Comparison of VTrans’ Bridge Assessment Data and VTANR’s Geomorphic Assessment Information to Assist in Scour Potential Prediction

Ian Anderson, Sebastian Downs, Donna Rizzo, Dryver Huston and Mandar Dewoolkar
School of Engineering, The University of Vermont

Scour is the primary factor in bridge failure throughout the United States, and is a major concern in Vermont. The Vermont Agency of Transportation (VTrans) rates bridges in the State for its susceptibility to scour type failure. The scour rating is largely bridge- and site-specific, and does incorporate stream characteristics and larger scale correlations for scour events. The Vermont Agency of Natural Resources (ANR) is conducting fairly detailed Stream Geomorphic Assessments to judge the sensitivity of streams as they deviate from the reference condition. This work provides a large resource of information about rivers and streams on a larger scale, and could be an untapped asset in the scour assessment of VT bridges.

This presentation will feature the work and findings on utilizing VTrans’ data on bridges and scour ratings, and ANR’s work characterizing rivers and streams, on how the information may be used for better scour predictions. It will also assess if there was a link between scour events and stream characteristics during Tropical Storm Irene.

This study is funded by VTrans and USDOT via UVM TRC.

ESTIMATING THE EFFECT OF MOBILITY AND FOOD CHOICE ON OBESITY

Geoffrey Battista

A majority of Americans are overweight, with nearly one-third of the total population classified as clinically obese (BMI > 30). The prevalence of obesity and its related health consequences has evoked a considerable response by policymakers, but the condition has been difficult to address due to its various causes. Previous studies have indicated that the topographical features of the built environment affect individual mobility and food choice, which in turn impact caloric energy balance. This current research contributes to deeper understanding of this relationship by considering northern New England, a region with a unique rural and seasonal environment. The analysis will estimate the size and significance of individual mobility and food pattern choices on caloric energy balance while accounting for both seasonality and individual perceptions of navigability of the built environment in northern rural climates.

Panel data from 654 individuals residing in Vermont, New Hampshire, and Maine were gathered through the “Transportation in Your Life” survey from 2008 through 2009. The panel data set contains individual level data, including both time constant and time (seasonal) variant variables. The geospatial characteristics of the built environment – grocery stores, convenience stores, fast food and full-service restaurants, recreational amenities, and trails – were incorporated into the model using geographic information systems. Panel participant accessibility to features of the built environment was assessed through as-the-crow-flies buffering and real-distance network analysis from geocoded participant addresses. While the final models have not yet been estimated, previous results suggest rural residents are both more car-reliant and more likely to rate their travel time to various amenities as “too long,” a combination of factors that discourages active commuting and inhibits caloric energy balance.

Keywords: obesity, mobility, energy balance, built environment, food systems, complex systems
NON-COMPLIANT DRIVER BEHAVIORS AT SINGLE-LANE ROUNDBOUTS
NATHAN P BELZ, M.S., E.I. Doctoral Candidate, College of Engineering and Mathematical Sciences
University of Vermont, Burlington, VT 05405 Email: nathan.belz@uvm.edu

Roundabouts, in general, are an emerging type of intersection design in the United States. Moreover, capacity and operational models for roundabouts are inadequate since they are derived primarily from concepts of existing stop- and signal-controlled intersection, and based largely on data collected abroad where roundabouts are more common. This research aims to develop a new model calibrated and validated with real-world data collected using a video method to improve the ability to correctly model roundabout operations and more accurately estimate capacity and level-of-service.

The Transportation Research Board (TRB) has identified the necessity for research to determine whether non-geometric factors such as driver familiarity and traffic conditions can also have significant impacts on driver behavior at roundabouts in the United States. The types of driver behavior and vehicle interactions that occur at roundabouts have yet to be comprehensively studied. By identifying and characterizing the types and frequency of all driver behaviors, we can more accurately represent traffic operations at roundabouts in microscopic simulation models and better facilitate the planning and design.

Entry behavior at roundabouts is generally modeled using gap-acceptance methods; this assumes that a driver enters the roundabout only when there is a sufficient gap in the circulating traffic for that driver to enter safely. This is widely discussed as not always being the case, yet the current models of roundabout operations do not reflect this. Because there is a lack of rigidly defined priority and traffic control at roundabouts, driver behavior types are subject to a wider range of behaviors than are observed at conventional stop- and signal-controlled intersections. A fundamental issue with roundabout operations is that some drivers either: 1) stop for no reason when there are sufficient gaps or no other vehicles in the roundabout; 2) enter into gaps that are neither sufficient nor safe; or 3) yield to entering vehicles while circulating.

Current microscopic roundabout models that use either gap-acceptance or car-following approaches are unable to adequately account for these non-compliant driver behaviors. Furthermore, current validation methods do not explicitly account for these non-compliant type behaviors observed in this study. A cellular automata model is used to evaluate the relative influence that varying levels of priority-taking and priority-surrendering behavior have on single-lane roundabout performance measures including queuing, capacity, and delay. Cellular automata models are particularly useful for analyzing dynamic and complex interactions, like the non-compulsory nature of yield-at-entry traffic control at roundabouts.

