Student projects that have received support from the UVM Transportation Research Center

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Aaron Witham

Organizational Characteristics that Relate to a Central Presence in Hyperlink Networks in the Context of Sustainable Transportation

Advisor: Richard Watts, CDAE

A hyperlink network analysis was conducted on 121 organizations promoting sustainable transportation policy in three primarily rural, adjacent states: Maine, New Hampshire, and Vermont. Previous studies have linked web presence with organizational success. Organizations in this study include regional planning commissions, metropolitan planning organizations, governmental departments, and non-profit advocacy groups. A web crawler was used to gather data on which organizations hyperlink to each other. This data was then used to construct social network maps illustrating how each organization fits into the larger architecture of their state network. Researchers were interested in determining what organizational characteristics relate to having a central location within these networks. After calculating different measures of centrality, correlations were run between centrality and a range of organizational attributes that were collected from an online survey of participants. These attributes included how influential an organization is according to its peers, how frequently it communicates with others, how useful its information is to others, what year it began focusing on sustainable transportation, founding date, budget size, number of paid and unpaid staff, percentage of resources dedicated to sustainable transportation, and number of partnerships related to sustainable transportation. Additionally, the centrality scores were correlated with data on media coverage in the Associated Press between 2008-2010. Results show significant correlations with media coverage, frequent communication, and the perceived influentialness of the organizations. This suggests, among other things, that transportation organizations with a central online presence surrounding a given topic tend to be more influential toward influencing that topic in the policy arena.

Qiong (Nancy) Liu

Examining spatial autocorrelation for obesity in northern New England

Advisor: Brian Lee, CEMS

The paper will begin with an examination of Spatial Autocorrelation (SA) for obesity in Northern New England. The existing literature mostly ignores the spatial component and correlates obesity with environmental factors using traditional aspatial statistical methods, which could produce biased results if spatial patterns exist. Using data from a three-state transportation survey, the Body Mass Index (BMI, representing obesity) of the respondents will be examined for the existence of SA at different spatial scales. If strong SA is detected, then analysis using spatial regression methods will be performed. Those results will be compared with the results from aspatial regression methods and assessments will be made on the importance of accounting for SA. It is expected that by using both spatial and aspatial regression methods, different relationships between obesity and the built environment will be found, which would reinforce the significance of examining SA before conducting traditional aspatial analysis.

Joseph Krupa

Consumer Survey Data Analysis for Market Adoption of Plug-in Hybrid Vehicles

Advisor: Donna Rizzo, CEMS

Concerns regarding instability in oil prices and environmental health have led to pressure in the United States to reduce oil consumption and pollution associated with transportation. Plug-in Hybrid Electric Vehicles (PHEVs) are one potential factor in oil consumption and pollution reduction, while offering many of the same capabilities of conventional vehicles. However, it is not clear what combinations of governmental policies and manufacturer-marketing strategies will be most cost-effective in promoting successful market penetration of this new vehicle technology. In this work, we attempt to detect novel multivariate associations using real-world consumer survey data, with the aim of discovering which demographic or attitudinal characteristics might best predict whether consumers are likely to become early adopters of PHEVs. We collected a large consumer dataset using Amazon Mechanical Turk (a crowd sourcing platform). Demographic comparisons to USA demographics show strong nation-wide representation. To overcome the statistical challenges inherent to large datasets, preliminary exploration utilized a genetic algorithm to find which combination of consumer attributes best predict their likelihood of purchasing a PHEV. Prediction capability and attribute associations are also explored with more traditional statistical methods and Artificial Neural Networks. These findings will then be used to better inform our existing agent based
model of PHEV market penetration, with the ultimate aim of helping policy makers identify leverage points where policies might be most effective in promoting consumer adoption.

