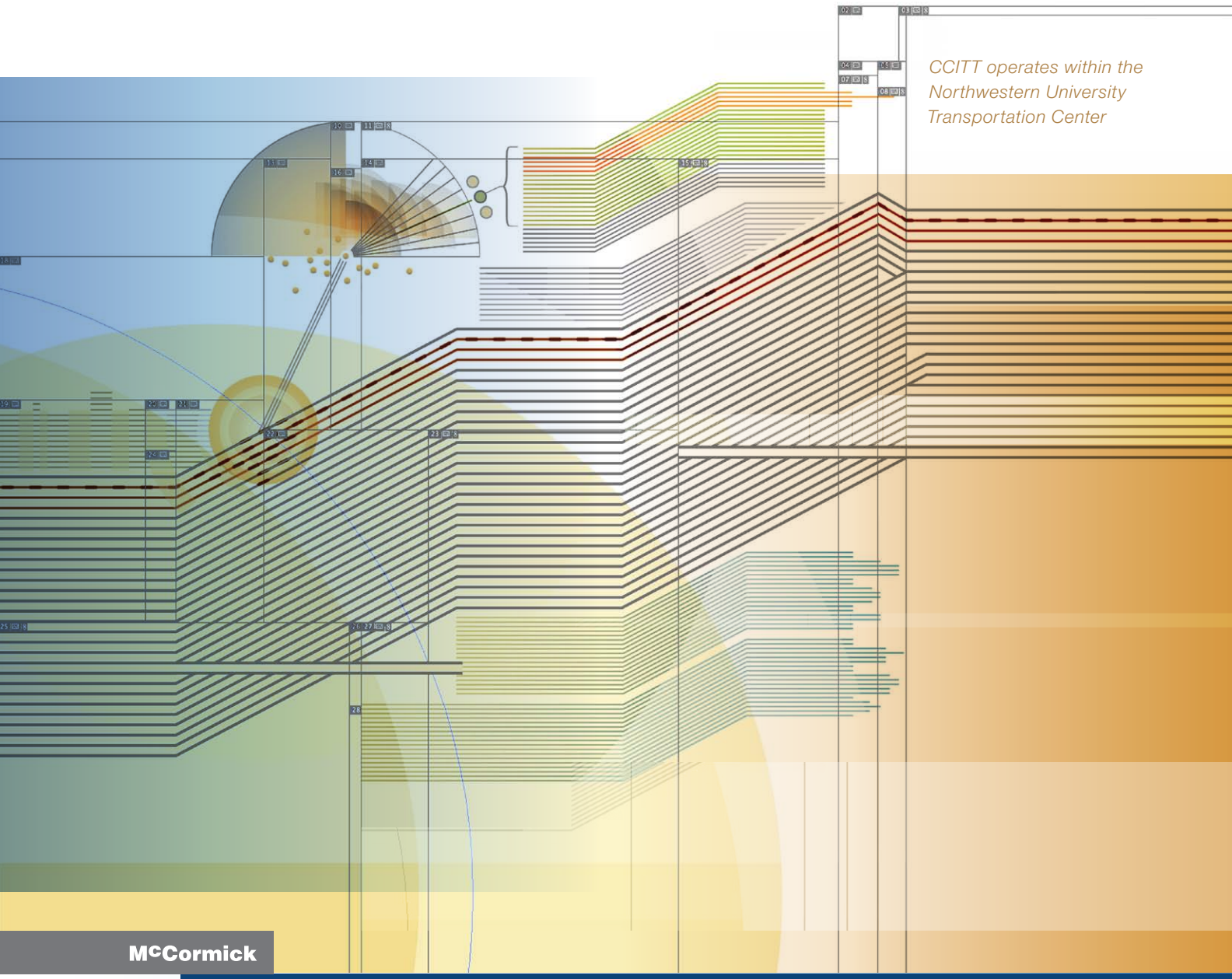
Center for the Commercialization of Innovative Transportation Technology

CCITT

Annual Report 2012

CCITT operates within the Northwestern University Transportation Center



McCormick

Northwestern Engineering

Northwestern University Transportation Center

CCITT 2012

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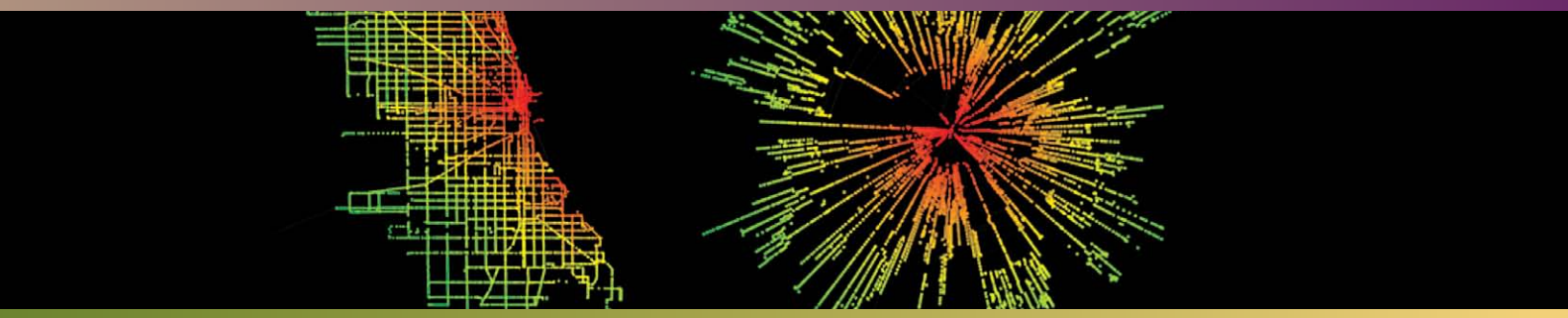

To quote Shoeless Joe Jackson in *The Field of Dreams,*

"If you build it, they will come." Unfortunately, we all know that the uptake and implementation of university innovations is not that simple. Inventing and potentially producing a novel process or product does not mean transportation users–public or private–will necessarily put it into use.

The commercialization of university-developed technology—not merely the knowledge transfer of academic research—is bolstered through strong partnerships with industry and public sector partners. And among these industry and public sector partners, there are those that have the vision, willingness, and capability to integrate novel research outputs into their operations and cultures. The key is to find these open-minded partners, and bring into focus the relevant problems they need solved.

At CCITT and the Northwestern University Transportation Center (NUTC) we continuously seek to cultivate connections with industry and public sector partners who are committed to innovation. Last year, we hosted Industry Workshops in the spring and fall that coincided with NUTC's Business Advisory Council (BAC) meetings: *The Electrification of Transportation* and *Data-Driven Business – Challenges and Best Practices in the Transportation Industry*. Both sessions highlighted organizations seeking to drive change in the public and private sector. They also fostered existing (and built new) relationships and conduits for two-way information flow with the University. Over the summer we supported Booz Allen Hamilton's *MegaCommunity Simulation to Re-Imagine Infrastructure*, a "war game" style exercise to envision innovative solutions to national transportation infrastructure problems. As the signature event of the year, Ford CEO Alan Mulally addressed our students, alumni, faculty, BAC, and friends at the 31st William A. Patterson Transportation Lecture.

In 2012, our researchers completed five projects involving strong collaboration with Philips, Ford Motor Company, Google, Norfolk Southern Railroad, and Union Tank Car Company. CCITT initiated two new projects related to transit; one with the Chicago Transit Authority (CTA) as a key partner. We also helped initiate two significant projects outside of the USDOT framework with the CTA and Echo Global Logistics.

Our commitment to training future professionals remains strong. Fourteen graduate students and three undergraduate students substantively contributed to applied research projects during the year. CCITT and NUTC also hosted 19 transportation research seminars for students, and supported four dissertation fellow research awards.

Looking ahead to 2013 and beyond, we anticipate building new partnerships, reinforcing others and discovering new challenges on which to collaborate in order to enhance the economic competitiveness and health of our transportation system.

Sincerely,

Bret Johnson
Director, CCITT

Investigators

Principal Investigator

Hani Mahmassani is CCITT's Principle Investigator. Dr. Mahmassani holds the William A. Patterson Distinguished Chair in Transportation and serves as Director of the Northwestern University Transportation Center. 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.