By incorporating priority-taking and priority-surrendering into a new traffic simulation model, this research targets the deficiencies in current methods and models that function under the invalid assumption of solely gap-acceptance behavior. The significance of this research is the development of a theoretical framework for describing priority-taking and priority-surrendering behavior at single-lane roundabouts. Furthermore, no current simulation model explicitly accounts for priority-taking or priority-surrendering."
Best Practices in Transportation Communications and Applications for UVM’s Transportation Research Center

Ben Carlson

This research examines best practices in communication and outreach among transportation organizations to inform communications by the UVM Transportation Research Center. By assessing these best practices, the most effective measures are determined to improve communications for this organization. This research primarily studies the communications efforts of the American Association of State Highway and Transportation Officials (AASHTO) and the United States Department of Transportation (US DOT). The efforts of these leading institutions are compared to the efforts of state departments of transportation and university transportation centers (UTCs). This involves assessment of (1) website design, (2) social media strategies, (3) newsletters, and (4) event promotion. These areas are assessed qualitatively through observation and analysis of online practices, informed through a literature review of communication best practices in transportation. Conversations with individuals involved in communications efforts at these organizations are also included in the assessment. This research is applied to incorporate applicable practices in these four areas into the development of the UVM Transportation Research Center’s communication plan.

Hybrid Vehicle Fuel Efficiency and Operation in Real-World Driving Conditions - a micro-scale Vermont case study

Matt Conger

Hybrid vehicles are gaining acceptance among American consumers, with a multitude of new models flooding the passenger car market. Fuel efficiency gains are reported to range between 25% and 50% over conventional vehicles, yet reported EPA fuel economies do not necessarily reflect real world driving conditions. In Vermont, where temperature variation and road terrain vary considerably compared with other regions, hybrids registrations are currently 2.5% of the total passenger car fleet and are increasing annually at 20%. In this case study, a 2010 Toyota Camry hybrid - utilizing the same synergy drive technology as the popular Prius - and a comparable conventional Camry are driven over an 18-month period on a 50 km (32mi) route through a multitude of road classes in Chittenden County. Using a link-based approach, operational parameters are collected at 1 Hz along four different road classes. Four vehicle operational modes are classified to characterize and compare driving conditions across road classes. Results reflect hybrid fuel efficiency to be relatively optimal (compared to conventional) under low speed, congested driving conditions, while under interstate driving the gains are negligible. Hybrid fuel rates under varying operational modes show little effect from changes in ambient temperature. The hybrid fuel rates are more significantly effected by high magnitude road grade than conventional fuel rates across all speed ranges.

Biodiesel vs. Petro-diesel: a comparison of particle number emissions at 80% load

Tyler Feralio

Diesel on-road vehicles are main contributors to particulate matter pollution in urban areas. Subsets of the diesel vehicle fleet are currently utilizing blends of petro-diesel and biodiesel for fuel. As time goes on, the number of these vehicles is projected to grow.

The amount of particles emitted from a diesel engine running on biodiesel is different than that of the same engine running on petro-diesel. It has been shown that ultra-fine particles (UFP, diameter < 100nm) cause adverse health effects in humans which include aggravated asthma, decreased lung function, irregular heartbeat, and even nonfatal heart attacks. Because of their small size, these particles do not contribute substantially to the standard measurement of particulate matter, Particle Mass (PM).
For this reason, the Particle Number (PN) metric, which counts the number of particles in different diameter ranges, presents a clearer picture of the particles that likely cause the most harm.

The objective of this research was to determine whether an engine running on neat biodiesel emits more or less UFP than the same engine running petro-diesel. Here, PN distributions were measured from a 1.9L Volkswagen diesel engine in real-time for neat petro-diesel (B0) and neat soybean oil based biodiesel (B100) with an Engine Exhaust Particle Sizer (EEPS, 32 channels, 5.6 – 560nm range). For these experiments the engine was run at a constant 80% load (2200 RPM, 67% throttle, producing ~104Nm of torque). The results show that operation with B100 tends to emit more nanoparticles in the 10nm diameter range than for petro-diesel, however, there also seems to be a decrease in the number of nanoparticles with diameters centered at 45nm.

Future research will continue to explore PN emissions of petro-diesel and biodiesel as the engine is subjected to a transient drive cycle. The results will more accurately represent real-world, on-road emissions.

**Drive Like a Local! Findings From the Vermont State Crash Database**

Kristine Harootunian

This study examined single- and two-vehicle police-reported crashes in Vermont between 2003 and 2008. It evaluated the likelihood of being at fault for out-of-state drivers versus in-state drivers. Analysis using nominal logistic regression estimated that out-of-state drivers are over twice as likely to be at-fault for a single-vehicle crash and 6.5% more likely to be at-fault for a two-vehicle crash.

Season and road type were statistically different interactions between in-state and out-of-state drivers for single-vehicle crashes. Driving during the winter months had more pronounced effects of increasing single-vehicle crash fault for out-of-state drivers than for in-state drivers, while driving during the summer decreased the odds of being at-fault for out-of-state drivers. In-state drivers, on the other hand, were more apt to cause a crash on unpaved roads. The interactions were less pronounced for two-vehicle crashes as none of the variables tested were significant for either group.

The crash evaluation of fault for “foreign” drivers’ crashes has been understudied in the United States. Previous research, conducted mostly in other countries, has been limited but has shown that foreign drivers are more likely to be involved in a crash. This study in Vermont strongly suggests the need for further study of this factor as well as identification of associated interventions.

