Program Progress Performance Report
University Transportation Centers
Cover Page TranLIVE

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Project Title: TranLIVE (Transportation for Livability by Integrating Vehicles and the Environment

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SEMI-ANNUAL REPORTING CATEGORIES
TranLIVE
July 1, 2013 to December 31, 2013

1. ACCOMPLISHMENTS:

A. University of Idaho:

Joint graduate seminar series among all five partner universities for summer semester was a success.

i. *Developing and Testing Eco-Traffic Signal System Applications*

a. Documented the characteristics of fuel consumption and vehicle emissions at signalized intersection approaches using an advanced engine performance modeling software tool.
b. Investigated the relationship between actuated control parameters and fuel consumption and vehicle emission levels for fully actuated signaled intersections operating on an isolated or free mode of operation.
c. Developed guidelines for actuated control parameters to minimize fuel consumption and vehicle emissions for fully actuated signaled intersections operating on isolated or free mode of operation.
d. Developed an architecture for a Hardware-in-the-loop simulation environment for connected-vehicle applications at isolated intersections.
e. Compared and evaluated different corridor coordination control plans, optimized using different objective functions for fuel consumption and environmental efficiency.

ii. *In situ Transesterification of Microalgal Oil to Produce Algal Biodiesel*

At this stage, the objective was to find out the most influences process parameters and the optimized process condition for *in situ* microalgal biodiesel production.

Due to the large numbers of experiments (i.e., total 288), a large amount of time was required to conduct the experiments. During the past six months, 94 of the total 96 sets of experiments have been completed. There are still 2 sets to be conducted before statistical analysis and optimization can be performed.

Preliminary observation of the experimental results revealed that the *in situ* transesterification behaves quite differently under super-critical and sub-critical methanol conditions.

Once all samples are chemically analyzed, we will process and statistically analyze the data. Optimal process conditions will be concluded based on the statistical modeling and analysis.

iii. *Security and Survivability of Real-Time Communication Architecture for Connected-Vehicle Eco-Traffic Signal System Applications*

The work proposed in the project has been completed and the final report has been submitted for review.

iv. *Developing Active Learning Materials for the Introductory Transportation Engineering Course*

The objective for this project was to develop and test activity-based curriculum for the intersection operations section of the introductory course in transportation engineering. Research focused on concepts that presented difficulties to students and identifying ways in which the material to support conceptual learning could be improved. An initial draft of a module on signalized intersection operation was developed and tested during the spring semester 2013. As a result of this pilot test, significant modifications were made to this draft

module during the summer and fall 2013. Intensive external review of the material was conducted by five reviewers. A final version of the module was completed in December 2013.

v. ***Calibration of Multi-Scale Energy and Emissions Models***

a. Collected field vehicle-emission field data for different vehicle types under different speed and acceleration operation model using a tool that consists of an emission analyzer connected to the vehicle's exhaust tail pipe.
b. Generated and documented vehicle-emission and fuel consumption data for different vehicle types under different speed and acceleration operation model using the GT-Suite, an advanced engine modeling software tool.
c. Generated and documented vehicle-emission and fuel consumption data for hybrid vehicles using the GT-Suite model.

vi. ***Pyrolysis Bio-Oil Upgrading to Renewable Fuels***

The main desired impact of this project is the improvement of bio-fuels production to reduce the reliance on fossil fuels largely used in the transportation sector. Based on preliminary findings, Ni (nickel) based catalysts work well for converting pyrolysis bio-oil into hydrocarbons.

We have successfully prepared Ni-NS (nickel-nanospring), but at low levels for this proof of concept study. We have developed a range of tools to characterize the catalysts and assess its activation. The Ni-NS catalyst gave low conversions of guaiacol (model compound) to products, but the starting material/Ni ratio was 1000:1 which proved to be an effective catalyst.

Main accomplishments:

a. Fractionation of pyrolysis bio-oil: bio-oil was produced via the fast pyrolysis of pine at 500˚C.
b. Catalyst preparation and characterization.
c. Hydrogenation of bio-oils and model compounds.
d. The final report has been submitted for review.

vii. ***Progress in Catalytic Ignition Fabrication, Modeling and Infrastructure***

Work progressed with updating some of the Small Engine Research Facility equipment and the final report has been submitted for review.