Dirk Brockmann
Associate Professor, Engineering Sciences and Applied Mathematics

Jennifer L. Chan
Assistant Professor, Emergency Medicine, Feinberg School of Medicine

Yip-Wah Chung
Professor, Materials Science and Engineering

J. Edward Colgate
Allen K. & Johnnie Cordell Breed Senior Professor in Design

Irina Dolinskaya
Junior William A. Patterson Professor of Transportation, Assistant Professor, Industrial Engineering and Management Sciences

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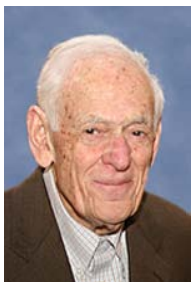
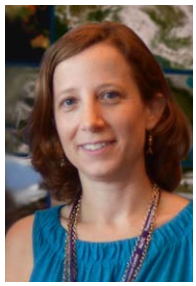
Civil and Environmental Engineering

Michael Peshkin
Professor,
Mechanical Engineering



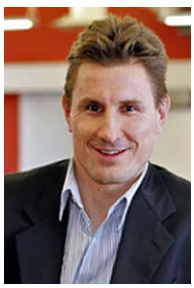
Morris Fine
Professor Emeritus
in Service,
Materials Science and Engineering



Karen Smilowitz
Associate Professor,
Industrial Engineering and Management Sciences

Aggelos Katsaggelos
Research Professor,
Electrical Engineering and Computer Science

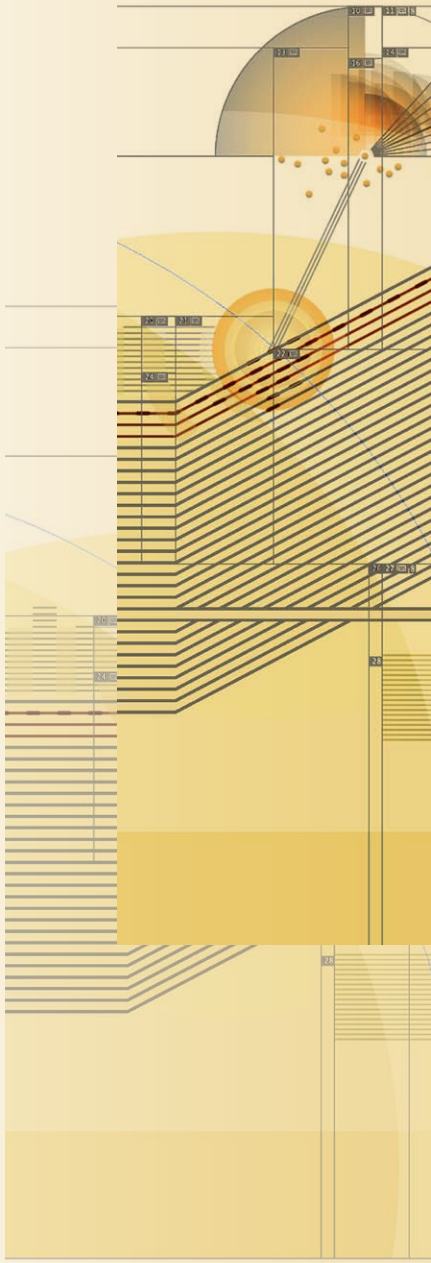
Sotirios Tsaftaris
Adjunct Professor,
Electrical Engineering and Computer Science



Diego Klabjan
Professor, Industrial Engineering and Management Sciences, Director, Master of Science in Analytics Program

Semyon Vaynman
Research Professor
Materials Science and Engineering

Yu (Marco) Nie
Associate Professor,
Civil and Environmental Engineering



Research

Completed Projects 2012

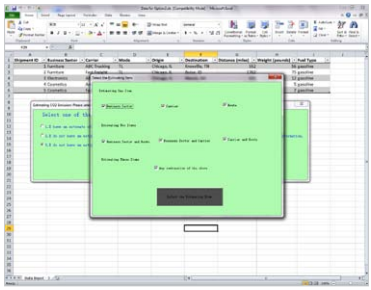
A FRAMEWORK FOR ESTIMATING EMISSIONS OF FREIGHT TRANSPORT OPERATIONS

Principal Investigator: Pablo L. Durango-Cohen, Associate Professor, Civil and Environmental Engineering

Challenge: Many companies strive to anticipate and meet compliance requirements for new environmental regulations. For corporations with extensive and high-volume distribution systems, emissions from transport operations constitutes a significant contributor to their environmental impact. In the ongoing effort to quantify and reduce shipping operations' carbon footprint (and other pollutants), readily available data is not being adequately harnessed to provide reliable and meaningful numbers. This data can and should support strategic shipping and supply-chain decisions that positively affect emissions totals. Such decisions may lead to redesigning warehousing and distribution networks or may include adjustments to equipment specification and resource allocation. Properly presented, these numbers will also facilitate consistent performance comparisons, year-to-year.

Approach: This project envisions an online platform to estimate truck emissions based on economic models of marginal emissions contributions from individual shipments across the supply chain. Durango-Cohen is developing an online tool that will represent an improvement over existing methods and will pave the way for transport operators to address and embrace emissions-reduction efforts. The approach—which may also be applied to other modes of freight transport—provides several practical advantages over currently available methods. In particular, it is:

- based on data that are commonly available from freight carriers
- uses models of marginal emissions contributions instead of aggregate
- can perform more detailed analysis, i.e. by route, carrier, business sector, etc.
- provides error bounds, describing the precision of emissions estimates
- provides quantitative support for strategic shipping and supply-chain decisions.



The "selecting analysis items" screen in the emissions estimating software tool.

Results: With research assistants Yikai Chen, Madison Fitzpatrick, and Yidan Luo, Durango-Cohen's current transport emissions project is extending a research partnership begun four years ago with the global company, Philips. This new software tool, a rigorous processing platform that takes advantage of imperfect but very useful data, employs Visual Basic; and uses the most accurate and cost-effective estimation methodologies available. It is rigorous and allows various data sets. The output gives a more detailed analysis, which can well support practical decision making.

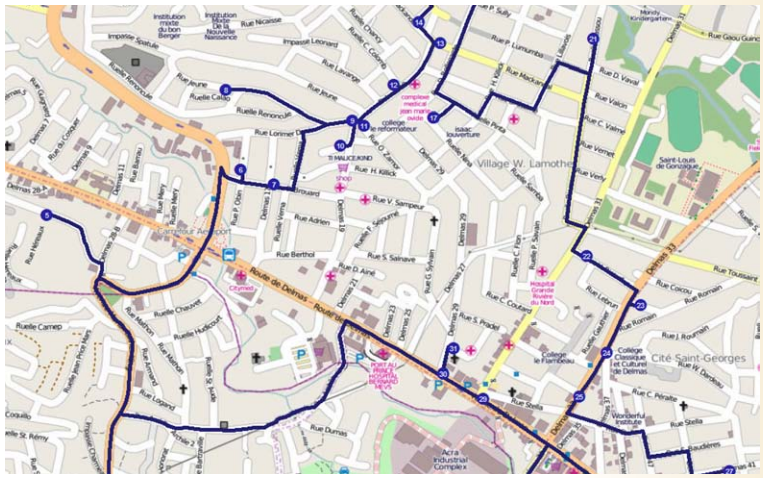
Further Research: Additional work is necessary to make the tool available online. In addition, the researchers see possible next steps in extending the results into the measurement of nitrous oxides and particulate matter. The researchers are creating a practical tool that sets up an attractive "least path of resistance" for businesses to follow toward more responsible operations. Durango-Cohen and his team expect the continuing research to lead to additional tools in support of evaluating and reducing transportation's environmental impact through low-cost, smart methods of inquiry and reporting that utilize existing data.

INTEGRATION OF REAL-TIME MAPPING TECHNOLOGY IN DISASTER RELIEF DISTRIBUTION

Principal Investigator: Irina Dolinskaya, Assistant Professor, Industrial Engineering and Management Sciences
Co-Principal Investigator: Karen Smilowitz, Associate Professor, Industrial Engineering and Management Sciences
Co-Principal Investigator: Jennifer Chan, Assistant Professor, Emergency Medicine

Challenge: Vehicle routing for disaster relief distribution involves many factors that distinguish this problem from those in commercial settings, given the time sensitive and resource constrained nature of relief activities and the uncertainty caused by rapidly changing conditions.

Approach: This project focused on dynamic routing models for the distribution of relief supplies and services in humanitarian settings. There is the potential to improve these models, and thus improve the effectiveness of humanitarian relief, by using new applications of mapping technologies and real-time information to mitigate the effects of dynamic changes during humanitarian crises and disasters and the significant uncertainty that exists in these settings. The work, which was also supported through the Google Research Awards Program, evaluated the improvements from these technologies for relief organizations in the field and developed a set of test cases for the research community to better design and test their routing models and solution approaches.



An example of a test case disaster relief delivery route, Port Au Prince, Haiti. (map source: OpenStreetMap)

Results: The researchers demonstrated that identified sources of uncertainty in relief routing can be mitigated through available real-time information about the affected region, taking urban search and rescue (USAR) operations as a motivating case and a starting point for modeling.

Accomplishments:
(1) developed a testbed of routing problems designed specifically for humanitarian relief routing, to be used by the research community to evaluate new modeling and solution approaches;
(2) quantified the benefits of technology for agencies engaged in humanitarian relief through improved operations research models that incorporate this technology; and
(3) launched an online server housing the developed testbeds with the capabilities for other academicians and practitioners to use—as well as contribute to the database.

The success of creating field-appropriate dynamic stochastic routing models for humanitarian logistics and transport can be improved by incorporating new information streams (e.g., text messages, Twitter, online mapping)—often created by newer technologies and social media—providing a real-time picture of disaster and humanitarian environments. The processes required to filter, structure, and make sense of this large body of information are changing to match these new streams.

Recent humanitarian crises have demonstrated that ready-made, deployable systems for structuring, managing, and sharing heterogeneous data streams are essential to disaster preparedness.

The Northwestern University Humanitarian and Non-Profit Logistics Initiative Web site serves as a central point for outreach, dissemination of research results, and sharing data sets and other research products. The site currently houses information about the pilot study discussed above, as well as generated network data sets.

Further Research: In order to be usable, the testing models must be integrated into data work flows before a crisis strikes. Further efforts will identify the types of data that are most important in improving model performance and that can be realistically integrated into relief operations. The researchers will also provide recommendations, workflows, and research products targeted to practitioners.

In Winter 2014, PI Smilowitz will initiate a new course in humanitarian logistics in the department of Industrial Engineering and Management Sciences that will incorporate work from this project and establish case studies to be used in the course and made available to other universities.