**The relationship between multimodal transportation infrastructure and housing prices in Baltimore**

Chester Harvey, Advisors: Austin Troy (UVM), Morgan Grove (USDA Forest Service)

Accessibility to transportation infrastructure is an important factor of property values. As cities develop increasingly multimodal transportation networks to provide alternatives to car travel, access to these networks is likely to be an important consideration for homebuyers. This study aims to reveal how overlapping access to vehicular, bus, rail, and bicycle networks are related to the sale price of residential properties, and whether access to particular combinations of network access may yield advantages to neighborhood economic development. To investigate this we use a statistical method called hedonic regression, which assesses thousands of individual properties according to a bundle of attributes that include property-based measures, such as improvement value and quality of construction, as well as place-based measures, such as access to transportation networks. Parameters of the model reveal the portion of a sale price that can be associated with each attribute. The study is based in the city of
Baltimore, which is home to a handful of small transit systems as well as a burgeoning on-street bicycle network. While these networks are limited in scope compared with some cities, Baltimore provides useful insight on the early-stage development of alternative modes that is representative of many mid-sized American cities.

Is Biodiesel Really Better?
John Kasumba, Britt Holmen
University of Vermont, School of Engineering
Burlington, VT

Biodiesel use and production has significantly increased in the United States and in other parts of the world in the past decade. This is mainly because of the reduction in production of petroleum-based diesel. Also, recent research has shown that emission of some pollutants such as CO, particulate matter (PM), SO2, hydrocarbons, and polycyclic aromatic hydrocarbons (PAHs) is greatly reduced with biodiesel. However, some research findings have shown that some unregulated emissions such as carbonyls in the gas-phase are increased with biodiesel. Very limited research has been done to investigate the carbonyl emissions in the particle-phase.

In this study, an Armfield CM-12 automotive diesel engine was used to generate particulate matter from two biodiesel feedstocks (soybean and waste vegetable oil biodiesel). The PM emissions were sampled by a variety of instruments: - engine exhaust particle sizer, EEPS (TSI Inc, Model 3090) for measuring particle size distributions between 5.6 and 560 nm in real-time; scanning mobility particle sizer, SMPS (TSI Inc, Model 3936) also for particle size distributions between 2 nm and 1000 nm; Teflon filters for gravimetric mass, and quartz fiber filters (QFF) for chemical analysis of the exhaust PM using gas chromatography mass spectrometry (GCMS). PAHs, carbonyls, and alkanes have been measured in the biodiesel and diesel exhaust PM. Preliminary results show that the total PAHs emissions are reduced between 2 – 10 times with B20 soybean biodiesel, while the total carbonyl emissions seem to increase with biodiesel. Alkanes have also been found to be in higher concentrations in petrodiesel exhaust PM than in biodiesel exhaust PM.

A Model to Predict Impervious Surface Impacts of Land Use and Transportation System Change with UrbanSim
Isaac Lawrence
Master’s Student, Natural Resources
University of Vermont
Transportation Research Scholar, UVM Transportation Research Center

The importance of impervious surface area (ISA) as an indicator of human impact on ecosystems and a driver of increases in flooding has been well established. In order to predict impervious surface outcomes for municipal and regional Master Planning processes, Reilly et al. (2002) developed and tested a model of ISA based on commonly available planning data. Since publication, adoption of agent-based land use and transportation models by planning authorities and researchers has increased. UrbanSim, one increasingly popular model, provides a powerful, flexible environment for predicting land use and transportation system change. In order to leverage UrbanSim towards the management of flooding and stream health with impervious surface as a proxy, I propose and test a model to predict ISA within a Chittenden County, Vermont implementation of UrbanSim. In addition, I compare the model developed to Reilly et al. as well as a simple factor model commonly utilized in hydrologic modeling.
Transportation Workforce Development in Vermont and Northern New England
Nicholas Leggett

Transportation is a multi-disciplinary sector that depends on a wide array of professionals to design, build, operate and maintain systems at the local, state and national levels. The transportation workforce faces many obstacles, most notably that roughly 40-50% of the transportation workforce is slated to retire in the next 5-10 years. There are opportunities to retain and retrain this mature workforce, as well as attract workers from other fields that have been displaced but have cross-over skills. Challenges to be overcome include the rapid change in technology and skills required to remain relevant. At the opposite end of the workforce spectrum students and young persons are not replenishing the ranks of those who are leaving and are aggressively competed for by other industries. Through a series of outreach educational initiatives, the UVM Transportation Research Center, through a FHWA funded Transportation Education Development Pilot Program, has explored four strategic interventions to help attract, retain, and retrain the transportation workforce in Vermont and northern New England. These initiatives include the Transportation Systems Academy (TSA) for graduating high school seniors and targeted transitional populations (e.g., Veterans), the Transportation Systems Institute (TSI) for incumbent transportation department workers, Second Careers in Transportation Program for mature workers, and an assessment of the role of community colleges with the American Association of Community Colleges (AACC) and support of a new associate's degree program in business operations in transportation at the Community College of Vermont. The expected results from the implementation of these programs include slowing of the projected retirement rate, the attraction of professionals from other fields into second careers in transportation, and the funneling of youths and adults through career & technical centers and into entry-level positions at transportation employers.