a. A dynamometer-equipped engine has been setup to train student researchers on how to safely and properly use the dynamometer and emissions equipment before they do those types of tests on their research engines.
b. Using additional funding from the Murdock Trust (match funding), we were able to purchase research-quality exhaust analyzers for carbon dioxide, oxygen, nitrogen oxides, carbon monoxide, and unburned hydrocarbons. These funds also allowed us to purchase components to upgrade our fuel meter cart. The system will interface with our mini-dilution tunnel and particle mass monitor.
c. An in-cylinder heat release model has been created that allows the simulation of instantaneous in-cylinder pressure, emission formation, and effects of ignition timing on these parameters. It has been used to predict an efficiency map for the YZ250F engine, and was validated by experimental data collected in the Small Engine Research Facility.

viii. ***Design Improvements and Performance Validation of a Competitive Hybrid FSAE Vehicle***

a. The first year final report has been completed and can be viewed at http://tranliveutc.org/engr/niatt/tranlive/projects/2012/design-improvements-and-performance-validation-of-a-competitive-hybrid-fsae-vehicle.

b. The second year work on the vehicle is underway. Component redesign began summer 2013. Notable improvements include an updated battery management system, new brake calipers (to reduce rolling resistance), throttle-by-wire engine control, and an integrated hybrid system controller that will make decisions about the split of power contributed from each system.

ix. ***Curriculum Development for K-12 Sustainable Transportation Education***

a. Created an Instructor's Guide for a ten-day summer camp. The guide is comprised of three units related to sustainable transportation (see table below).

Unit	Day	Topic	Activity
Vehicle Technology	1	Vehicle Dynamics	Calculate Vehicle Forces
	2	Engine Design	Test Engines
	3	Emissions and Pollutants	Calculate Emissions
Traffic Engineering and Operations	4	Vehicle Detection	Design Loop Detector
	5	Coordinated Intersections	Coordinate Traffic Signals
	6	Traffic Safety	Use Driver Simulator
	7	Highway Design	Design a Highway Section
Transportation Science and Planning	8	Traffic Forecasting	Estimate Traffic Impacts
	9	Bicycle and Pedestrian Planning	Conduct Pedestrian Audit
	10	Public Transportation	Plan a Bus Route

b. Delivered a two week summer camp on the UI campus. Working with STEM Access Upward Bound, we hosted and taught 21 high schools students.

c. After the on-campus summer camp, the students went to Washington, DC to meet with congressmen, learn about transportation policy, and experience the traffic of a large city.

d. Surveyed and interviewed the student participants to assess learning and impact from the summer camp.

e. Preparing a scholarly publication to report our findings.

x. ***A High-Speed Trapezoid Image Sensor Design for Continuous Traffic Monitoring at Signalized Intersection Approaches***

A unique image sensor was designed and sent for fabrication on January 3, 2014. Software for background and moving objects extraction was developed and demonstrated on a platform using an existing rectangular imager.

xi. ***Upgrading Biomass Pyrolysis Bio-oil to Renewable Fuels***

We have prepared Ni decorated nanosprings (Ni-NS) catalysts for (i) characterization of the catalyst by x-ray photoelectron spectroscopy (XPS), H_2-temperature programmed reduction (H_2-TPR) analysis, and electron microscopy, (ii) evaluated the activation conditions (reduction) of NiO to Ni on the Ni-NS catalysts, (iii) produced several batches of Ni-NS on stainless steel mess support for catalysis evaluations.

Hydrodeoxygenation (HDO) treatment on guaiacol (a bio-oil compound) was carried out in a batch reactor. The Ni catalytic HDO reactions have been carried out in batch reactors with long reactions times. Analysis of the products is still underway.

xii. ***Direct Drive AC Rim Motor for Responsive Energy Control of Alternative Electric Vehicle***

Senior design teams: Our first senior design team, composed of Electrical Engineering seniors, completed their work on battery design. Our second senior design team began designing the major subsystems of the Electric Vehicle.

When we created the team, more than twenty volunteers showed up. They have been helping with the designs described above. They are also porting over the work from the Hybrid Vehicle Team that finishes its work this upcoming semester.

xiii. ***Daily Travel Feedback to Encourage Eco-Routing***

a. Collected GPS data: We provided a GPS app to 81 volunteer participants to collect their travel behavior for one week.
b. Developing a webpage to provide feedback to users.

xiv. ***Eco-driving Modeling Environment***

a. Developed a simplified fuel efficiency model based on a generic brake-specific fuel consumption (BSFC) map for an inline 4-cylinder engine. By using the engine RPM and engine torque variables provided by the NADS MiniSim with the generic BSFC model, power and approximate engine efficiency, fuel consumption, and fuel economy can be estimated within the MIniSim simulation environment.
b. Using Windows Presentation Foundation (WPF) an EcoDash was created and will run along with other system components in real-time with MiniSim. The developed EcoDash overlays on top of the existing MiniSim Dashboard that include a speedometer, a tachometer, and in the center of the speedometer cluster is an acceleration display.