This research effort has included a number of undergraduate and graduate students: current Northwestern PhD students Luis de la Torre and Zhenyu (Edwin) Shi. Undergraduate students engaged in the pilot study are Alex Huang, Alex Ma, Sara Schmidt, Nancy Xu, and Brandon Zhang.

Research

Completed Projects 2012

iTRAC WIRELESS: INTELLIGENT COMPRESSION OF TRANSPORTATION VIDEO FOR WIRELESS NETWORKS

Principal Investigator: Aggelos Katsaggelos, Research Professor, Electrical Engineering and Computer Science
Co-Principal Investigator: Sotirios Tsaftaris, Adjunct Professor, Electrical Engineering and Computer Science

Challenge: Transmitting high-quality real-time video for transportation (moving vehicle) monitoring and surveillance has thus far required communication channels with bandwidth on the order of mega-bits per second per channel. A more flexible and cost effective solution, video compression technologies, can be applied at the remote sensors such that the compressed bitrate can be carried via modern wireless communication channels. Although the video compression technology H.264 has been shown to significantly reduce the bandwidth requirement, most systems currently in use are not optimized for transportation videos and employ generic video encoding procedures—approaches that are not application aware, may not be standard compliant, and do not take into account the lossy nature of wireless channels. A solution tailored to the efficient transmission of transportation video is required.

Approach: The researchers' previous work (*iTRAC: Intelligent Compression of Traffic Video,* funded by CCITT) demonstrated that it is possible to further reduce bitrate by focusing resources in an application aware context. While remaining standard compliant it was shown that computationally simple, temporal- and frequency-filtering operations could maintain high tracking accuracy, with reduced bitrate.

The current project pursued the development and testing of a transportation video wireless transmission system that integrates components at both the transmitter and receiver sides to increase performance (tracking accuracy) while minimizing bitrate, given channel losses.
The main focus of the work was in optimizing:
- bit allocation within video frames
- error protection schemes for video packets; and
- concealment strategies in case of losses, while
- maximizing tracking accuracy at the receiver's end, and
- minimizing computational load at the encoder's side.

Results: The researchers fully developed a video coding and transmission system specifically tailored to automated centralized vehicle surveillance and monitoring. Video signal components were analyzed and information less important to tracking was removed effectively by pre-processing steps. To mitigate the negative effects of channel losses to automated tracking of vehicles, we combined forward error correction at the transmitter and an error concealment module at the receiver.

The effectiveness of the new system was tested using real-life video sequences. The video coding and wireless transmission system yields significant performance improvement over the state-of-the-art H.264-based implementations and is shown to allow for over 80% reduction in bitrate for comparable tracking accuracies.

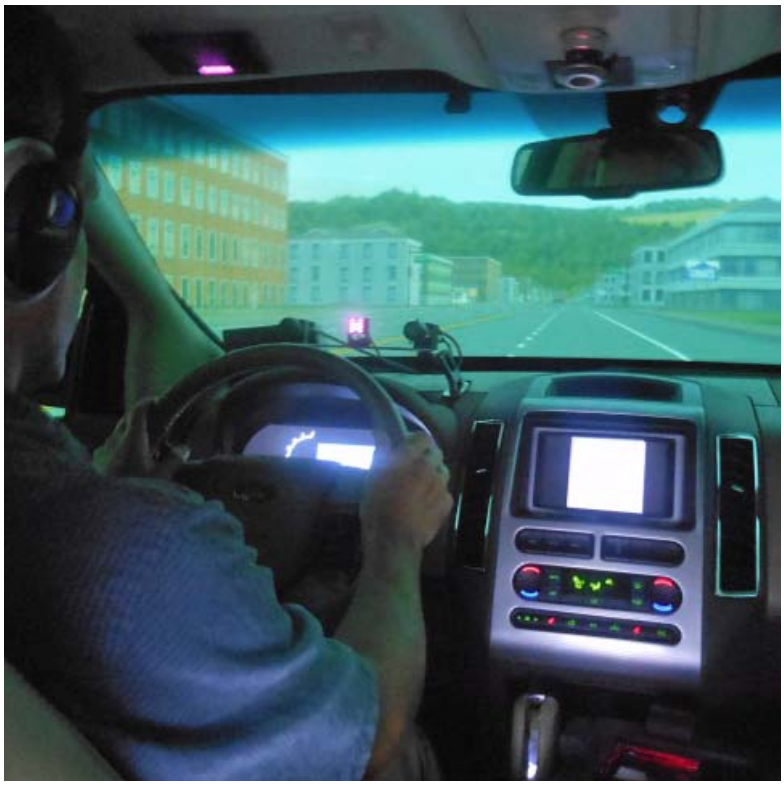
HAPTIC INTERFACE FOR VEHICULAR TOUCH SCREENS

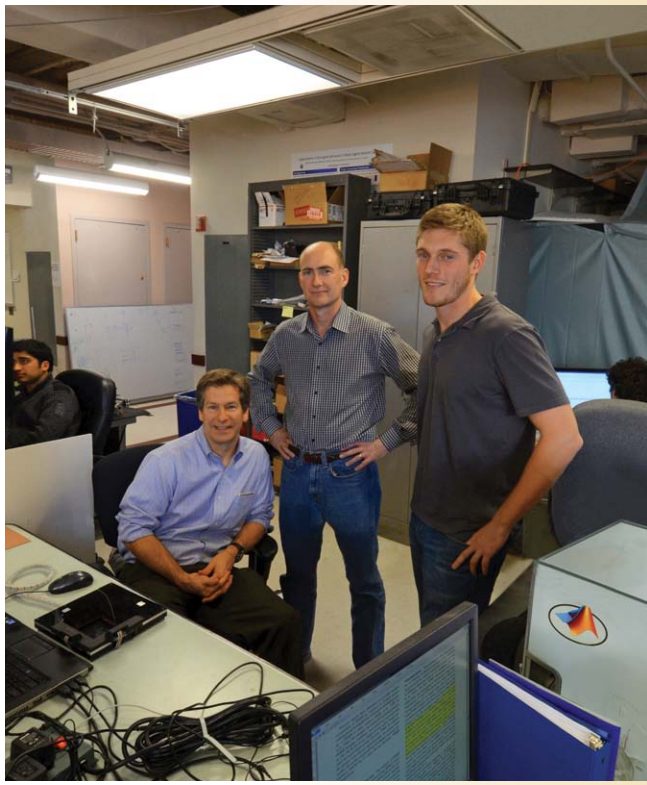
Principal Investigator: James Edward Colgate, Professor, Mechanical Engineering
Co-Principal Investigator: Michael Peshkin, Professor, Mechanical Engineering

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

Approach: Professors J. Edward Colgate and Michael Peshkin have developed a number of novel technologies for providing haptic feedback on a touch screen. What interests them is altering the physics of the glass surface of a touch screen in order to create the perception by a user that his or her fingertips have engaged and can move a control element—a sliding bar or turnable knob. For instance, one version of the haptic touch screen—by modulating and localizing minute vibrations of the glass surface—creates the impression that a specific area of the smooth screen is "sticky" or produces more friction on the fingertip. The screen control technology, sensing where the finger is making contact with the glass, can then respond, track, and move the "sticky" zone to correspond to the fingertip movement. It is as if a user had touched a 3-dimensional sliding switch and moved it to adjust some device in the car—a music volume control or air conditioner fan speed, for instance.

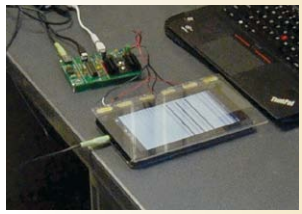
Below: CCITT director Bret Johnson (sitting) with professor Ed Colgate (center), and graduate student Joe Mullenbach in McCormick Engineering Haptics Lab.





Above left: Inside Ford's VRTTEX driving simulator, conducting haptic touch screen experiments.

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



Haptic interface prototype that incorporates off-the-shelf e-book reader hardware.

Results: Colgate and Peshkin have partnered with Ford Motor Company in this recent CCITT funded study that takes advantage of Ford's advanced driving simulator, the VIRTTEX, in Dearborn, Michigan. Working with Colgate and Peshkin, graduate student Joe Mullenbach built a device known as a TPaD and integrated it into a Ford Edge vehicle mock-up within the driving simulator. Mullenbach then ran experiments with 25 volunteer drivers, testing those drivers on two types of tasks: a simple button acquisition, and a more complex level adjustment. Drivers consistently performed better with haptics, spending less time looking away from the road and completing the tasks just as easily as with vision alone. Moreover, drivers had an overall preference for the combination of visual and haptic cues.

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

Research

Completed Projects 2012

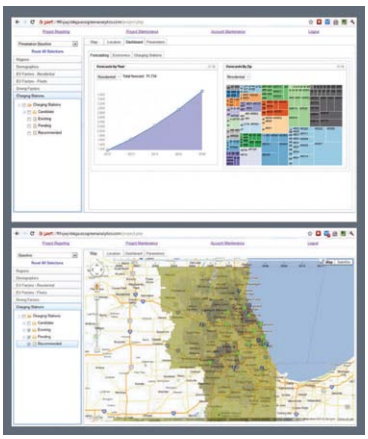
AN AGENT-BASED INFORMATION SYSTEM FOR ELECTRIC VEHICLE CHARGING INFRASTRUCTURE DEPLOYMENT

Principal Investigator: Diego Klabjan, Professor, Industrial Engineering and Management Sciences

Challenge: The current scarcity of public charging infrastructure is one of the major barriers to mass household adoption of plug-in electric vehicles (PEVs). Although most PEV drivers can recharge their vehicles at home, the limited driving range of the vehicles restricts their usefulness for long-distance travel. There is the need for a system that enables a more strategic set of considerations to be utilized when determining deployment of new charging infrastructure.