Exposures to Emissions from Combustion of Biodiesel Fuels (B100/B20) Elicit Differential Responses in Redox-Sensitive Pathways

Exposure to airborne particulate matter (PM) is associated with higher risk for cardiopulmonary diseases but mechanisms for the effects remain unknown. Combustion of biodiesel fuels (BD) is associated with lower emission of PM but the health consequences of exposure to exhaust from combustion of pure soy BD (B100) or a 20% (w/w) blend (B20) is unclear. To examine the in vivo responses to inhalation of exhaust generated by B100 and B20 combustion, ApoE-deficient mice were exposed by inhalation to B100 or B20 PM at 0, 50 or 150 μg/m3 (n = 8-10/group), 4 h/day for 3-days. Mice were sacrificed ~24 h after the last exposure and blood, tissue, and bronchoalveolar lavage fluid (BAL) were obtained. Total cell and differential counts as well as protein and LDH concentrations in blood and BAL were not affected by exposure to either exhaust. However, Western blots of lung homogenates revealed higher plasminogen activator inhibitor-1 (PAI-1), catalytic subunit of glutamate-cysteine ligase (GCLC), the transcription factor, NF-E2-related factor 2 (Nrf2) and protein carbonyls in mice exposed to 50 μg/m3 B100 in comparison with mice exposed to filtered air or 150 μg/m3. No significant differences were found in any of these parameters in the B20-exposed mice. These data suggest that short-term exposure to the lower dose of B100 exhaust was associated with oxidative stress (protein carbonyls) and consequent activation of redox-sensitive pathways (Nrf2 and GCLC) and that PAI-1 may contribute to lung injury and risk for thrombosis. It would be important to determine the relative contribution of pure BD versus the presence of petrodiesel in the B20 blend in producing the
differential responses, both of which would affect particle size and composition. (This abstract does not represent U.S. EPA policy).

Assessing the use of UrbanSim for energy consumption estimates: A Chittenden County case study
Tim Pede

UrbanSim is an agent-based model that simulates the development of a given geographic area (ie. city, town, or state), including land use, transportation, and environmental impacts over 20 years or more. Although the combustion of fossil fuels is closely linked to land use and transportation, there has been little use of UrbanSim for the prediction of energy consumption. I present my progress on the development of such an indicator for the UVM Transportation Research Center’s Chittenden County 2005 Baseyear Model of UrbanSim, and summarize similar past applications and their utility. Predictions for annual energy consumption can be grouped in three main sectors: 1.) residential 2.) commercial/industrial and 3.) transportation. Estimates are essentially based off the variables/indicators associated with residential units (household income, year built, number of residents), employment locations (sq. ft. per sector), and road segments (VMT, fuel economy). Although data for the residential and transportation portion of the energy consumption indicator is readily available, developing the commercial/industrial portion will be significantly more difficult and has yet to be accomplished.

Managing for Solitude in Wilderness: Transportation, Trail Use, and the Wilderness Act in Olympic National Park
By: W. Vinson Pierce, III.
Dr. Robert E. Manning

Within a day’s drive of almost ten million people, Olympic National Park provides a respite from urban life for those living in cities like Vancouver, Canada; Portland, Oregon; and the Seattle-Tacoma-Bellevue, Metropolitan Area in Washington State. With almost three million visitors in 2011, park managers must consider the crowding implications associated with increasing visitation in a park that is 95% federally designated wilderness and, as stipulated in The Wilderness Act of 1964, must provide outstanding opportunities for solitude and a primitive and unconfined type of recreation. As part of a survey designed to inform the Olympic National Park Wilderness Stewardship Plan, visitors were asked to rate their experiences hiking on various wilderness trails throughout the park to determine acceptable use levels for high and low use trails in the three main ecological zones of the park: Coastal, Rainforest, and Mountain. Data collected from the survey will be used to determine social carrying capacity for various trails throughout Olympic National Park.

Multi-scale integrated modeling of high volume pedestrian travel and experiential quality in a large nature-based recreation area
Nathan Reigner, Jeremy Wimpey, Jillian Spies, Robert Manning

Recreational behaviors are complex and dynamic. This is particularly true when recreation areas are large, experiential opportunities diverse, and use volume high. Freedom of movement and from the interference of others are key elements of high quality recreation. Influenced as much by site design and management as by the magnitude of use, these freedoms often underlie quality objectives for parks and protected areas. When seeking to manage large, complex and diverse areas in a holistic and systematic way, area-wide use patterns must be linked with site-specific crowding related impacts. This
research presents an integrated approach to modeling pedestrian travel and experiential quality at multiple spatial scales.

Spatial models of a recreation site, and particularly its trail network, provide a basis for analysis and integration. Not only do the spatial data describe travel routes and functions of recreation areas, it also facilitates measurement experiential quality. Furthermore, spatial analysis allows experiential quality and system functionality to be understood at multiple, interconnected scales.

At a macro-scale, the trail systems allow visitors to travel from origin to destination. GIS-based network models analyze the efficiency and quality of routing within the trail system. Network models identify trail features or patterns of visitor behavior that may compromise the capacity of the trail system in terms of function and/or experiential quality.

Meso-scale computational models use the outputs of macro-scale network models to examine capacity related challenges to the trail network’s function and experiential quality. They are designed to develop more refined capacity assessments for regions of the trail network to guide site development and travel management strategies.

Micro-scale models test the effectiveness of management actions. Analogous to previous studies employing indicators and standards of quality for crowding on trails and at recreation sites, these micro-scale models join pedestrian simulation with statistical analyses of trail capacity to evaluate system function and experiential quality.