B. <u>Old Dominion University</u>:

i. ***New Strategies for the Emergency Vehicle Routing to Reduce Response Time Using Vehicle-to-Vehicle Communications*** **-** Nothing to report at this time.

ii. ***Real-Time Prediction of Queues at Signalized Intersections to Support Eco-driving Applications***

Drs. Cetin and Rakha collaborated on a TRB paper to estimate the total fuel consumption and CO_2 emissions at a signalized intersection from the data provided by probe vehicles. Traffic flow through an intersection is simulated to generate vehicle trajectories under both congested and uncongested conditions. Six different vehicle types are modeled in the simulation for the purpose of calculating fuel consumption levels. By using the VT-CPFM, the total fuel consumed by each vehicle is determined for a given trajectory. Several alternative methods are presented to estimate the total fuel consumption from the sample data provided by the probe vehicles. The results show that a simple extrapolation of the fuel consumed by probes to the rest of the traffic does not yield very accurate results. A more accurate solution is obtained by capitalizing on the probe trajectories to construct trajectories for the non-probe vehicles.

iii. ***Exploring Image-based Classification to Detect Vehicle Make and Model***

Project completed. Final report can be viewed at http://tranliveutc.org/engr/niatt/tranlive/projects/2012/exploring-image-based-classification.

iv. ***A Study on the Impact of Parameter Uncertainty on the Emission-based Ranking of Transportation Projects***

Using various test sites in Virginia Beach, extensive analyses were conducted to investigate the impact of capacity, demand and emission uncertainty on the ranking of capacity expansion projects when the goal is to reduce vehicular emissions (using MOVES). We have found that previous analyses in the related literature employed procedures that might be inadequate as confidence intervals have not been used. Using our new procedures, among all test networks, it was found that project selection based emissions is rather robust to uncertainty. In order to reduce the significant amount of computation time running MOVES, we also investigated the effectiveness of using common random numbers. It was found that computation times were reduced substantially.

v. ***Reducing Energy Use and Emissions through Innovative Community Designs: Methodology and Application***

Behavioral models were developed and literature provides a sense of how people might respond to information. A paper on volatility of driver decisions was accepted for presentation in the 2014 annual meeting. The paper articulates how to generate eco-friendly traveler information.

Work completed also includes obtaining smart growth scenario data, and developing a Hampton Roads model in TransCAD.

vi. ***Optimize Freight Routes and Modes to Minimize Environmental Impacts***

a. Additional literature was reviewed to account for new information found relating to similar work.
b. A conceptual model has been discussed for data retrieval and calculation.

C. <u>Syracuse University:</u>

i. The TranLIVE research projects undertaken by Syracuse University are as follows:–

a. Project 1: *Enhancing TSM&O Strategies through User Cost Analysis and Life Cycle Assessment*; Xifan (Jeff) Chen is now in the process of collecting various ITS elements data from different resources to calculate their lifecycle impacts using GaBi, and performing their lifecycle benefit/cost analysis. Sharareh Pirzadeh is helping Jeff.
b. Project 2: *Assessing Social and Environmental Impacts of Work-Zones in Arterial Improvement Projects*; Sudipta Ghorai identified various MRR activities for flexible and rigid pavements and has done a thorough study of their construction process. He used LCA tools like "Athena Impact Estimator for Highways" and "GaBi" to evaluate the life cycle environmental impacts of various MRR activities in terms of CO_2 equivalent.
c. Project 3: *Assessing Environmental Impacts of Traffic Congestion and Vehicular Emissions on Groundwater and Fresh Water Supplies*; Jeremy Tamargo has developed sample extraction and analytical methods for PAH analysis. He has also developed methods for collecting rain runoff samples and extracting the PAH. Mallory Squier has calibrated the water flow measurement equipment, developed a wireless transmission link so that signals from the equipment can be transmitted directly to the SU campus, and set up a rain/snow collector for measuring the incoming precipitation.