Approach: In this research project, Professor Diego Klabjan and PhD student Timothy Sweda developed an agent-based (owner/driver) information system named EVIDENT to identify patterns in residential PEV ownership and driving activities.

Charging station decision-makers—city governments, utilities, or private entities such as mall and fast-food restaurant operators—need relevant information to help them decide on the "yes/no" and "where" and "how" for such infrastructure. This information includes (1) EV demand consideration, (2) the current locations of stations, (3) the implied service time on car owners, and (4) power grid implications. All of these aspects can 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 place and build the infrastructure.



The electric vehicle charging model system, EVIDENT, has been implemented using data from the Chicagoland area and tested with multiple charging station deployment scenarios. EVIDENT has already been used in select deployments around the country.

Results: Predicting decisions and actions from the driver/owner point of view, this system successfully captures the recharging behaviors of PEV drivers when both public and home charging options are available as well as EV adoption when different vehicle types are available in the market. It has been demonstrated that the availability of public charging infrastructure can indeed affect consumers' vehicle purchasing decisions and should be considered when modeling infrastructure deployment for alternative fuels.

Further Research: Investigation into the causes of these adoption patterns will permit more specific recommendations to investors on how best to deploy new charging infrastructure. As a next step, spatial analysis of PEV adoption patterns utilizing demographic and geographic data could be performed to gain insights into the evolution of the residential PEV market. In addition to how many, infrastructure developers and charging station providers will want to know where new charging stations should be deployed. The deployment strategies will also depend on the infrastructure developers. For example, a developer seeking to maximize station utilization will tend to place more stations near densely populated or frequently visited areas, whereas another developer interested in expanding public charging access may prefer to target regions that are less busy and not adequately served by the existing charging infrastructure. Understanding how PEV adoption occurs with respect to geography as well as to demographics will prove critical to determining the most effective charging infrastructure deployment strategies.

EVALUATION AND APPLICATION OF SUPER-TOUGH STEEL FOR USE IN TANK CARS TRANSPORTING CRYOGENIC LIQUIDS

Principal Investigator: Semyon Vaynman, Research Professor, Materials Science and Engineering

Co-Principal Investigator: Morris Fine, Professor Emeritus in Service, Materials Science and Engineering

Co-Principal Investigator: Yip-Wah Chung, Professor, Materials Science and Engineering

Challenge: Fracture of rail tank cars carrying cryogenic liquids such as chlorine results in a number of industrial accidents each year. One incident in 2005 in Graniteville, South Carolina, led to nine deaths and at least 250 injuries. A super-tough steel (NUCu70ST) had been developed and investigated at Northwestern University through prior funding from the Infrastructure Technology
Institute and CCITT.

The Next-Generation Rail Tank Car Project, an innovative joint initiative of industry and government agencies, has focussed on the design and implementation of a next-generation rail tank car with enhanced ability to safely transport hazardous chemicals. In preliminary mechanical and fracture studies performed at Northwestern University and at Union Tank Car Company (UTLX) and its contractors, NUCu70ST was shown to significantly outperform all other steels tested, including steels currently used in tank-cars as well as other high-performance steels on the market.

With AARSC approval, Union Tank Car Company hopes to build one or more experimental tank cars with the research team's super-tough NUCu70ST steels.

Approach: With UTLX as a partner, the research team took steps to further develop and make ready for market the 70-ksi-yield strength NUCu70ST for use in tank cars transporting cryogenic liquids. The principal Investigators facilitated UTLX's mechanical, fracture testing, welding programs and interpretation of the results. UTLX obtained two 300-lb experimental plates of NUCU70ST—each produced to our specifications and heated to a different temperature by Sophisticated Alloys, Inc.

Results: The mechanical properties of both NUCU70ST steels met the tank car specifications while fracture toughness of the steels at low temperature significantly exceeded these specifications.

Since welding is very important during tank-car production, the welding of our steels was studied under laboratory and shop conditions with welding consumables currently used for tank car construction. Two welding procedures were used: laser welding and submerged arc welding. The steels in as-welded condition has excellent fracture toughness. However, the stress relief heat treatment produces a reduction in fracture toughness.

To investigate the reason for reduced fracture toughness of the steel weld after stress relief, the welds before and after stress relief were examined at Northwestern University and ArcelorMittal Steel Company's Global R&D Center using optical and high resolution scanning electron microscopy, microhardness measurements and X-Ray diffraction. While there was a small (approximately 10%) hardness increase in welds after stress relief, there was no difference in the microstructure and in crystal structure of as-produced and stress-relieved welds. Thus, while the researchers suspect that copper precipitates in the weld become more coarse during stress relief and therefore affect the fracture toughness of the weld, these precipitates are too small to be observed by the high-resolution scanning electron microscope.

Further Research: Higher resolution transmission electron microscopy most likely is needed to detect the difference in size, morphology and location of copper precipitates in the welds before and after stress relief to explain the welds embrittlement. ArcelorMittal Global R&D, based on UTLX's request, is planning to perform such a study. UTLX is planning stress relief studies at lower than 1200ºF temperature to find out if the embrittlement is also observed at lower stress-relief temperatures.

Even though stress relief is generally not needed for low-carbon steel, the tank-car code requires the stress relief of welded steels. UTLX is working with American Association of Railroads Standard Committee (AARSC) on changes in the tank car code for some tank car designs in order to allow the use of welding without stress relief. Elimination of the stress relief procedure, if warranted, would result in significant new efficiencies in tank car manufacturing while gaining the benefits of tougher steel.

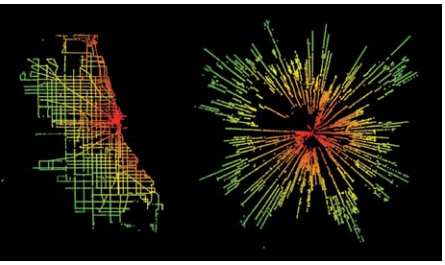
Research

New Projects 2012

SHORTEST PATH TOMOGRAPHY: A TOOL FOR OPTIMIZING PUBLIC TRANSIT NETWORKS, PHASE 1

Principal Investigator: Dirk Brockmann, Associate Professor, Engineering Sciences and Applied Mathematics

Challenge: As cities strive to create more sustainable, livable, and energy-efficient environments, urban transit systems must improve their performance and increase their practical capacity to serve additional riders. There is the need to develop effective ways of seeing heretofore hidden structures and relationships in transportation network and network behaviors—allowing agencies to better manage resources and optimize services



Above left, a conventional geographic map of the Chicago Transit bus network. At right is a SPaTo representation showing the effective distances from the central downtown area.

Approach: Dirk Brockmann and the project research team, including graduate students Olivia Woolley-Meza and Isaac Velando, are applying mathematical algorithms recently developed in Northwestern's engineering/math lab that are based on an emerging area of computer science known as shortest path tomography (SPaTo)—the visualization and analysis of a complex network's internal characteristics by means of analyzing external end point or node data. When completed, this tool will enable the extraction of essential and salient features from available large scale network data.

The project is extending SPaTo technology to the urban transit system. The team is creating a user interface that bridges the gap between local and global network perspectives by providing a novel view of an entire transit network from a manager's or controller's specified perspective. Its capabilities will detect and visualize hidden structures in complex, multi-scale and time-dependent transit systems. Implicit transit-related geographic subdivisions and de facto boundaries—all affecting the flow of riders—will become visible and can then be addressed through modifying mode-specific or time-dependent parts of the complex network. The interface will make it possible to model changes within the system. The consequences of adding/removing service to specific locations or adjusting routes can be simulated and tested interactively without resetting or restarting the simulation.

Results: A prototype version of the software is up and running in Brockmann's lab and has been applied to multi-scale, complex networks in various hypothetical settings. Work is underway to bring the interface and coding to pilot study readiness—a sophisticated, scalable and platform-independent computational software application tailored to urban transportation and transit systems. The pilot study and application benchmark is being developed in collaboration with the Chicago Transportation Authority (CTA) in one of the United States' largest metro areas.

FLEXIBLE TRANSIT OPERATIONS FOR DYNAMIC MOBILITY

Principal Investigator: Hani Mahmassani, William A. Patterson Distinguished Chair of Transportation, Director, NUTC

Challenge: Although increasing transit mode share is known to alleviate congestion, Americans still prefer driving for its relative reliability, comfort and convenience. Despite awareness of sustainability and climate change, transit mode share has seen only slight increases each year as it has adapted poorly to changes in human behavior and activity patterns.

Approach: This project has the purpose of measuring the role of customer satisfaction and schedule flexibility in mode choice and then explicitly modeling behavior in the system design via more open communication between riders and operators. The proposed solution moves toward managing passenger mobility rather than merely a single agency's role in that mobility by delineating potential demand- and time-varying service concepts.