Richard Nam

*Intra-household Vehicle Allocation and Transportation System Efficiency*

**Advisor: Brian Lee**

The reduction of personal vehicle fuel consumption may be achieved in three ways. They include changes to travel behavior, vehicle technology and fuel efficiency. In this study, the effect of intra-household vehicle allocation, one type of travel behavior, on fuel consumption is analyzed. Recent advances in vehicle technology have improved fuel efficiency but there may be possible reductions in fuel consumption from changes in travel behavior. One such behavior may be the result of maximizing the fuel efficiency of existing household fleets. Intra-household vehicle allocation is the decision process in which households assign their vehicles to their drivers. The reduction in fuel consumption occurs when the household driver with the highest annual VMT is reassigned to the vehicle with the highest miles per gallon (MPG) rating, and so forth. Data for this study comes from the 2009 National Household Travel Survey Vermont Add-on. Our analysis includes only households with a vehicle fleet of two or greater and who reside in the state of Vermont (households, n=1190). Due to the predominately rural environment of Vermont and the limited number of alternatives to personal vehicle travel, changes to the intra-household vehicle allocation process may have a large impact per household than their more urban counterparts. Within this sample 29.8% of households exercised efficient intra-household vehicle allocation behaviors. In our preliminary analysis, we found a 3% to 11% reduction in fuel consumption if households allocated their vehicles efficiently. The next step in our analysis is to develop models that can help explain inefficient intra-household vehicle allocation.

Nathan Belz

*Ridesharing and the Journey to Work in Vermont: Modeling Composition of Vehicle Occupancy using the 2009 National Household Travel Survey*

**Advisor: Lisa Aultman Hall, CEMS**

Ridesharing serves to mitigate pollution and congestion with minimal investment of public capital while also increasing the efficiency of the transportation system. This research addresses the gaps in the literature on the structure and formation of ridesharing by identifying individual, household, and physical-environment characteristics that correspond with an individual’s choice to rideshare instead of drive alone. In order to fully understand ridesharing behavior, there first must be a better understanding of who is in the vehicle not just how many. A distinction is made between *intra*-household (internal) and *inter*-household (external) ridesharing. Using the Vermont add-on sample of the 2009 National Household Travel Survey, a multinomial logit and nested logit model were developed to examine the determinants of ridesharing. The analysis in this research stresses the importance of how ridesharing behavior is extracted from survey data - improper methods drastically under-represent number of trips being taken with multiple occupants. Further, a new method for calculating household vehicle availability is presented, which places less importance on drivers that are not full-time workers. The results indicate that employment density, distance to work and working in small urban area have positive influences on the likelihood of ridesharing. Vehicle availability, age, sex (male), and time spent per trip on the journey-to-work were all found to negatively influence the propensity to rideshare. Cost of travel does not emerge as having a significant effect on ridesharing likelihood.

Kristin Williams

*Spatial effects of roads on soil nematode communities in forested areas of Vermont*

**Advisor: Deborah Neher**

Roadways have a potential number of ecological effects on adjacent soil communities via physical and chemical alteration of the roadside. The objective of this study was to determine the spatial extent of the effect of the road and these transported materials on forest soil nematode communities immediately surrounding roadways based on road type (highway, 2-lane paved, and gravel rural). This research is located within two watersheds in the state of Vermont, where deicing salts are spread regularly on roads during winter months. Transects were constructed at right angles to the road, with samples along each transect based upon micro-topography. Soil quality was also determined by chemical and physical analysis. The proportion of nematode trophic groups proved to be a more useful indicator of micro-topography effects than did the maturity index or genera diversity, though there were statistical differences (p≤0.05) in most measures based upon road type. Transect topography also affected the results. The ditch is a specific feature with a different nematode community
including the prevalence of algal feeders, probably due to the water, pollutants and nutrient regime. It was difficult to separate out the effects of pollutants from the effects of alteration in vegetation. In many cases the forest nematode community was different from that of the grassy roadside. However, results suggest that pollutants are being filtered by the forest edge. There was a higher proportion of fungal feeders in the forest, and higher proportion of plant feeders in the roadside. Canonical Correspondence Analysis revealed that not only did nematode trophic structure change with distance from the road, but also the composition of families and genera. Results suggest that larger grassy areas associated with high traffic, high speed roads may be vectors of plant parasites.