D. <u>Texas Southern University</u>:

i. ***A Systematic Evaluation of the Impacts of traffic Condition Information on the Reduction of On-road Mobile Emissions***

a. Reviewed collected GPS based speed profile data from both freeway and arterial road sections in Houston, Texas for a period of six months.
b. Developed the input required for running MOVES.
c. Developed models for estimating emissions for different types of roadways under different congestion levels.
d. Conducted case studies to evaluate the impacts of traffic condition Information on vehicle emissions under an incident condition.

ii. ***Education and Outreach Activities***

Support for student travel to present research papers or to attend academic conferences, including:

a. The 2014 TRB Annual Meeting, Washington DC, January 12-16, 2014.
b. Intelligent Transportation Society Texas Chapter Annual Meeting in Houston, December 2013.

iii. ***Develop an Integrated Data Management System at the Microscopic, Mesoscopic, and Macroscopic Levels to Assess the Environmental Impacts of Transportation System***
   a. Further improved framework of the data management system, including the data structure, and vehicle emission and travel activity data sources.
   b. Further improved computer programs.
   c. Used part of emission and activity data collected at TSU to test the computer program and web language.
   d. Further tested part of the database for sample use of emission estimation for different purposes (drive through lane at restaurants, heavy duty diesel buses, LDVS VSP,etc.).

iv. ***Use the Driving Simulator to Synthesize the Related Vehicle Specific Power (VSP) for Emission and Fuel Consumption Estimations***

The VSP from simulator and from real-world are compared and analyzed. A summary of the comparison was presented at the ITS 2013 annual meeting in Japan.

v. ***Develop Multi-scale Energy and Emission Models for Arterial Traffic Systems***
   a. Developed city-specific driving cycles for transit buses based on VSP distribution.
   b. Analyzed emission characteristics of heavy-duty diesel transit buses at intersections of urban areas.
   c. Developed speed correction factors based on speed specific VSP distributions for urban restricted access roadways.
   d. Analyzed the effects of bus rapid transit policy strategies on CO_2 emissions.

vi. ***Improve the Environment for a Livable Community: Advance the AERIS Program by Developing and Testing Eco-traffic Signal System Control Applications***
   a. The test of the developed V2I communication system is further analyzed at un-signalized intersections, signalized intersections with sun glare, and in work zones. Impacts of different human factors are in further analyses.
   b. Tested eco-driving in front of an intersection with different scenarios and tested the V2I system in driving simulator for more and safer scenarios.

vii. ***Developing Short Range Vehicle-to-Infrastructure Communication Systems***
   a. Developed a wireless communication system to provide warning message to drivers when approaching intersections, work zones and other areas.
   b. Tested in stop sign intersections, signalized intersections with sun glare, and work zones.
   c. Further testing in driver simulator for more scenarios considering more human factors.

E. <u>Virginia Tech</u>:

i. ***Develop Eco-adaptive Cruise Control Systems***
   a. Compared and evaluated different forms of driving (manual, conventional cruise control and eco-cruise control).
   b. Tested the eco-drive system on a sample freeway section and wrote a paper on this effort.
   c. Final report has been submitted for review.

ii. ***Develop Green Cooperative Adaptive Control Systems in the Vicinity of Signalized Intersections***
   a. Developed the cooperative adaptive control system logic in the vicinity of signalized intersections.
   b. Extended the logic to use dynamic programming to optimize the driver throttle input on a continuous basis.

iii. ***Develop Dynamic Eco-routing Systems***
   a. Tested the eco-routing logic on two large networks: downtown Cleveland and downtown Columbus.
   b. Final report has been submitted for review.

iv. ***Develop Multi-scale Energy and Emission Models***

a. Developed and validated the VT-CPFM model.
b. Started developing a framework for modeling diesel engine vehicle fuel consumption levels.
c. Started developing a framework for modeling transit vehicle fuel consumption and emission levels.
d. Investigated the potential for use of electrified vehicles to serve traveler needs using naturalistic driving data.

2. PRODUCTS:

A. University of Idaho:

i. ***Developing and Testing Eco-Traffic Signal System Applications***

a. Sherief Elbassuoni and Ahmed Abel-Rahim, "Modeling Fuel Consumption and Emissions at Signalized Intersection Approaches: A Synthesis of Data Sources and Analysis Tools", Proceedings of the 54th Annual Transportation Research Forum, Annapolis, Maryland, March 21-23, 2013, pp. 156-170.
b. Thesis: Christopher (Kip) Davidson, "Actuated Control Parameters to Reduce Vehicle Emissions and Fuel Consumption at Isolated Intersections," December 2013.

ii. ***In situ Transesterification of Microalgal Oil to Produce Algal Biodiesel***

a. A manuscript was published:
Bi, Z. and B. He. 2013. Characterization of microalgae for the purpose of biofuels production. Trans. ASABE 56(4):1529-1539.
b. A technical presentation on preliminary study of *in situ* transesterification of microalgal oil to produce algal biodiesel was presented orally at the 2013 International Annual Conference of the ASABE held in Kansas City, KS on July 23, 2013.