The integration of pedestrian travel and quality models at multiple scales facilitates system-wide capacity assessments. The chain of causal events and feedbacks can be understood, visualized and manipulated to inform management of trail networks for both system functionality and experiential quality.

Keywords: Crowding, Spatial Networks, Simulation Modeling

**Packetized Plug-in Electric Vehicle Charge Management**

Pooya Rezaei

Plug-in electric vehicle (PEV) charging could cause significant strain on residential distribution systems, unless technologies and incentives are created to mitigate PEV charging during times of peak power consumption. This paper describes and evaluates a decentralized ‘packetized’ approach to PEV charge management, in which PEV charging is requested and approved for time-limited periods. Because the method is adapted from approaches for bandwidth sharing in communications networks, it simultaneously ensures that constraints in the distribution network are satisfied, that communication bandwidth requirements are relatively small, and that each vehicle has equal access to the available power capacity. This paper compares the performance of the packetized approach to an optimization method and a simple charging scheme in a test case with a constrained 500 kVA distribution feeder, with customers charged based on time-of-use retail
pricing. The results show substantial advantages for the packetized approach in terms of providing all vehicles with equal access to constrained resources without substantially increasing travel costs. The proposed method does not require that vehicles report or record driving patterns, providing benefits over optimized approaches by preserving privacy and reducing computation and bandwidth requirements.

Index Terms—Communication systems, Plug-in electric vehicles, Smart charging

Aircraft Sound and its Effect on the Visitor Experience in Grand Canyon National Park
Ellen Rovelstad
Robert Manning

Scenic air tours over national parks and related areas provide a unique way to experience these natural and cultural areas. However, air tours can have impacts on the perceived quality of “soundscapes” or “natural quiet” experienced by park visitors on the ground. It can then be challenging for park managers to balance the impacts of air tours with the needs of more conventional visitors on the ground. A program of research was recently conducted in the national parks to address this issue. Three research methods were used at Grand Canyon National Park, Arizona to address the possible impacts of air tours on recreation experiences on the ground. Methods used included visitor surveys, acoustical surveys (strategic placement of recording microphones), and GPS track logs of visitor groups to determine the geographic location of their visit in the park. Visitors were contacted at three sites along the South Rim of the Grand Canyon and asked to complete the survey questionnaire and carry GPS devices to help determine their exposure to aircraft sound. Acoustical surveys and GPS tracks show that over an 8 hour time period, the study sites in the park were exposed for aircraft noise as much as 45% of the time. A majority of visitors (55 to 86%) of visitors reported that they heard aircraft during their visit in the park. A majority of survey respondents (53 to 69%) indicated that hearing aircraft tended to detract from their experience. These results indicate that the presence of aircraft sound is a salient indicator of quality for backcountry visitors in Grand Canyon National Park, and that most visitors are exposed to aircraft sounds for a substantial portion of their visit to Grand Canyon. The multi-method nature of this study represents a step forward in the study of the effects of aircraft sound on visitor experience in backcountry settings because it uses physical data to gather estimates of sound exposure and relates those estimates directly to the visitor experience on the ground.

This program of research was funded by the U.S. National Park Service and the Volpe National Transportation Systems Center. Cooperators on this research include Resource Systems Group, Colorado State University, Southern Utah University, HMMA, Inc., and the University of Vermont.

Automated Counting of Bicyclists and Pedestrians
Ben Schilling

Traffic monitoring through video has been an area of research for years and though methods have continued to improve, especially in terms of automobiles, detecting and counting pedestrians and bicyclists continues to be a problem. Automobile characteristics and behaviors on roadways are very predictable while bicyclists and specifically pedestrians are highly unpredictable. The most accurate method of counting pedestrians would be to manually watch every video; however this is a slow and tedious process.

Our program aims to automate as much of the process as possible and provide the user with quick, accurate estimates with efficient error checking. This is accomplished by analyzing every video, detecting any moving objects, and saving features for these objects including size, shape, and speed. The detected objects are then classified by comparing the saved object features against trained feature values for the different
Bicycle Transportation and Quality of Life: Qualitative Connections between Mobility and Wellbeing
Phoebe Spencer

Transportation and mobility are considered key components of quality of life because they mediate and shape the ways individuals interact with the built and natural environments around them. In this project, we contribute to the developing field of quality of life studies that focuses on the importance of the experience of transportation, specifically the effects of bicycle use on wellbeing. Previous scholarship demonstrates that bicycle use provides numerous benefits for riders by enhancing mobility through healthy and relatively inexpensive transportation. These factors are major components shaping the quality of life for individuals worldwide. Bicycle use has clear and measureable impacts on health and environment, yet the specific effects of utilitarian bicycling on subjective perceptions and objective measures of quality of life are largely unknown.

Through this research, we examine the relationship between quality of life, transportation sustainability, and bicycle transportation by asking: How do everyday cyclists and transportation professionals think about the relationship between quality of life and bicycling? Do cycling transportation and culture impact aspects of quality of life beyond transportation and mobility, and what are these extensions? By examining these questions, we provide a critical analysis of the concept of quality of life within the framework of mobility and bicycle studies. In-depth interviews were conducted among everyday transportation cyclists and bicycle transportation professionals in Burlington, Vermont in order to gain understanding of connections between bicycle transportation and quality of life. Support for our critique of current quality of life paradigms is provided through qualitative interview analysis, identifying personal histories and perspectives on cyclist experience, practice, and perceptions of wellbeing.

