project, "Supporting Sustainable Development of Transportation Infrastructure: Developing a Modeling Framework to Integrate Life-Cycle Assessment within Decision Models."

In Fall 2010, Professor Diego Klabjan successfully submitted a proposal to NUvention Energy to explore the commercial potential and outline a business plan for a software information system that could result from his research on electric vehicle infrastructure deployment. A team of MBA and Master of Science in Engineering Design and Innovation students will begin an analysis of the market opportunity in the Winter 2011 quarter.

Peter Appel Visits Northwestern

In September, Peter Appel, administrator of the Research and Innovative Technology Administration (RITA), got a taste of the interdisciplinary transportation research and education at Northwestern University. He toured CCITT, the Northwestern University Transportation Center, and the Infrastructure Technology Institute (ITI) and listened to faculty and student research presentations.

After the presentations, Appel spoke to more than 50 faculty and students about his years in the transportation industry: how when he worked in the airline industry he worked with airline buffs, and when he worked in the railroad industry he worked with rail buffs, but that ultimately he considers himself a "transportation buff."

"I'm interested in getting people or things from A to B in the most effective way possible" while helping both people and society, he said. One of the US DOT's top goals is safety, he said, and one of the purposes of RITA is to partner with universities on cutting-edge research that will continue to improve safety and infrastructure in all modes of transportation. Though highway deaths have decreased significantly since the 1960s (down to about 33,000 last year), more can be done. While the last 50 years have been about improving the safety of automobiles and infrastructure, Appel predicted that the next 50 years will be about using wireless information from car to car to avoid crashes altogether.

"We want to work with the best researchers to come up with the best way to attack this problem," he said. When asked for advice for students interested in going into transportation field, Appel advised students to network with colleagues from different disciplines who look at transportation from different angles. "The issues you face in transportation … are so relevant from one mode to the next," he said. "Try different things out. It will make you more employable. Plus, you'll just enjoy it more."

Jay Walsh, Peter Appel, and Hani Mahmassani listen to student research presentations

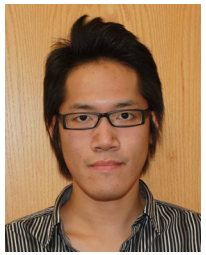
Dissertation Fellows

As part of CCITT's commitment to education and research, we provided support to four dissertation fellows beginning September 2010. All four fellows, Elaine Croft McKenzie, Bill Pun, Xing Wu, and Zitao Zhang, demonstrate a strong commitment to translating their research from the lab to the world.

Elaine Croft McKenzie

Elaine is a PhD candidate the Department of Civil and Environmental Engineering in the Transportation System Analysis and Planning Program. Professor Pablo Durango-Cohen serves has her dissertation advisor. Elaine's research is focused on the development of analytical methods to evaluate the environmental impacts associated with a product's life cycle and supply chain. Her research integrates economic input-output models of life cycle assessment (EIO-LCA) with optimization models to exploit synergies with models of product and process design. In this effort she aims to address the limitations of the EIO-LCA model, and explore optimal solutions, tradeoffs and sensitivity analysis, which are not available in other LCA methods.

Elaine is applying this new framework to case studies to understand the various economic and environmental factors involved in strategic infrastructure decisions, and to inform policy decisions promoting sustainability within the transportation sector. One case study involves the reexamination of the bus fleeting problem in the context of the emergence and adoption of new bus technologies (e.g. fuel cell, hybrid, compressed natural gas). By adding in environmental impacts such as greenhouse gas emissions and energy use over the lifecycle and increasing the number of alternative bus technologies, the bus fleeting investigation becomes quite intricate. Croft-McKenzie and Durango-Cohen intend to establish a modeling framework for understanding and evaluating strategic management decisions within the transportation sector, as well as more general decisions of product design and substitution.



Chan Seng "Bill" Pun

Bill is a PhD candidate in the Department of Industrial Engineering and Management Science under the guidance of Professor Diego Klabjan. Bill's research is focused on the theory and practice of Revenue Management (RM) in the airline industry with respect to the passenger and cargo sectors. On the passenger side, Bill's research is aimed at developing a stochastic optimization model for "seat" nesting decisions that would be used at the beginning of the booking process, as opposed to the back end of the process as it is done now. So-called nesting policies protect seats for potential high revenue passengers. This novel idea that enables the sharing of seats of low-fare passengers with higher-fare passengers has gained the attention of a leading airline reservation booking company that agreed to provide data and to evaluate Bill's solutions against the company's proprietary solution. The plan is to develop an efficient algorithm by adapting some well-known algorithms and applying it to the current state of the art software solutions.