RELIABLE ROUTING IN TRANSIT NETWORKS

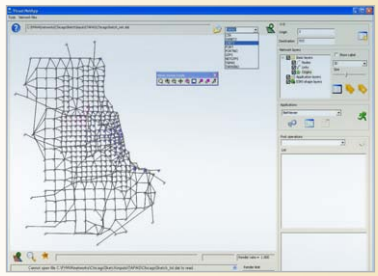
Ongoing Project 2012

Principal Investigator: Yu (Marco) Nie, Associate Professor, Civil and Environmental Engineering

Challenge: Riders can have a less than ideal experience using public transit in metropolitan and rural areas due to a wide variance in transit headways. Principal investigator Yu (Marco) Nie and his students are developing routing algorithms to incorporate reliability attributes of transit routes in planning tools and in rider information systems for trip planning purposes. The mathematical principles and methodologies that drive the tools will allow transit agencies to better evaluate the reliability of their bus systems and improve service to their ridership.

Travel reliability is a critical dimension in the user experience of public transportation services. Prior to this project, Nie, his research assistants, and a collaborator at the Chicago Transit Authority (CTA) surveyed commuters from the Chicago metropolitan area and found that travel reliability is the second most important factor that affects commuters' route choices, next only to travel times. Transit systems are affected by uncertainties of various sorts, ranging from extreme weather conditions and serious traffic accidents to unforeseeable mechanical failures and human errors, in addition to variability in demand patterns. While these uncertainties could adversely disrupt transit services, their overall impacts are rarely documented and understood in existing systems. As a result, neither transit operators nor transit users are able to make proactive decisions to ensure reliable travel. Ignoring the impacts of uncertainties often results in misallocation of limited resources in the transit system.

From the user point of view, the lack of reliability either encourages overly conservative risk-averse behavior or leads to uncomfortable, and sometimes disastrous, disruptions. Not surprisingly, almost half of the commuters who responded to the commuter survey described their transit service as "unreliable."



Example of the VNET platform interface with the Chicago area shown.

Approach: The researchers are developing enhanced routing algorithms that will help transit agencies measure and analyze the reliability performance of transit services and help travelers hedge against uncertainties in transit networks. Using a case study approach, the researchers will test these reliability-sensitive transit routing algorithms on the CTA bus routes using three months of real-time transit feed service data. The main objective of the test is to verify the relative benefits (e.g. time savings for achieving the same level of reliability) of reliable-routing and evaluate the computational efficiency of the algorithms.

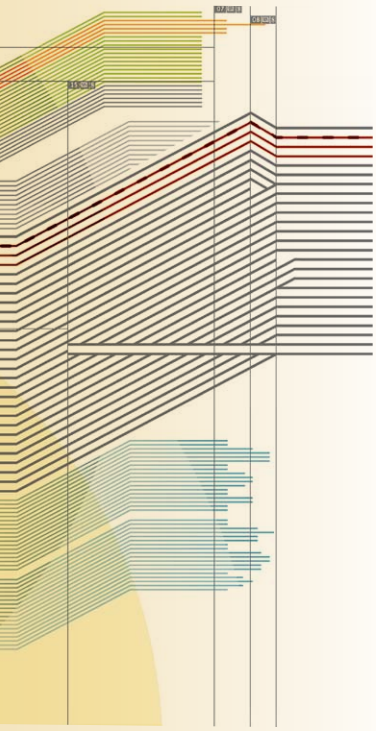
Results: The research has resulted in the development of two software applications that allow users to process General Transit Feed Specification (GTFS) data sets and visualize and analyze the CTA's real-time transit feeds on the VNET software tool. VNET, short for Visual Network, is a graphical user interface planning tool developed by Nie's lab to build and evaluate transportation networks.

Using these new software applications on VNET, an examination of the actual bus headway distribution incorporating the CTA's operational data has shown that these distributions are very different from the exponential distributions commonly assumed in traditional transit routing models. A a result of this finding, the researchers approximated the headway distribution using Gamma distribution and developed both analytical formulae and numerical procedures to estimate route choice probability. Accordingly, a hyperpath-based routing algorithm that aims at minimizing expected travel time has been implemented and tested. Preliminary results suggest that Gamma distribution generates significantly different route choice probability compared to traditional methods.

Further Research: In partnership with the CTA and Google, Inc. (using its bus tracking applications) Professor Nie seeks to build a prototype reliability-based transit route planning tool and test it on an operational transit network.

Technology Transfer

Highlights



Research conducted by Diego Klabjan has resulted in a Web-based information system, EVIDENT, that uses state-of-the-art data analytics for site selection of public charging stations. The system includes a Google maps-based display of demographics, traffic, social interactions, and other attributes; a spatial prediction of electric vehicles owners; estimates of their driving patterns; and an optimization-based selection of locations for charging stations. The EVIDENT system has already been used in select deployments around the country.

Investigators Irina Dolinskaya, Karen Smilowitz, and Jennifer Chan—through their project on real-time mapping technology in disaster relief:

- Developed a testbed of routing problems designed specifically for humanitarian relief routing, to be used by the research community to evaluate new modeling and solution approaches;
- Quantified the benefits of technology for agencies engaged in humanitarian relief through improved operations research models that incorporate these new approaches
- Launched an online server dedicated to Humanitarian and Non-Profit Logistics at Northwestern University that houses the developed testbeds with the capabilities for other academicians and practitioners to use—as well as contribute to the database.

Investigator Yu (Marco) Nie's research lab has developed VNET (for Virtual Network), a simple, flexible and extensible graphic user interface to support a wide variety of network-related applications. In his ongoing Flexible Transit Operations for Dynamic Mobility project, Nie and his students have developed two VNET applications that allow users to:

- process General Transit Feed Specification (GTFS) data sets, and
- visualize and analyze the Chicago Transit Authority's real time transit feed data.

Presentations

INFORMS Annual Meeting, October 2012, Phoenix, Arizona

Timothy Sweda, CCITT 2010 Student of the Year and Ph.D. candidate in Industrial Engineering and Management Science, chaired the session: *Decision Making for Electric Vehicles*; and at the same session presented *Optimal Routing and Recharging Algorithms for Electric Vehicles* (Sweda, Diego Klaban, Irina Dolinskaya). Sweda is advised by Diego Klabjan, Professor, Industrial Engineering and Management Science.

Luis E. de la Torre, CCITT 2011 Student of the Year, Ph.D. Candidate, Electrical Engineering and Computer Science, presented *Using Real-Time and Crowdsourced Data to Improve Disaster Relief Operations* (Torre, Jennifer Chan, Irina Dolinskaya, Karen Smilowitz) at the *Issues in Humanitarian and Sustainable Supply Chains* session. He is advised by Irina Dolinskaya, Assistant Professor, Industrial Engineering and Management Science.

International Electric Vehicle Conference (IEVC), IEEE International, March 2012

Timothy Sweda presented two papers: *Finding Minimum-cost Paths for Electric Vehicles,* and *Simultaneous Vehicle Routing and Charging Station Siting for Commercial Electric Vehicles.*

European Signal Processing Conference (EUSIPCO), August 2012, Bucharest, Romania

Leonidas Spinoulas, Ph.D. Candidate, Electrical Engineering and Computer Science, presented the paper *Tracking Optimal Error Control Schemes for H.264 Compressed Video for Vehicle Surveillance*, on behalf of authors Zhaofu Chen, Eren Soyak, Sotirios A. Tsaftaris, and Aggelos K. Katsaggelos. Spinoulas is advised by Aggelos K. Katsaggelos, AT&T Professor of Electrical Engineering and Computer Science.

Journal Publications

Journal of Socio-Economic Planning Sciences, Special Issue: Disaster Planning and Logistics: Part 1; Volume 46, Issue 1

Luis E. de la Torre, Irina Dolinskaya, Karen Smilowitz, authors. The paper *Disaster Relief Routing: Integrating Research and Practice*, provides an analysis of the use of operations research models from the perspective of both practitioners and academics —through interviews with aid organizations, reviews of their publications, and a literature review of operations research models in transportation of relief goods conducted as a part of a CCITT award.

Conference

CCITT Co-Hosts the 2nd International Conference on Evacuation Modeling and Management (ICEM 2012)

The Second International Conference on Evacuation Modeling and Management (ICEM) brought 70-plus participants from 10 countries representing over 40 institutions to the Evanston, Illinois, campus of Northwestern University on August 12-15, 2012. ICEM 2012 was co-sponsored by the Northwestern University Transportation Center (NUTC) and its U.S. DOT funded institute—the Center for the Commercialization of Innovative Transportation Technology (CCITT). ICEM's purpose: To stimulate, formalize, and share new research projects that advance scientific insights leading to improved emergency response evacuation planning and implementation.

Event Parameters

NUTC Director/CCITT Principal Investigator (and Chair of the Conference) Hani Mahmassani provided an overview of the event's parameters to the attendees:

- focused on the methodological cross-disciplinary challenges of developing and applying models of evacuation processes and decision-oriented analytics
- includes all aspects of modeling and management of evacuations: flow physics, behavior, specific hazard requirements, strategy optimization
- multi-hazard perspective: seeking commonality across causes, yet recognizing unique characteristics and time frames
- cross-disciplinary: hazard domain (fire, flood, etc.), traffic flow, architecture, transportation systems, modeling, simulation, visualization
- vehicular traffic and pedestrian crowd flow
- advanced tool development and applications
- small yet international gathering to encourage discussions and exchanges.

Linking Theory, Data, and On-the-Ground Response

The ICEM Conferences are narrowing the gap between researchers' emerging tools for hypothetical event traffic simulation (modeling and analysis) and administrators' actual planning and emergency management.