Pervious Concrete Pavements for Cold Climates – Mechanical and Hydraulic Behavior, Durability, and Field Performance
Lalita Oka, Ian Anderson and Mandar Dewoolkar
School of Engineering, The University of Vermont, Burlington, VT

In recent years, pervious concrete pavements have been found to be a sustainable choice over traditional asphalt pavements particularly under light traffic conditions such as parking lots and walkways. High void contents in pervious concrete allow water to percolate in the ground reducing stormwater runoff and helping groundwater table to recharge. Reduction in runoff also has a major advantage of reducing harmful waste and contaminants getting transported to nearby water bodies such as lakes and rivers.

A long-term monitoring study has been undertaken at UVM’s Trinity parking lot, which was recently constructed and includes pervious concrete. The specific objectives of this study are to: 1) investigate the effects of maintenance operations e.g., salting and plowing on infiltration rate and
strength of pervious concrete; 2) monitor the effects of natural freeze-thaw cycles on the performance of the pervious concrete; and 3) to monitor the quality of groundwater in the vicinity of the pervious pavement. The field infiltration rates are being measured at regular time intervals (about 2 months). The long term monitoring is expected to help optimize the maintenance and cleaning operations. A number of sensors are placed in ground at the site to monitor temperature, groundwater level, electrical conductivity, soil moisture, and precipitation. The water samples from the wells in the vicinity are being tested for nutrients (e.g. phosphates, nitrates, nitrites), heavy metals (e.g. lead, copper, zinc), motor oils, along with routine tests on pH, conductivity, and turbidity. Some of the water quality testing is incorporated in a lab course for Environmental Engineering students. This study is funded by UVM-TRC and UVM Transportation and Parking.

Simultaneously, another comprehensive study has been undertaken to systematically develop a pervious concrete mix design suitable for northern climate. The specific objectives of this study are to investigate the effects of various constituents, casting methods, surface application and curing time on the overall performance of pervious concrete which includes the mechanical properties (unit weight and compressive strength), hydraulic properties (permeability and void content) and durability (freeze-thaw and salt exposure) of pervious concrete. This project is funded by the Vermont Agency of Transportation and UVM-TRC and is in collaboration with Norwich University.

New England Transportation Consortium
Amanda Hanaway-Corrente

The New England Transportation Consortium (NETC) is a research cooperative between the state DOTs of Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island and Vermont. VTrans is currently the state lead. The NETC is a valuable regional partnership for the identification, prosecution and dissemination of shared transportation research initiatives. The NETC represents:
- Financial leveraging opportunities and regional partnerships.
- Stronger partnerships between university faculty and state DOTs.
- User-defined, diverse research topics.
- Opportunities for research dissemination and training to practitioners in the field.

Now entering its third decade, the NETC was developed to help New England states meet their special research needs by pooling resources and expertise. The NETC is now a well-established successful multistate partnership. The Massachusetts Institute of Technology (MIT) and the American Association of State Highway and Transportation Officials (AASHTO) jointly managed the program through December 1994, at which point the Region I Office of the Federal Highway Administration (FHWA) assumed the management of the program until the states developed a permanent management structure for the program in 1995. Grant management and coordination has been housed at a number of institutions in the past 15 years including the University of Connecticut and its home through Summer 2011, the University of Massachusetts-Dartmouth. Beginning in Fall 2011, the University of Vermont Transportation Research Center will provide coordination services for the NETC.
Park Partnerships for Sustainable Transportation: Assessing the Full Circle Trolley Pilot Program
Robert Manning, Laura Anderson, William Valliere, Nathan Reigner, Vinson Pierce, Ellen Rovelstad

In recent decades, public land management agencies have become increasingly concerned about the potential impacts of visitor vehicle traffic in and around parks, forests, and other recreation areas. In summer 2010, an innovative alternative transportation service was implemented in the small community of Woodstock, Vermont to address this issue. Funded through the Department of Transportation – and implemented through a partnership between Marsh Billings Rockefeller National Historical Park and local agencies and organizations – the Full Circle Trolley Pilot Program set forth several goals for the free electric shuttle: reduce congestion and parking problems; educate riders about renewable/sustainable energy; protect natural and cultural resources; contribute to economic vitality; and serve as an exemplar of partners working together. In 2012, partner interviews (n=9) and rider surveys (n=143) were conducted to assess the program’s success in meeting its goals and to consider opportunities and barriers to a permanent shuttle service in the region. Findings suggest mixed success in meeting program goals. While a useful service for visitors, partners viewed the trolley as having less utility for residents and businesses. Partners and riders agreed on the strength of the shuttle’s educational environmental message, but were less certain about the degree of positive impact of the trolley on the environment and park and community resources. Barriers to a permanent shuttle service include: 1) continuation of funding at the end of the federal grant; 2) relatively low ridership levels; and 3) providing regular and predictable service given the limitations of an electric vehicle. At the same time, opportunities exist to increase ridership through expanded marketing and outreach. Findings from the study help to inform planning, service, and management of the Full Circle Trolley and have implications for related alternative transportation partnerships.