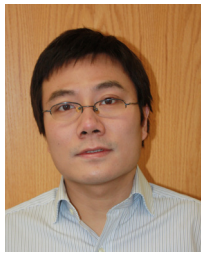
2010 CCITT Student of the Year

Advisor Diego Klabjan and CCITT Student of the Year Tim Sweda

Timothy Sweda is currently a second-year PhD student in the Department of Industrial Engineering and Management Sciences. He received his BS in Engineering from Harvey Mudd College and his MS in Industrial Engineering and Management Sciences from Northwestern University. Sweda's research utilizes both optimization and simulation methods to develop micro-level deployment strategies for charging infrastructure for electric vehicles. His advisor is Diego Klabjan. Outside of academics, Timothy serves as an officer for the INFORMS student chapter at Northwestern, and as the assistant concertmaster of the Northwestern Philharmonica orchestra.

Sweda was selected as the CCITT Student of Year for his research and academic excellence as well as self-motivation and independent problem solving skills. He proposed the creative and innovative application of agent based modeling for the simulation of driving and purchasing behavior of potential electric vehicle operators. A distinguishing and novel feature of the model is the micro-level analysis and the incorporation of social networking features. In a relatively short period of time, Sweda has developed a computer simulation of the driving behavior of a single driver or agent, including a useful graphical interface based on a GIS tool.

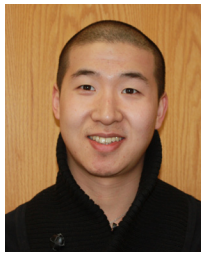
For air cargo, Bill is developing a resource allocation model for mid-term cargo capacity planning, a process in which shippers would bid for cargo space in the beginning of a season. A full-scale numerical experiment will be performed with real world data provided by a leading international airline to compare his solutions with the standard models used by the leading vendors. These outcomes will be compared with solutions obtained from the models used by a leading provider of airline revenue and booking software and a leading provider of air cargo RM software.



Xing Wu

Xing is a PhD candidate in the Department of Civil and Environmental Engineering under the supervision of Professor Yu "Marco" Nie. Xing's dissertation topic is "Routing and Traffic Assignment in Stochastic Networks." His dissertation work builds on two CCITT funded projects in which he has been involved with Professor Nie. Through these research projects, he and Nie developed a software tool, Chicago Testbed for Reliability (CTR), to: visualize and analyze Chicago traffic data from Gary-Chicago-Milwaukee (GCM) data set; construct and display travel reliability measures for the Chicago network; and provide reliable route guidance for the Chicago area and compare it with conventional routing algorithms.

In his research, Xing has studied the reliable a priori shortest path (RASP) problem, which aims to find a priori paths that are the shortest to ensure a specified probability of on-time arrival, and also in a travel-time temporal and spatial dependent network. During the final year of Xing's research, he is refining the reliability-based traffic assignment problem and developing analytical techniques to incorporate travel time reliability into route choice and traffic assignment models.



Zitao Zhang

Zitao is a PhD candidate the Department of Civil and Environmental Engineering in the Transportation System Analysis and Planning Program. He is advised by Professor Pablo Durango-Cohen. Zitao's research focuses on transportation economics, a branch of economics that deals with the allocation of resources within the transport sector and has strong linkages with civil engineering. Instead of optimizing the transportation network at an operational level, his research emphasizes the strategic move of different stakeholders in managing the transportation system, and intends to provide policy recommendations to decision-makers in areas such as congestion pricing, transit project funding and financing, and public-private partnership regulation and cooperation.

One area of particular interest to CCITT is Zitao's investigation of public pricing in the freight railroad business. During his fellow year, Zitao intends to develop an Erratic Business Index (EBI) that can be used to categorize and differentiate pricing strategy of different types of commodities based on route choices, origin-destination mileage, and profit gains. He and Durango-Cohen hope the research can help railroad freight businesses to further improve its management efficiency and pricing effectiveness, as the costs of pricing a single move can be quite high. Zitao was also recently selected by the International Road Federation as an Executive Fellow.