Presentations approached evacuation modeling—predicting the behaviors of systems and individuals—from several perspectives, examining and modeling how people and systems behave in emergency environments ranging from skyscraper fires to hurricane landfalls to flooding and earthquakes. Many researchers explained new methods for real-world event data collection and visualization, while others provided insights and tools originating in game theory, psychology, traffic physics, simulation modeling, and optimization strategies.

Keynote Presentations

Professor Karen Smilowitz, NUTC faculty affiliate and CCITT researcher, delivered a compelling introduction to the field of humanitarian logistics.

Serge Hoogendoorn, Professor of Civil Engineering and Geosciences at Delft University of Technology (DUT), described innovative methods of traffic data collection and outlined behavioral insights and models that have been achieved in the University's prototype lab.

TRB Annual Meeting

The Transportation Research Board (TRB) 91st Annual Meeting

CCITT investigators shared research findings at the Transportation Research Board (TRB) Annual Meeting, Washington, D.C., 1/2012.

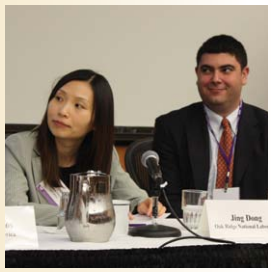
Faculty affiliates, researchers, and students participated in panel discussions, conducted workshops, presented papers, and gave poster presentations on a variety of transportation-related research. Topics included network modeling, driver behavior, data and information innovations for researchers, airline economics, planning methods and models, infrastructure systems and operations, and traffic management. CCITT Principal Investigator Hani Mahmassani and investigator Yu Nie—as well as students Charlotte Frei and Omer Verbas—presented.

Technology Transfer

Workshops

The Electrification of Transportation: A Look at the Road Ahead

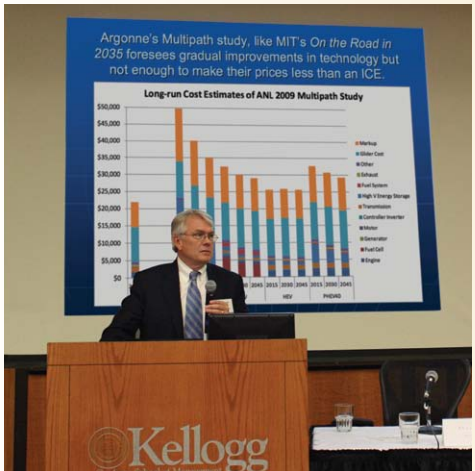
With ever growing concerns regarding the need for diversification of our country's energy resources and the recent emergence of consumer and fleet electrical vehicles (EV), this NUTC workshop explored opportunities and challenges facing the implementation of electric vehicles, the current state of the EV market, factors impacting the user experience and user adoption, and transport electrification in the context of other energy choices.



The April 2012 workshop consisted of two panel discussions, the first: Infrastructure, Policy and Regulatory Hurdles, and the second: EV User Demand, Impacts and Constraints. From the educational, public, and private sectors, panelists provided insights on:

- developing public codes and standards for electric vehicles (EVs)
- justification for funding for charging stations
- transportation agency support
- electric vehicles and the smart grid
- forecasts for, and barriers to, EV adoption
- consumer experience in charging their EVs
- electric vehicles–input from leading car-share provider 350Geen, Inc.

Dr. David Greene, Oak Ridge National Laboratory Senior Fellow, wrapped up the full-day event with the feature presentation: *Why Electrify? A New Paradigm for Transportation's Energy Transition.* He offered comprehensive observations derived from the last 100-plus years of transportation technologies, fuel types, and shifts in impact and efficiency. Greene then provided reasonable projections and caveats based on the oncoming constraints and trends that are driving global advances toward reduced-emissions ground transportation solutions.



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

In October, 2012, CCITT Co-Sponsored an industry workshop Providing the Transportation Perspective on Big Data.

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

Panel I Presentations

CCITT researcher Diego Klabjan provided the Big Data subject overview and stressed its implications for businesses. After Klabjan's introduction, Ogi Redzic, Vice President of Nokia Location & Commerce, filled in several details and stressed some of the same fundamentals. Their key points can be summarized as answers to three basic questions:

What is Big Data?

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

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

How is Big Data characterized?
- high volumes and velocity, variety, complexity
- arriving in real time
- new opportunity to analyze questions
- prompting innovation to create better, targeted services and products, faster.

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

Panelist Ken Sain, from Boeing, discussed "The Digital Airline"—how new methods of data collection, transmission, analysis, and distribution are set to improve aircraft design, engineering, and maintenance; and decrease down time and flight schedule disruptions.

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

Panel II Presentations

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

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

Mahmassani offered these takeaways:
- a volatile business environment places a higher premium on good data
- the challenge is to extract simplicity from complexity (the explosion of data sources)

- data is power—a critical competitive asset; leaders will exploit the opportunities
- business intelligence and analytics– these are the broad categories in which it is critical to create information and knowledge from big data masses
- more data and greater data dependence creates vulnerabilities: bias, security risks, obsolescence
- make data your friend.

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

Bill Driegert of Coyote Logistics, in his remarks, brought up the issue of cost vs. value: What is the value of the data versus the cost to capture it? Is more data better? The data should help you create actionable intelligence to support decision-making that is: (1) executional; (2) tactical; or (3) strategic. Driegert described the system design guidelines that Coyote Logistics follows in order to make the most of data and information:
- focused: the presentation of data should be focused around a user and a task
- intelligent: real-time predictive analytics and intelligently designed computer screen layouts improve the effectiveness of decision-making
- automated: users shouldn't have to dig for information relevant to them, it should be displayed and prioritized by relevance.

Technology Transfer

Workshops

CCITT Co-hosts a Strategic Simulation to Re-imagine Infrastructure

Transportation Center faculty and staff, including Director and Professor Hani Mahmassani, Professor Joseph Schofer and Associate Director Bret Johnson, collaborated with a Booz Allen Hamilton (BAH) team and the

Chesapeake Crescent Initiative to design, develop, and host a two-day "wargame" exercise to identify potential infrastructure solutions to reduce congestion and support the efficient intra- and inter-regional flow of goods and people in the United States. The July 23-24 Mega-Community Simulation to Re-Imagine Infrastructure brought together business, government, academia, and transportation leaders who simultaneously met as working groups in Chicago, Orlando and Washington, D.C.

CCITT worked with BAH to recruit "players" for the Great Lakes Megaregion, as well as provide assistance for the Florida Megaregion. In addition to teams representing federal and financial decision makers recruited by BAH, the working groups at each location were organized in four categories: freight, carriers (passengers), public infrastructure owners, and customers (businesses, military, passengers). The working groups independently brainstormed innovative infrastructure concepts, and then shared input via virtual AV connections as a single mega-community through an iterative process.
The Great Lakes Megaregion portion of the event hosted participants from Illinois, Indiana, Michigan and Wisconsin, including several industry collaborators: Mike Burton (C&K Trucking), Craig Philip (Ingram Barge), and Paul Nowicki (BNSF).

Endowed Lecture

Ford CEO Alan Mulally Delivers the 2012 Patterson Transportation Lecture

On April 18, 2012, Alan Mulally, President and Chief Executive Officer of Ford Motor Company, delivered the 31st Annual Patterson Transportation Lecture to a packed audience of students, faculty, alumni, professionals, and the public.

Alan Mulally, Ford Motor Company CEO, speaks at Northwestern.

In his talk titled *The Ford Story* Mulally chronicled Ford's 21st-century fall and rise—highlighting Ford's dismal state in 2006 and its "relentless implementation" of key objectives leading to its resurgence.

Ford, under Mulally leadership has:

- streamlined collaboration and communication to breed innovation and accountability
- divested itself of brands such as Jaguar and Volvo, creating a single-minded focus on Ford and Lincoln
- committed to reaching best-in-class vehicles
- accelerated R&D while simultaneously matching production to demand.

Mulally acknowledged that electrification is "the next frontier" and that the industry sits at the epicenter of numerous national and global issues, including corporate responsibility, environmental sustainability, economic development and energy independence.

Education

CCITT director Bret Johnson with Charlotte Anne Frei.

2012 Student of the Year.

Charlotte Anne Frei, Ph.D. Candidate in Transportation Systems Analysis and Planning, has been chosen as the recipient of the CCITT 2012 Student of the Year Award for her innovative contributions to a Chicago Transit Authority bus fleet allocation study. She also contributed to the NUTC/FHWA-sponsored 2011 workshop: Travel Behavior Research and Modeling, playing a key role in helping to coordinate the conference and in summarizing its recommendations.

Her research projects focus on public transportation demand and travel behavior. The goal of her thesis work is to model customer satisfaction in order to explicitly account for transit user behavior in design of public transit operating schemes. Charlotte is active in the Chicago chapter of the Women's Transportation Seminar, where she is currently developing partnerships and resources to enhance knowledge of transportation related careers among high school girls. She is also the co-chair of the Society of Women Engineers graduate student committee, organizing programs to engage female graduate students.

In addition, Charlotte Frei received an Eisenhower Transportation Fellowship, 2012–2013.

Dissertation Year Fellows

The Dissertation Year Fellowships, partially supported by CCITT, are highly competitive and selective awards given to PhD candidates focusing on transportation research at Northwestern University who are in their final year of dissertation completion.