VT Clean Cities Coalition
Tom McGrath

“The Vermont Clean Cities Coalition (VTCCC) is a statewide outreach program with the mission to reduce petroleum fuel consumption in transportation. One of over eighty coalitions funded by the US Department of Energy (DOE) Clean Cities Program, VTCCC promotes strategies that reduce, replace, and eliminate gasoline and diesel use. To achieve this goal, VTCCC works with public and private entities throughout Vermont, offering resources and support in order to assist with fuel-reduction practices.

In Vermont, current petroleum-fuel-reduction programs include:
- Biodiesel
- Compressed Natural Gas
- Propane
- Hybrid-electric, plug-in-hybrid-electric, and battery-electric vehicles
- Idle-reduction policies and technologies
- Vehicle miles traveled (VMT) reduction programs
- Eco Driving

In Vermont, current petroleum-fuel-reduction programs include:
VTCCC is now beginning work on the two-year project Removing Barriers, Implementing Policies and Advancing Alternative Fuel Markets in New England. Collaborating with Clean Cities coalitions in Maine, New Hampshire, Massachusetts, and Rhode Island, this project includes:

- Work with MPOs
- Draft Model Policy Language
- Barrier Reduction Initiatives
- Safety & Training Initiatives
- Market Development & Outreach Initiatives

The relationship between measures of urban form and body mass index in diabetic adults: A case study from Vermont

By Austin Troy, PhD1 and Benjamin Littenberg, MD 2

1. University of Vermont
   Transportation Research Center
   Austin.Troy@uvm.edu

2. University of Vermont
   College of Medicine

We analyzed the relationship between measures of urban form and body mass index (BMI) using data from the Vermont Diabetes Information System (VDIS) on 610 adult diabetics, while controlling for a number of potential confounders, including diet, exercise, income, gender, age, medications, and others. We found a strong positive correlation between BMI and commercial density measured at a 250 meter scale, a result which remained significant even when spatial autocorrelation was accounted for. This result, which is contrary to much of the previous literature, suggests that the mechanism driving the relationship between BMI and density is different in a predominantly rural and exurban region like Vermont than in a large metropolitan area, which is where most of the previous literature was conducted. We hypothesize that the lack of a significant alternative to automobile transport coupled with a dispersed land use pattern means that marginal increases in density in most areas of Vermont are unlikely to lead to significantly greater walkability or active transport. Further, low commercial density may proxy greater access to outdoor recreation opportunities or greater necessity for outdoor physical labor related to rural occupations (e.g. farming) or property maintenance (e.g. brush clearance). However, another result suggests that density is not the only facet of urban form that matters: one of our two models finds a significant reduction in BMI for subjects living within 1 km of a designated downtown core. While density is higher than average in these cores, it may be other design characteristics associated with walkable neighborhoods—such as mix of uses, pedestrian infrastructure, and difficulty in parking—that make them more walkable, leading to lower BMI for nearby residents.
Testing an integrated land use and transportation modeling framework for a small metropolitan area

By Austin Troy, PhD1, Brian Voigt, PhD 2, Dale Azaria1 and Adel Sadek, PhD3

1. University of Vermont
Transportation Research Center
atroy@uvm.edu
2. University of Vermont
Rubenstein School of Environment and Natural Resources
3. SUNY Buffalo
Civil, Structural and Environmental Engineering

This poster introduces and summarizes a first-of-its-kind integration of a dynamic, second-by-second traffic router/micro-simulator (TRANSIMS) with the UrbanSim land use model, implemented in Chittenden County, VT. It first describes how and why these components were integrated. It next describes a preliminary comparison of the land use outputs of this highly complex and time-intensive model integration to a more standard integration of UrbanSim with a traditional four-step transportation demand model using TransCAD. Statistical tests found only slight differences in the land use predictions between the two model integrations for 2030. Although these differences were slight, their spatial patterns shed light on how transportation models influence the outcome of land use models. In particular, differences in land use predictions appear to relate to TRANSIMS’ predictions of emergent traffic bottlenecks along routes that serve peripheral areas where there is poor redundancy in route choice. These results suggest that land use models are at least somewhat sensitive to the type of transportation model that is used to generate accessibility measures. Nonetheless it is impossible to say with the data at hand which is more accurate for long term predictions. It is unlikely that the benefits of adding TRANSIMS or similar micro-simulators to a land use model outweigh the high costs of implementation. However, this assessment may vary with context. Our study site is a small metropolitan area with only modest population pressures and limited traffic congestion. Our results indicate that differences in predictions between model integrations grow as population forecasts are artificially increased, so integration of TRANSIMS may be of greater use in more congested areas.

Development of a High Speed Dual-Channel Impulse Ground Penetrating Radar for Transportation Infrastructure Safety Inspection

Tian Xia, Dr. Dryer Huston, Anbu Selvam Venkatachalal, Yu Zhang

Ground Penetrating Radar utilizes electromagnetic waves to study the underground structures, assess the quality and identify the defects. During the inspection, the radar transmitter emits EM waves into the subsurface structure. By analyzing the reflected signal, the properties of the subsurface can be identified and characterized. Such non-invasive technique can provide useful information for transportation infrastructure maintenance and condition assessment efforts. A variety of GPR systems are currently available for highway and bridge deck assessments. However, various factors, such as the relatively low signal sampling rate, bulky mechanical structure, and ground coupling antennas installed at close proximity to the detection surface, limit the scanning speed of these GPRs to speeds that are too slow to move with traffic, and instead require lane closures and other traffic disruptions. This research presents efforts at overcoming these drawbacks and constraints by developing a new air-launched UWB GPR system that can be installed at the bottom side of the vehicle to operate at the
normal driving speed, with customized signal processing methods to identify the targets like rebars and delamination. Of particular value is the subsurface inspection without disrupting normal highway traffic.