Student Researchers

Matt Christner
Undergraduate Student
Mechanical Engineering

Eren Soyak
Graduate Student
Electrical Engineering & Computer Science

Timothy Sweda
Graduate Student
Industrial Engineering and Management Sciences

Luis de la Torre
Graduate Student
Industrial Engineering and Management Sciences

Mujing Ye
Graduate Student
Industrial Engineering and Management Sciences

Yan-Jin Zhu
Graduate Student
Mechanical Engineering

Joe Zissman
Undergraduate Student
Civil and Environmental Engineering

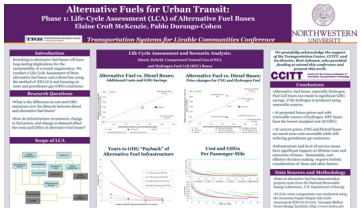
Tech Transfer

ISASH: Information System for gAng ScHeduling

Professor Diego Klabjan has launched a small business, EcoGreen Analytics, to commercialize research developed in his lab. The mission of EcoGreen is to provide analytics-based software solutions for the smart grid, electric vehicle infrastructure, renewable energy, and data driven problems in the railway, logistics, and airline industries.

One of EcoGreen's initial products is ISASH: Information System for gAng ScHeduling, a pending commercial version of software developed through his CCITT project, "Business Intelligence for Gang Scheduling." Railways employ several gangs (groups of maintenance workers) to repair their track infrastructure. Gangs move along track sections in order to complete a sequence of maintenance tasks spanning an entire year. The ISASH software aims to provide for the efficient scheduling of gangs at a scheduling tactical level. A software brochure and a "demo" of the gang scheduling software are available at the EcoGreen web site for download:http://www.ecogreenanalytics.com/demo.htm.

PhD Student Elaine Croft McKenzie Selected to Attend the UTC Spotlight Conference on Transportation for Livable Communities


Alternative Fuels for Urban Transit:
Phase 1: Life-Cycle Assessment (LCA) of Alternative Fuel Buses
Elaine Croft McKenzie, Pablo Durango-Cohen
Transportation Systems for Livable Communities Conference
NORTHWESTERN UNIVERSITY
Introduction
Research Questions
Life Cycle Assessment and Scenario Analysis
Diesel, Hybrid, Compressed Natural Gas (CNG), and Hydrogen Fuel Cell (HFC) Buses
Alternative Fuel vs. Diesel Buses: Additional Costs and GHG Savings
Alternative Fuel vs. Diesel Buses: Price changes for CNG and Hydrogen Fuel
CCITT
Scope of LCA
Years to GHG "Payback" of Alternative Fuel Infrastructure
Cost and GHGs Per Passenger-Mile
Data Sources and Methodology

Civil and Environmental Engineering PhD candidate Elaine Croft McKenzie was selected to present a poster, "A Strategic Optimization Framework for the Bus Fleeting Problem: Examining the Advantages and Tradeoffs of Alternative Fuel Buses," at the UTC Spotlight Conference on Transportation for Livable Communities. Elaine Croft McKenzie is a student in the Northwestern University Transportation Center and the Civil and Environmental Engineering department. CCITT sponsored her trip to Washington, DC, for the conference in October. In her presentation she demonstrated the overall life-cycle monetary costs and greenhouse gas emissions associated with four transit bus technologies – diesel, hybrid-electric diesel, compressed natural gas and hydrogen fuel-cell. For example, her analysis of hydrogen fuel-cell bus fleets included the costs and greenhouse gas emissions that come from the production of hydrogen, the transport of the fuel to the depot, the manufacture of the fuel cells, and the electricity needed to charge the bus's batteries. Elaine has a BA in Psychology from the University of Chicago and an MS in Civil and Environmental Engineering from Northwestern University. Her advisor is Professor Pablo Durango-Cohen.

Director Johnson Gives Talk at University of Illinois' Computational Transportation Science Seminar

Johnson served as a guest speaker at the University of Illinois' Computational Transportation Science (CTS) Seminar Series in the fall. CTS Director Dr. Ouri Wolfson, who is no stranger to startup companies and commercialization projects, served as host. CCITT appreciated the opportunity to share some of its strategies for success and project outcomes with our local transportation research colleagues.