Brad Lanute
Assessing Urban Sprawl Metrics and their Applicability to Chittenden County, VT
Advisor: Austin Troy, RSENR
There have been barriers to the adoption of a consensus definition of urban sprawl despite a large literature on the subject that acknowledge both its importance in producing negative social and environmental outcomes as well as its multi-dimensionality. This is the consequence of many unrelated disciplines researching the phenomena with their own methods and interests as well as the highly contextual nature of the phenomenon of sprawl itself. Consequently, this has hindered consensus over how to measure sprawl from a built form perspective leading to many approaches as well as various metrics explaining similar dimensions of urban sprawl. There have been various studies that have developed such metrics in an attempt to find significant relationships between built form and conventional outcomes that are expected from urban sprawl such as increased vehicle miles traveled. The aim of this talk is to present an assessment of what dimensions are typically measured with regard to sprawl, what particular metrics have been developed to measure those dimensions, and finally, what approaches and metrics seem appropriate for the measurement of sprawl in Chittenden County, VT.

Alexander Hilshey
An Activity-Based Travel-Demand Modeling Approach to Estimating Electric Vehicle Charging Load
Advisor: Paul Hines, CEMS
Plug-in Electric Vehicles (PEVs) require a substantial electric load to charge batteries between travel tours. Given mass adoption of PEVs, battery charging may create new power load peaks during non-traditional times or may substantially increase the magnitude of pre-existing load peaks. These peaks are periods in which electric distribution infrastructure, specifically distribution transformers, may incur increased aging, which may potentially lead to component failure. Understanding how PEV charging will impact distribution transformer aging is important to utilities who are preparing to support the PEV fleet. This paper describes a method to estimate PEV charging load profiles using concepts in activity-based travel demand modeling. The model will dynamically predict PEV driver travel behavior based on one-day travel survey data, from which charging load characteristics (charging start time and duration) may be obtained. Though research is still in progress, results of this study are expected to show that the activity-based approach to PEV load forecasting reduces bias as compared to more simplistic stochastic PEV load models, yet still compares favorably to PEV load forecasts generated with a pure sampling strategy assuming actual travel behavior data. Additionally the model will serve as a solid starting point for dynamically generated multi-day PEV load forecasting.

Tiyasha De Pinto
Integrating Sustainability with Transport Asset Management Processes: Governance of Intergovernmental Decision Making on Prioritizing Transport Projects
Advisor: Asim Zia, CDAE
For enabling the integration of sustainability considerations in transport asset management processes, this study assesses the critical role of governance of intergovernmental decision making, which is undertaken by state and regional agencies to prioritize transportation projects for STIPs (State Transportation Implementation Plans) required by federal legislation. We hypothesize that the criterion of “system preservation” dominates the selection and implementation of transportation projects in the current governance network. In contrast, environmental sustainability related criteria are under-emphasized in project prioritization processes. We test this hypothesis by statistically modeling the STIP project prioritization processes between Chittenden County Metropolitan Planning Organization (CCMPO) and Vermont’s Agency of Transportation (V-Trans) for two project classes between 2006 and 2010: roadways and traffic operations. Focus groups, interviews, and analysis of CCMPO and V-Trans project prioritization data informed the statistical modeling of complex inter-governmental and technical
decision making processes undertaken by this intergovernmental governance network. We find a statistically significant effect of “system preservation” criterion on project prioritization scores, while the projects that score better on environmental sustainability criteria in CCMPO’s assessment are under-prioritized by V-Trans. We discuss the implications of these findings on the need to modify the governance of intergovernmental decision making processes for prioritizing transport projects if sustainability considerations are to be seriously integrated with transport asset management and investment decision making processes.