The system comprises of a dual-channel Ultra Wideband RF front end that generates high amplitude (~21 Vpp) nanosecond width pulses using a step-recovery diode based design, high speed real time sampling digitizer (8 Gsps) that acquires all the reflected pulses and multi-core high speed (4 cores and 3 GHz) processor for streamlined data acquisition from the ADC and signal processing in parallel. A FPGA based control system is designed to synchronize the two channels transceiver circuits, the digitizer and external peripherals (wheel encoder) to track the survey distance. Customized signal processing methods, including Curvelet Transform filter and Clutter Removal filter, have been developed to reduce systematic noise, environmental noise and clutter signal. Curvelet transform (CT) is a multi-scale analysis algorithm which can analyze the line and curve edge characteristics, and has better approximation precision and good directivity. Due to the high dielectric permittivity contrast at the air-ground interface, a strong response is recorded as ground reflection by GPRs. This response (clutter) is the main component of the interference which blurs the responses of objects buried under ground. Through frequency analysis of clutter and object geometrical models respectively, an adaptive high pass digital filter is designed to remove the clutter while preserve the object features. To test and evaluate the GPR performance, steel reinforcing bar detection experiments of different setups like suspended in air, in sand box, in concrete block, and in soil are performed.

**Active vibration damping for circuitry onboard aircraft**  
Stephen Pearson

Vibrating circuitry onboard aircraft can be systematically damped by a voice-coil damper. An accelerometer is mounted to a circuit board test simulation with its output is sent through a PID controller. The controller shapes a new signal based on the accelerometer output to counteract the vibrations incurred by the circuit board. The damping can help ensure the safety of the craft, minimize its weight saving fuel costs, and save time and money from repair. Reducing the weight of an aircraft by 1% will reduce fuel costs by 0.25% to 0.75%. This leads to a decrease in the associated carbon emissions, helping to preserve fossil fuels and the environment.

**Strategic Bidding and Contract Renegotiation**  
Richard Sicotte, Hojin Jung, Georgia Kosmopoulou, Carlos Lamarche

This paper studies how the anticipation of ex post contract renegotiation results in ex ante strategic bidding behavior, thereby increasing procurement costs. We estimate the incidence and magnitude of strategic bidding using recent data on road construction projects in Vermont. We show that firms bid less aggressively on items that are expected to have positive quantity adjustments and more aggressively on items that are expected to have either negative quantity adjustments or price adjustments. Our structural model allows firms to predict quantity adjustments based on their historical probabilities and their access to engineers’ project plans. Our empirical analysis shows that the magnitude of estimated markups is systematically higher for projects with positive quantity adjustments than those without such renegotiations. The difference in markups across renegotiated and non renegotiated projects exceeds the difference in relative project costs by 3.84% at the mean level. At the itemized level, bidders increase their markups and strategically adjust their bids upwards on items that have a high likelihood of positive renegotiation and lower their bids on items with no likelihood of renegotiation to maximize their potential surplus while maintaining a relatively high likelihood of submitting a winning bid.
A Literature Review of Fracture Experiments on Asphalt Mixtures

Ting Tan

In this poster presentation, a literature review was conducted to examine the current experiments for the study of fracture behavior of asphalt mixtures. Four major experiments, which are the Indirect Tension Test (IDT), Single Edge Notch Beam (SENB) test, Semi-Circular Bending (SCB) test and Disk-shaped Compact Tension (DCT) test, were summarized with their specimen geometries, testing approaches and application ranges. Limitations of current methods were described based on the crack growth control and fracture mode characterization in mode I and mode II. Prior research has shown that mode III also contributed to the crack propagation in pavement system. Thus, an innovative experiment method is proposed to measure the mixed mode I and III fracture of asphalt mixtures using helix notch cylindrical specimen under torsion. General description is introduced for the proposed method, and preliminary results of Portland cement concrete specimen is presented in the end.

Evaluation of Design Assumptions for Structural Backfill of Abutments and Retaining Walls

Brian Gomez

The American Association of State Highway and Transportation Officials (AASHTO), along with other federal guidelines, recommend a maximum 5% fines content in structural backfill to be used at bridge abutments and retaining walls. In addition to providing effective drainage at these structures, guidelines specify the maximum fines content to be about 5% in an attempt to define a free-draining backfill condition where water is not retained behind the structure, thereby eliminating the need to design for hydrostatic pressure. It appears that this specification, related to the maximum fines content, is adapted largely as a rule of thumb since hydraulic conductivity of a soil is expected to decrease with increasing fines content. However, the effect of fines on hydraulic conductivity in structural backfills has not been studied in detail. In addition, guidelines on how far this high quality backfill should be extended behind an abutment or retaining wall are not clear.

The availability of quality structural backfill is declining and by specifying maximum allowable fines content to only about 5%, increases the cost of construction if not warranted. Therefore, this research investigates hydraulic conductivity and shear strength parameters of a granular structural backfill as the fines contents are changed systematically in a laboratory. The effects of placement density and confinement on these parameters are also studied. In addition, finite element simulations are conducted to investigate optimum geometry of the backfill configuration.