Publications

- E. Soyak, S. A. Tsaftaris, and A. K. Katsaggelos, "Content-aware H.264 encoding for traffic video tracking applications," in Proceedings of ICASSP, Dallas, TX, USA, March 2010, pp. 730 – 733.
- E. Soyak, S. A. Tsaftaris, and A. K. Katsaggelos, "Tracking-optimal pre- and post- processing for H.264 compression in traffic video surveillance applications," in Proceedings of ICECS, Athens, Greece, December 2010, pp. 380 – 383.
- E. Soyak, S. A. Tsaftaris, and A. K. Katsaggelos, "Quantization optimized H.264 encoding for traffic video tracking applications," in Proceedings of ICIP, Singapore, September 2010, pp. 1241 – 1244.16.
- L. de la Torre, I. Dolinskaya, and K. Smilowitz. 2011. "Disaster Relief Routing: Integrating Research and Practice."
- M. E. Fine, S. Vaynman, D. Isheim, Y-W. Chung, S. P. Bhat, C. H. Hahin "A New Paradigm for Designing High-Fracture-Energy Steels," Materials and Metallurgical Transactions, 41A, 2010, pp. 3318-3325.
- W-J. Lee, W-J. Chia, J. Wang, Y. Chen, S. Vaynman, M.E. Fine, Y-W. Chung, "Role of Surfaces and Interfaces in Controlling Mechanical Properties of Metallic Alloys", Langmuir, 26, 2010, pp. 16254 -16260.

Presentations

- Klabjan, Diego (2010) Strategic Gang Scheduling in the Railway Industry. Presented at Seventh Triennial Symposium on Transportation Analysis, Tromso, Norway.
- Nie, Marco; Xing Wu (2010) Application of Discrete Fourier Transform in Finding Reliable Shortest Paths. Presented at the 90th Annual Meeting of the Transportation Research Board, Washington, DC.
- Vaynman M. Fine; Y-W. Chung; C. Hahin (2010) High-Performance Steels for Infrastructure Applications. Presented at 2010 FHWA Bridge Conference, Orlando, FL.

Stephen Eick
VisTracks, Inc.
"A Visual Analytics Platform for Analyzing Position and Movement Data"
February 17, 2010

Michael Hellman
WiTronix
"The Story of a Startup Technology Business Serving the Transportation Industry"
May 27, 2010

Thomas Parkinson
Woodland Venture Management
"Successful Venture Investing in Transportation Technologies"
September 22, 2010

Neal Campbell
Traffic Cast
"Wireless Technology Impacts on Traffic Gathering and Dissemination"
October 17, 2010

John Hillman
Teng & Associates
"Building Better Bridges with Hybrid-Composite Beams"
October 26, 2010

2010 CCITT Technology Commercialization Speaker Series

Events

Federal Railroad Administrator Joseph Szabo Addresses NUTC Sandhouse Gang

Joseph Szabo addresses NUTC Sandhouse Gang

In April, Joseph Szabo, administrator of the Federal Railroad Administration, accepted the Transportation Center's and CCITT's invitation to address the Hagestad Sandhouse Gang. The Sandhouse Gang is a railroad-oriented discussion group comprised of faculty, students and industry representatives that is facilitated by the Transportation Center. Szabo shared his vision of rail as "the future of transportation in America." He described several ongoing projects to address freight rail congestion and freight / passenger rail bottlenecks in the Chicago area, and the Administration's $8 billion in federal funding allotted to the development of high-speed rail. He also discussed FRA's plans to improve interstate rail networks, to make rail competitive with air and auto travel and to generate a culture of rail ridership in the United States.

Pedestrian-Rail Safety Symposium

In June NUTC and CCITT, in collaboration with the City of Lake Forest, Illinois, organized and hosted a symposium focused on pedestrian safety around railroads. A recent and significant increase in pedestrian-train accidents and fatalities in the greater Chicago area prompted officials and rail safety advocates at the symposium to address two major issues: pedestrian distraction due to portable electronic devices such as cell phones and iPods, and the implications stemming from the planned introduction of high speed trains to the rail system. The interdisciplinary symposium brought together university researchers with practitioners from railroads, police departments and local municipalities.