Tyler Feralio
Title: Development of an Exhaust Dilution System for Real-World Particle Number Emissions Quantification between Petroleum-based Diesel and Biodiesel Fuels
Advisor: Britt Holmén, CEMS
Particulate matter (PM) is one of the six criteria pollutants addressed by the Environmental Protection Agency’s (EPA) National Ambient Air Quality Standard (NAAQS) (EPA, 08NOV2011). PM can cause adverse health effects because it is readily inhaled. As particle size decreases, the risk of these adverse health effects increases because smaller particles can penetrate farther into the human respiratory system to reside in the deep lung (EPA, 06JUL2011).
Transportation vehicles are main contributors to PM pollution in urban areas. Recently, there has been an increase in the use of biofuels for transportation. Bio-diesel is the biofuel of choice for vehicles powered with compression ignition (CI) engines. In this work, a sampling system was developed to enable measurement of the differences in exhaust particle number distributions from a CI engine fueled by both petroleum-based diesel and soy-based biodiesel fuel. This system draws a sample of the raw exhaust out of the tailpipe and dilutes it with clean, dry air. Reasons for this dilution include:

1. When the raw exhaust exits the tailpipe of a vehicle, it dilutes as it mixes with the atmosphere. This diluted mixture is what enters the respiratory system and is, therefore, what should be studied.

2. Instrumentation used to measure particle number distributions emissions cannot sample raw CI engine exhaust because the particle concentrations and exhaust temperatures are too high.

The dilution ratio of this sampling system must be closely monitored to ensure that measurements taken from test to test are equivalent. This has proven to be a difficult task primarily due to the pressure pulses found in an engine exhaust system. After extensive testing and modification, the measure of dilution ratio has improved greatly. Preliminary particle number distribution data is presented here for Petroleum-based diesel fuel, B20, B50, and B100.


John Kasumba
Chemical characterization of primary and secondary biodiesel exhaust particulate matter
Advisor: Britt Holmén, CEMS
There is an effort to replace petroleum-based diesel with biodiesel because biodiesel is renewable, and recent research has shown that the levels of some regulated emissions e.g., particulate matter (PM), CO, and SO2 from biodiesel are less than those from petrodiesel. Therefore, there has been an increase in biodiesel production and use in recent years. Some studies have, however, indicated that the unregulated toxic emissions like carbonyls from biodiesel are more compared to those from petrodiesel. Also, there is little information concerning the interaction of biodiesel exhaust PM with atmospheric oxidants such as ozone. The oxidation products of the reactions between ozone and the carbonyls emitted in the biodiesel exhaust could have worse health and environmental impacts than the primary emissions.
An Armfield Limited CM12 Automotive Diesel Engine operated in an aggressive cycle driving mode is used to generate PM from various biodiesel feedstocks (soybean, canola, and animal fat). The PM emissions are 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; electrical low pressure impactor, Teflon filters for measuring the gravimetric mass, and quartz fiber filters (QFF) for chemical analysis of the exhaust PM. Chemical analysis of the biodiesel exhaust PM is performed using gas chromatography mass spectrometry (GCMS). Recent laboratory experiments have concentrated on developing a method for extracting and analyzing the polar and non-polar compounds in the biodiesel exhaust PM using laboratory standards. In the future, PM sampled with QFF’s will be exposed to different ozone concentrations over a 24-hour period at room temperature
in order to investigate the products of the reactions between ozone and the carbonyls emitted in biodiesel exhaust PM. Carbonyls, PAHs, and quinones will be the compounds of interest in these experiments.