Each academic year a committee consisting of NUTC and CCITT core faculty members reviews and selects three to five fellows. In recent years, fellows, upon completing their studies and defending their dissertations, have gone on to highly sought after positions in industry, academia, and the public sector, such as:

Vice President, Strategy & Research • Blue Northern Energy

Associate, Booz & Company •

Freight Analyst, Cambridge Systems •

Senior Consultant • Resource Systems Group

Senior Engineer • The Mitre Corporation

Assistant Professor • University of Rochester

Yikai Chen, Ph.D. Candidate, Civil and Environmental Engineering
Dissertation Topic: Statistical Health-Monitoring for Transportation Infrastructure

Chen's dissertation research focuses on the development and validation of a statistical framework to support structural health-monitoring of transportation infrastructure with an emphasis on bridges. The research is motivated by technology advances, and by the need to address fundamental statistical and computational challenges to exploit these new sources of information to enable safe and reliable operations and guide investment decisions for preservation and renewal.

Luis de la Torre, Ph.D. Candidate, Industrial Engineering & Management Sciences
Dissertation Topic: Models & Algorithms for Coordination in Humanitarian Logistics

de la Torre's work concerns the challenges of effective transportation and distribution of essential goods following a large natural disaster. He is investigating a problem of coordinating relief organizations for distribution of goods and optimization algorithms for solving a large class of problems that include the coordination problem. His primary goal is to quantify the benefit of both limited and complex coordination schemes in transportation and distribution of relief goods under uncertainty.

Jiwon Kim, Ph.D. Candidate, Civil and Environmental Engineering
Dissertation Topic: Reliability in Traffic Simulation Models

With growing concern over unreliable travel times in urban networks and the associated costs of unexpected delays and frustration, travel time reliability is becoming an important issue in transportation network planning and traffic operations. Kim's research explores the incorporation of (network) supply-side reliability measures in planning, operations and economic evaluation models with the goal of providing practical ways of generating realistic reliability information for decision-making.

Timothy Sweda, Ph.D. Candidate, Industrial Engineering & Management Sciences
Dissertation Topic: Decision Making for Electric Vehicles

Sweda's work concentrates on: (1) the deployment of public charging infrastructure, and (2) route choices for drivers balancing efficient trips with charging options. He is using agent-based modeling to simulate and analyze EV adoption patterns under various charging infrastructure deployment scenarios and is developing dynamic programming algorithms to find trip paths and recharging strategies that minimize total travel time, energy cost, and battery degradation.

Education

Student Researchers

Peng Chen
Ph.D. Candidate, Transportation Systems Analysis and Planning

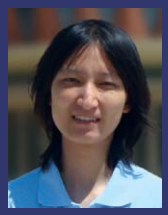
Madison Fitzpatrick
Ph.D. Candidate, Civil and Environmental Engineering

Qianfei Li
Ph.D. Candidate, Transportation Systems Analysis and Planning

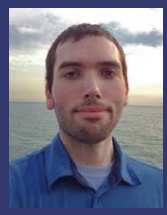
Timothy Sweda
Ph.D. Candidate, Industrial Engineering & Management Sciences

Yikai Chen
Ph.D. Candidate, Civil and Environmental Engineering

Charlotte Frei
Ph.D. Candidate, Civil and Environmental Engineering



Yidan Luo
Ph.D. Candidate, Civil and Environmental Engineering



Isaac Velando
Ph.D. Candidate, Applied Mathematics

Teresa Chen
Undergraduate Student, Industrial Engineering and Management Sciences

Mehrnaz Ghamami
Ph.D. Candidate, Civil and Environmental Engineering

David Meyer
Ph.D. Candidate, Mechanical Engineering

Omer Verbas
Ph.D. Candidate, Transportation Systems Analysis and Planning

Luis de la Torre
Ph.D. Candidate, Industrial Engineering and Management Sciences

Jeremy Halpern
Undergraduate Student, Civil and Environmental Engineering

Joe Mullenbach
Ph.D. Candidate, Mechanical Engineering

Olivia Woolley-Meza
Ph.D. Candidate, Applied Mathematics

Faculty Recognition

Irina S. Dolinskaya Appointed to the William A. Patterson Junior Professorship in Transportation, McCormick School of Engineering and Applied Science

Named to the 2011-2012 Northwestern Associated Student Government Faculty and Administrator Honor Roll

Diego Klabjan Launched Master of Science in Analytics program, McCormick School of Engineering and Applied Science

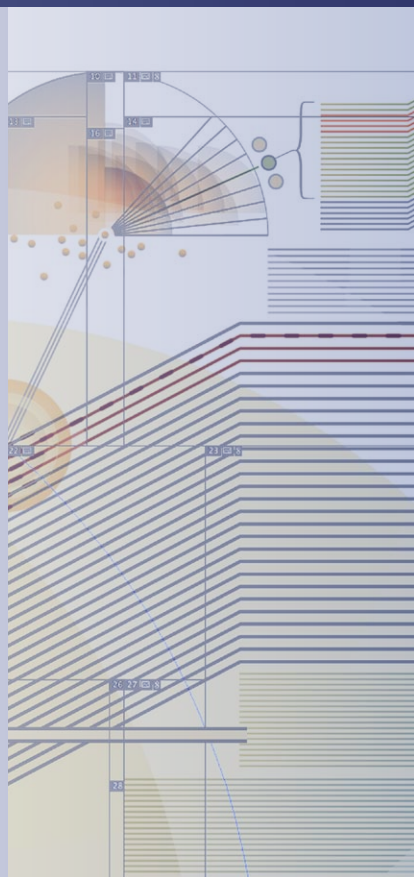
Hani Mahmassani Keynote Lecture, LATSIS Symposium 2012 – 1st European Symposium on Quantitative Methods in Transportation Systems; Lausanne, Switzerland

Chair of the 2nd International Conference on Evacuation Modeling and Management

Member of Scientific Committees of 5th International Symposium on Transportation Network Reliability (INSTR), Hong Kong; 5th International Workshop on Freight Transportation and Logistics (ODYSSEUS 2012), Greece

Appointed to Editorial Board of new EURO Journal on Transportation and Logistics

Karen Smilowitz Keynote Presentation, ICEM 2012, Second International Conference on Evacuation Modeling and Management; Evanston, Illinois



Seminar Series Events

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

09/27/2012
The Great Railroad Revolution: The History of Trains in America; Christian Wolmar, Author, British transport journalist

07/27/2012
Between GPS-based self-tracking and the diary: What is next for travel behavior studies?
Kay W. Axhausen, Professor, Institute for Transport Planning & Systems (IVT), Swiss Federal Institute of Technology, Zurich, Switzerland

05/24/2012
The Panama Canal as Precursor; Aaron J. Gellman, Professor of Transportation, NUTC, Adjunct Professor of Management & Strategy, Kellogg School of Management

05/10/2012
The Competitive Effect of Multi-Market Contact; Guy Arie, PhD in Management & Strategy, Kellogg School of Management, 2011-2012 NUTC Dissertation Year Fellow

04/26/2012
Leveraging the Mobile Cloud for Travel Demand; Joan Walker, Assistant Professor, Civil & Environmental Engineering and Center for Global Metropolitan Studies, UC–Berkeley

04/12/2012
Urban Travel Forecasting: A 50 Year Retrospective; David Boyce, Adjunct Professor, Civil & Environmental Engineering, Northwestern

04/05/2012
A Priority System for Multi-Modal Traffic Signal Control; Larry Head, Associate Professor & Department Head, Systems & Industrial Engineering, U. of Arizona

03/29/2012
Safety Without Borders: Raising the Bar on Traffic Safety Across the Globe Through Data, Research, and Collaboration;
David L. Strickland, Administrator, National Highway Traffic Safety Administration (NHTSA), U.S. DOT

03/01/2012
Traffic Congestion in Networks, and Alleviating It with Public Transportation and Pricing
Carlos F. Daganzo, Robert Horonjeff Professor of Civil Engineering, UC–Berkeley

02/02/2012
Vulnerability and Adaptation Options of European Transport Systems Towards Weather Extremes;
Claus Doll, Fraunhofer Institute for Systems and Innovation Research ISI

01/12/2012
A Trade-Space Analysis of Surface Alternatives for Short-Haul Passenger Air Travel; Laurence Audenaerd, Senior Engineer, Center for Advanced Aviation System Development, The MITRE Corporation, NUTC 2011 Dissertation Year Fellow

01/05/2012
Proactive Transmission Planning in Electricity Networks; Enzo E. Sauma,
Associate Professor of Industrial and Systems Engineering, Pontificia Universidad Catolica de Chile, Santiago, Chile

12/01/2011
Effectiveness and Equity of Future Transportation Financing Options; Zhang Lei, Assistant Professor, Department of Civil and Environmental Engineering, U. of Maryland

11/11/2011
NY Commuter Railroad's Response to Hurricane Irene; Howard Permut, President of Metro-North Railroad (MTA), New York

11/10/2011
Ranking of Information in Intelligent Transportation Systems; Ouri Wolfson, Professor of Computer Science, U. of Illinois Chicago

11/01/2011
Towards a 21st Century Postal Service; John C. Panzar, Professor Emeritus, Department of Economics, Northwestern