The symposium gave participants a forum to share experiences on what has and has not worked to improve safety and to brainstorm innovative ideas for future consideration. In addition to developing the symposium, NUTC faculty affiliate Dr. Ian Savage, NUTC BAC member Norman Carlson and Director Johnson facilitated the breakout discussions on Education & Communications solutions, Engineering & Design Solutions, and Enforcement Solutions. Civil and Environmental Engineering PhD student Emily Kushto assisted with the engineering breakout session. An executive summary of the symposium, including a set of recommendations to encourage change in pedestrian behavior and reduce the number of accidents, is available at: http://transportation.northwestern.edu/docs/2010/2010.06.22.Symposium_ExecutiveSummary.pdf.

City of Lake Forest, Ill. Mayor James Cowhey addresses pedestrian-rail safety issues

Beyond Transportation: The Economic Impact of Rail in Illinois

CCITT Director Johnson worked with the Office of the Governor of Illinois, Pat Quinn, and the Environmental Law Policy Center to develop *Beyond Transportation: The Economic Impact of Rail in Illinois,* an educational summit to foster a strategic vision for rail investment in Illinois. Approximately 150 people attended the event in January, including members of Congress, State legislators, heads of planning agencies and non-governmental advocacy organizations, business owners, transportation and economic development experts, university faculty and students. The summit highlighted the strong interrelation between economic development and investments in inter-city and intra-regional passenger and freight rail infrastructure in Illinois.

NUTC Director and CCITT Principal Investigator Dr. Hani Mahmassani moderated a panel discussion on "Connectivity in a Global Economy," as did NU Transportation Center affiliated faculty member Dr. Therese McGuire, Kellogg School of Management, who moderated a panel discussion on "Local Development/ Redevelopment/Tourism." Other panels covered "Manufacturing" and "Innovation and Sustainability." Johnson, NUTC post-doctoral fellow Dr. Pei-Wei Lin, and PhD students Laurence Audenaerd, Christopher Lindsey, and Charlotte (Whitehead) Frei provided support to the panel-discussion moderators, and contributed to NUTC's "Summary and Key Findings"

report for the Governor. The final report is available at: http://transportation.northwestern.edu/2010.01.15.BeyondTransportationSummit.html.

Industry Workshop: Cross Border Issues and Prospects for Freight

NUTC and CCITT hosted an industry workshop, Border Crossing Issues and Prospects for Freight, in partnership with the Consulate General of Canada in Chicago at the spring 2010 NUTC Business Advisory Committee meeting. The workshop featured a diverse group of speakers including Robert Harrison, Deputy Director for the Center of Transportation Research at the University of Texas, Austin; Kniffen Kelly, Director of Transportation Solutions, UPS; Mike Tamilia, Senior Manager, Customs and Transborder Operations, CN Railroad; and Dan Ujczo, Managing Director, Canada-United States Law Institute, Case Western Reserve University School of Law. CCITT Advisor Board member Professor Aaron Gellman moderated the session. The workshop achieved two primary goals: to identify potential bottlenecks in cross border operations; and, to stimulate near and long term research opportunities for NUTC and CCITT affiliated faculty members.

Industry Workshop – Greening of Transportation 2: Sustainability via Alternative Fuels

The October industry workshop, presented by the NUTC, CCITT and the Initiative for Sustainability and Energy at Northwestern (ISEN), featured speakers from influential US firms and government agencies sharing their best practices in deploying alternative fuels. The event was an excellent opportunity to learn status of and barriers to the adoption of several alternative fuels. Across several modes of transportation, the discussion

Panelists respond to audience questions at Greening of Transportation 2 workshop

considered the underlying economics, financial risks, and technical and infrastructure challenges standing in the way of wide scale implementation. After opening remarks from ISEN Director Bridget Calendo and Director Johnson, speakers at the event included: Mike Ellis, President, EA Logistics – "Use of Biofuels and hybrid trucks in logistics operations;" Donald G. Hillebrand, Director, Center for Transportation Research, Argonne National Lab – "Research on Alternative Fuels at Argonne;" Joshua C. Milberg, First Deputy Commissioner, Chicago, Department of Environment – "Chicago Area Alternative Fuel Strategy: Moving In the Future;" Keshav Sondhi, Chief Engineer, FedEx – "Electrification of Transportation;" and Bob Sturtz, Managing Director Strategic Sourcing-Fuel, United Airlines – "Aviation's Quest for Sustainable Biofuels." CCITT affiliated faculty member Diego Klabjan moderated the closing discussion and question and answer session.