Geoffrey May

*Vibration Monitoring and Load Characteristics Evaluation of I-89 Bridge 58N*

**Advisor: Eric Hernandez, CEMS**

Along with most states in the country Vermont has a rapidly aging infrastructure. A significant number of bridges, culverts, and roads are in dire need of repair or require complete reconstruction. The yearly monetary commitment to improve Vermont’s infrastructure is in the scale of tens of millions of dollars, at a minimum. With tight local, state, and federal budgets; reliable methods to prioritize repair/reconstruction projects are needed. The current methods for bridge condition assessment and repair prioritization rely on visual inspections by trained structural engineers; needless to say, these inspections are tedious, time consuming, and sometimes ambiguous. New methods recently developed at the University of Vermont which implement state-of-the-art sensors and signal processing technology along with structural dynamics and optimal estimation theory allow for real time bridge diagnosis, thus removing some of the drawbacks of visual inspections. The University of Vermont’s Structural Monitoring and Diagnostics Lab is partnering with the Vermont Agency of Transportation to instrument and monitor Bridge 58N on Interstate 89 in the town of Richmond, VT. The instrumentation consists of 24 strain sensors and 10 accelerometers. The main objective of the monitoring project is to measure the performance of the steel stringers which support the concrete road deck. These measurements will serve as a calibrator for the load distribution coefficients used in bridge load rating. In addition, finite element models of the bridge will be formulated and updated to better understand the structural behavior and reliability of the bridge deck under heavy traffic loads.

Peter Pettengill

*Traveler Perspectives of Greenway Quality in Northern New England*

**Advisor: Robert Manning, RSENR**

Greenways exist across a range of landscapes from urban to natural and serve society as transportation corridors as well as recreational pathways. The intent of this research was to: (1) investigate the relationship between transportation and recreation from a greenway user’s perspective; (2) consider and integrate transportation and recreation frameworks that measure quality of greenway travel; and (3) determine the significance of settings in users’ perceptions of quality. On-site surveys of users across three greenways in northern New England (n=841) were administered to solicit knowledge of how travelers use and perceive the quality of these facilities. Findings suggest greenways are used primarily for recreation, but often incorporate varying elements of transportation. Furthermore, travelers’ perceptions of quality differ across settings. This paper also illustrates that transportation and recreation planning frameworks may be integrated to provide a more holistic approach to greenway planning and management.

Phoebe Spencer

*Bicycle Commuting in Vermont: Environmental, Social, and Physical Challenges in a Northern Climate*

**Advisor: Richard Watts, CDAE**

Bicycle commuters in many areas of the world face the challenges inherent in combining non-motorized transportation and car-centric roadways. Commuters in Vermont are posed with the added challenge of a northern climate that makes cycling a largely seasonal activity. Although these conditions limit the popularity of year-round cycling, the work of bicycle advocacy groups and infrastructure improvements implemented by both the state and city governments have allowed cycling to become a functional transit mode and viable alternative to automobile transportation for many Vermont residents. Despite this growth, commuters continue to face limitations to bicycle use, especially when overcoming geographic and climatic conditions. Steep hills, snow, and limited daylight hours deter commuters from bicycling year-round, and these uncontrollable factors have put the metaphorical brakes on many potential cycling trips. A review of previous literature and policies suggest that non-motorized mobility is largely dependent on environment and social attitudes. This study aims to examine issues surrounding bicycle commuting in Vermont through a qualitative analysis of transcripts from focus groups and individual interviews. Transcript analysis software is used to identify major concerns for cyclists in Vermont with the goal of identifying specific barriers that can then be overcome through policy, behavioral, and infrastructural changes. These issues are important in recognizing limitations to mobility and working to break down these barriers.
Elysi Nelson

A Social Capital Basis for Environmental Concern: Evidence from Northern New England

Advisor: Thomas Macias, CDAE

This study, based on a random-digit dialing telephone survey of adults in Maine, New Hampshire, and Vermont, uses ordinary least squares regression to examine a relatively neglected element in the sociological literature on environmental concern, namely, the influence of an individual’s social capital on the formation of environmental attitudes. We argue that it is those individuals with a greater diversity of social connections who are most likely to be influenced by ecological perspectives grounded in conservation and environmental protection. Controlling for other theoretically relevant variables, we regress an index of environmental concern that gives special emphasis to environmental-economic trade-offs on our measures of relational and community social capital. While confirming much of the earlier work in this area, our model provides evidence that connections to other people play an important role in determining individual concern for the environment. Specifically, the number of respondents’ “weak ties” --that is, not their closest relationships-- and the average occupational status of respondents’ social ties, in general, were both positively correlated with environmental concern. Additionally, one of our three measures of community social capital, the number of visits from friends over the past month, was statistically significant and negatively correlated with environmental concern.