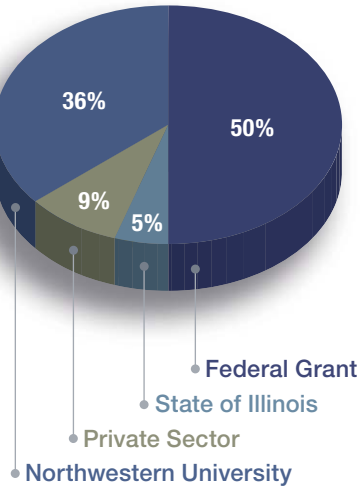
10/26/2011
Safety Technology, Fuel Economy, and Individual Mobility; David L. Strickland, Administrator, NHTSA, U.S. DOT

10/20/2011
Anticipating Disaster: Planning for Emergency Logistics Needs; Mark Turnquist, Professor of Civil & Environmental Engineering, Cornell University

Financial Totals

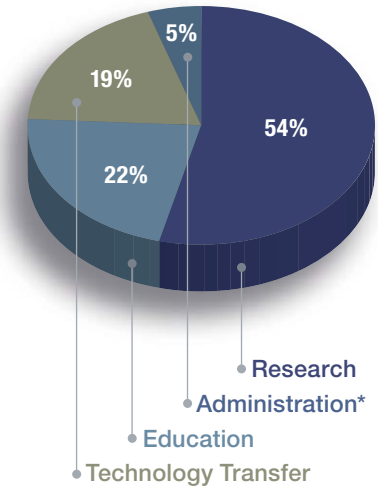
Funding Sources Total: $4,443,200

Project Period: 8/10/2005–12/31/2012



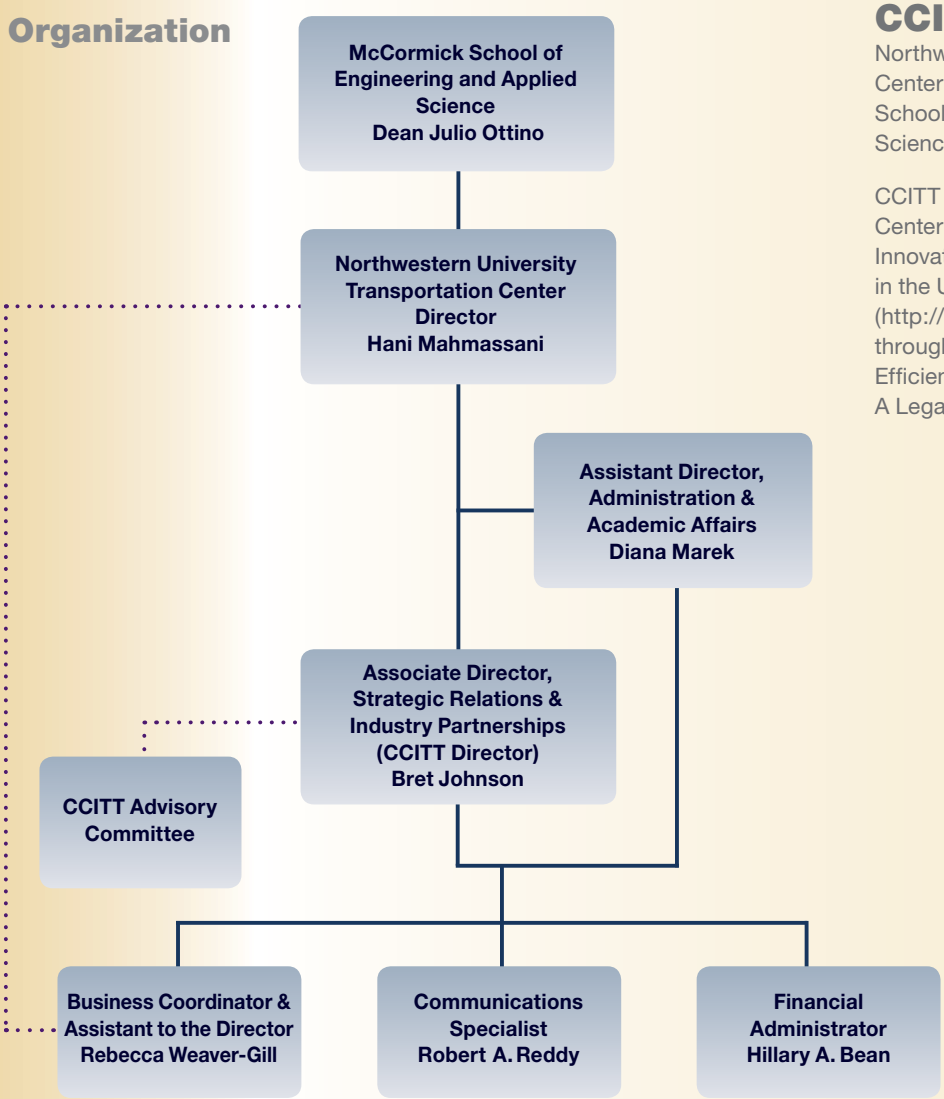
Expenditures Total: $4,353,100

Project Period: 8/10/2005–12/31/2012



*Also includes services, supplies, and computer hardware and software.

Organization



CCITT operates within the Northwestern University Transportation Center in the Robert R. McCormick School of Engineering and Applied Science at Northwestern University.

CCITT is a University Transportation Center Program of the Research and Innovative Technology Administration in the US Department of Transportation (http://utc.dot.gov/) and is funded through the Safe Accountable Flexible Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU).

Bret Johnson

CCITT 2012

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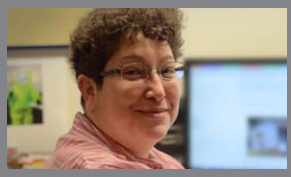

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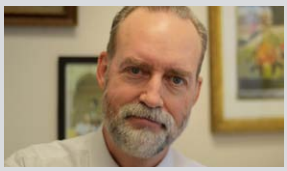

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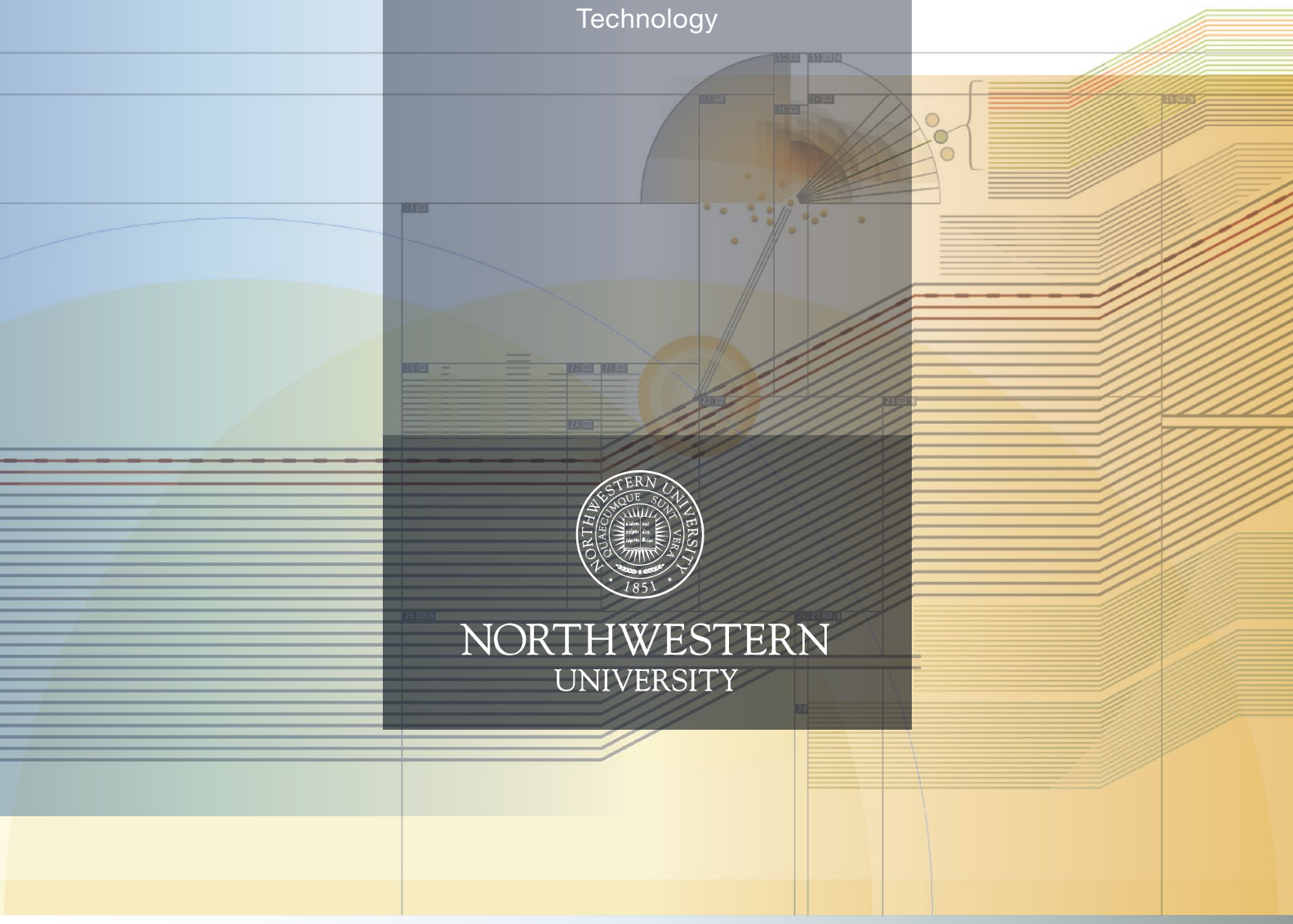

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