CCITT Welcomes President of the Center for National Policy

In October CCITT and the Northwestern University Transportation Center welcomed Stephen Flynn, president of the Center for National Policy, who spoke on "Next Generation Infrastructure" to over 100 decision-makers from industry and academia. In his talk, Flynn argued that there is no more critical national enterprise than engaging America's private and public sectors to renew the nation's infrastructure. By embracing this imperative, said Flynn, the United States has an opportunity to strengthen its economy and national security while protecting the environment and improving the quality of life for Americans. To ignore this imperative places the nation on a path to decline and decay and further exposes Americans to unforeseen threats and cascading consequences.

Stephen Flynn speaks on "Next Generation Infrastructure"

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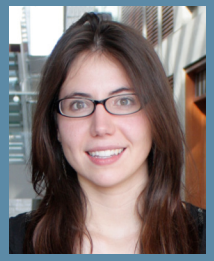

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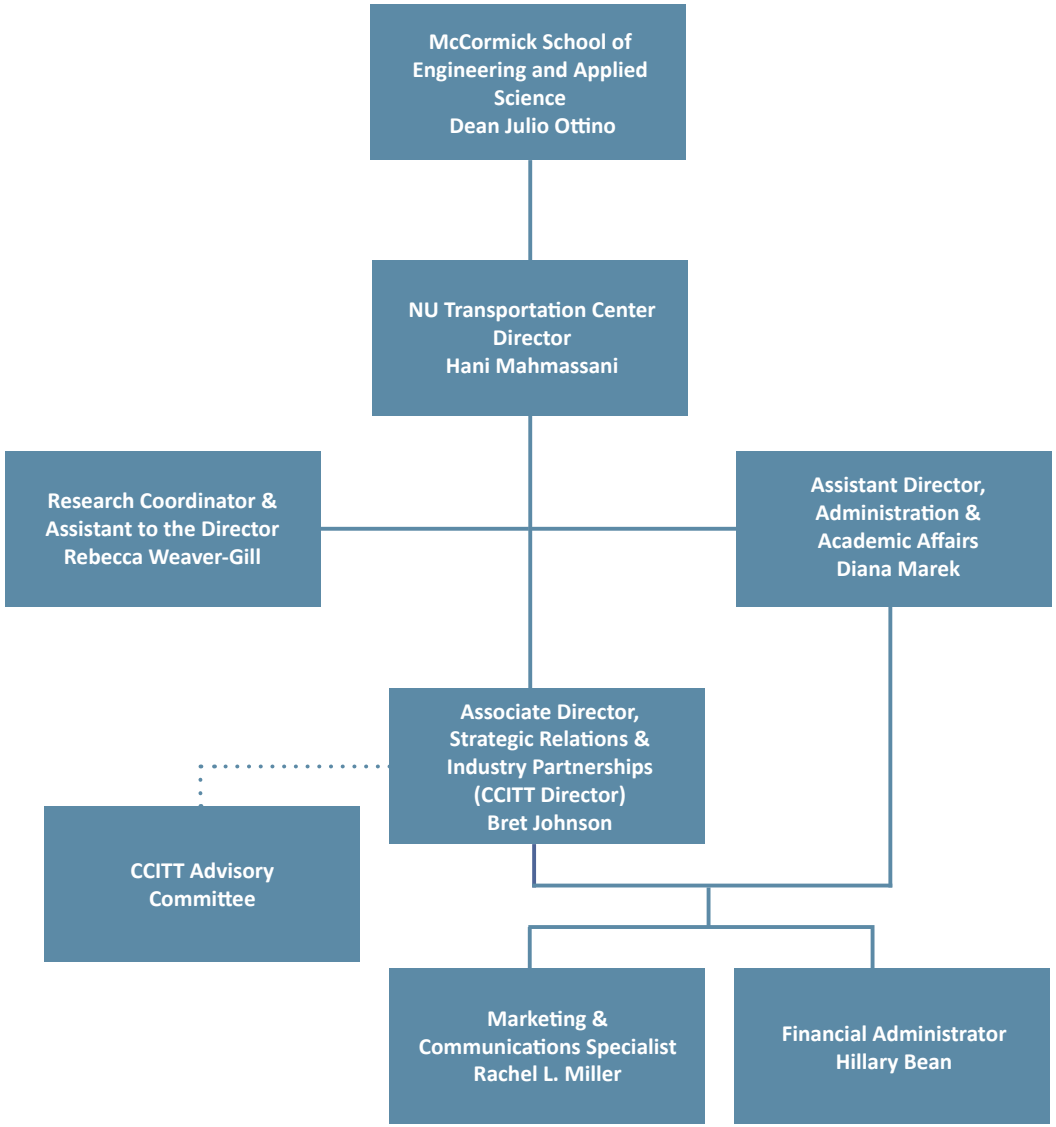

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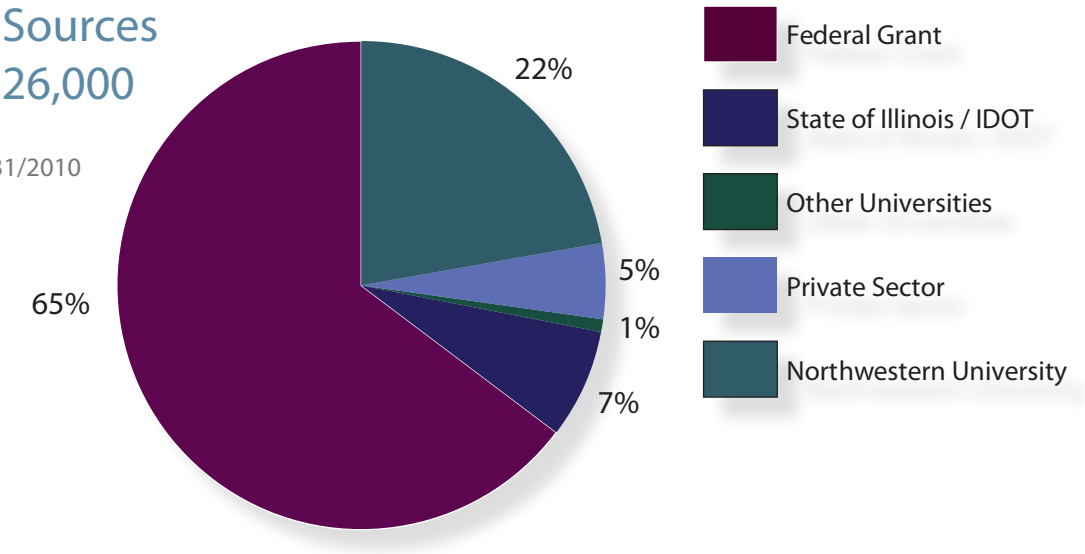

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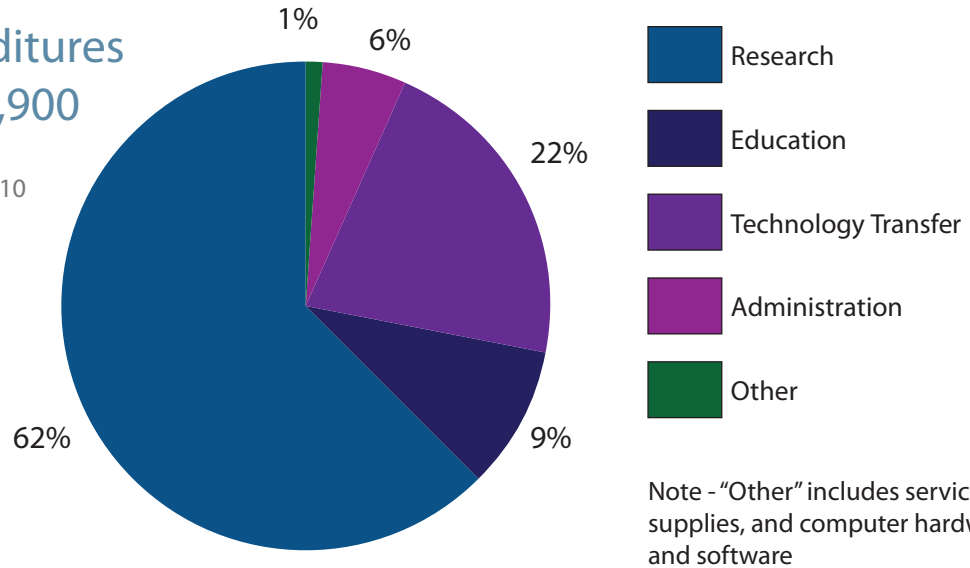

Note - "Other" includes services, supplies, and computer hardware and software

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