iii. ***Security and Survivability of Real-Time Communication Architecture for Connected-Vehicle Eco-Traffic Signal System Applications***

a. Published: Ahmed Serageldin, Hani Alturkostani, and Axel Krings, "On the Reliability of DSRC Safety Applications: A Case of Jamming", in Proc. Intl. Conference on Connected Vehicles and Expo, (ICCVE 2013), Dec. 2-6, 2013, Las Vegas.
b. Accepted: Ahmed Serageldin and Axel Krings, "The Impact of Redundancy on DSRC Safety Application Reliability under Different Data Rates", submitted to the 6th IFIP International Conference on New Technologies, Mobility and Security, (NTMS 2014), Dubai, March 30 - April 2, 2014.
c. Submitted: Ahmed Serageldin, and Axel Krings, "The Impact of Dissimilarity and Redundancy on the Reliability of DSRC Safety Applications", submitted to the 28th IEEE International Conference on Advanced Information Networking and Applications (AINA-2014) Victoria, Canada, May 13-16, 2014.

iv. ***Developing Active Learning Materials for the Introductory Transportation Engineering Course***

a. Final report completed December 2013.
b. Final module completed December 2013. "Operation, Analysis, and Design of Signalized Intersections, A Module for the Introductory Course in Transportation Engineering," Michael Kyte and Maria Tribelhorn, University of Idaho.
c. Example and homework problems spreadsheet solutions and templates, initial versions completed December 2013.

v. ***Calibration of Multi-Scale Energy and Emissions Models*** **-** Nothing to report at this time.

vi. ***Pyrolysis Bio-Oil Upgrading to Renewable Fuels***

a. Poster 1: Alex Kengne, David McIlroy, Armando McDonald (2013) XPS study of a Fischer-Tropsch cobalt catalyst supported on silica nanosprings during reduction", presented at the 2013 symposium of the Pacific Northwest of the AVS (American Vacuum Society) held in Troutdale, Oregon, September 19 – 20, 2013.
b. Poster 2: Alex Kengne, David McIlroy, Armando McDonald (2013) XPS study of a Fischer-Tropsch cobalt catalyst supported on silica nanosprings during reduction, presented at the University of Idaho during the 9th annual College of Science Student Research Exposition, November 8, 2013.
c. Poster 3: Alex Kengne, David McIlroy, Armando McDonald (2013) "Reforming of syngas into higher order alkanes using a Fischer-Tropsch cobalt catalyst supported on silica nanosprings", was presented at the 2013 MRS (Materials Research Society) fall meeting, December 1 – 6, 2013, Boston, Massachusetts.

vii. ***Progress in Catalytic Ignition Fabrication, Modeling and Infrastructure***

A presentation and paper about the measurement technique for α(T) was made at the ASME International Mechanical Engineering Congress and Expo (IMECE).

Quinn, C., Steciak, J., Budwig, R., Beyerlein, S., "Measuring the Coefficient of Thermal Resistance of Nanospring Combustion Catalysts," ASME Publication IMECE13-64912, 2013.

viii. ***Design Improvements and Performance Validation of a Competitive Hybrid FSAE Vehicle***

a. A hybrid vehicle performance model has been completed, allowing in-house optimization. Once testing and validation is completed, a technical paper will be authored.
b. Thesis: Dylan Rinker, "Use of a TK Solver Performance Model in the Design and Testing of a Formula Hybrid Racecar," 11/15/13.
c. Year 1 final report complete http://tranliveutc.org/engr/niatt/tranlive/projects/2012/design-improvements-and-performance-validation-of-a-competitive-hybrid-fsae-vehicle.

ix. ***Curriculum Development for K-12 Sustainable Transportation Education***

a. The instructor's guide: This 70 page document provides lesson plans for 10 sustainable transportation topics. Each section is intended to engage students in a fun and interesting way while still presenting transportation engineering concepts and fundamentals.
b. PowerPoint Presentations for each lesson: The presentations contain interesting images and questions suitable for high school students.
c. Student created blog: The summer camp participants blogged each day about what they learned. For example, here is a blog entry concerning their lecture on calculating Stopping Sight Distance: http://stemaccess.wordpress.com/category/summer-activities/.
d. Student created videos about the engineering profession: The students interviewed practicing transportations professionals to learn more about their career. They turned the interviews into videos. For example, here is an interview of a Civil Engineer: http://www.youtube.com/watch?v=gUhAS6pGSaU.
e. Student created Engineering EXPO presentation: The students created a poster presentation that will be on exhibit for the University of Idaho's College of Engineering EXPO at the end of April (typically the expo is for university students, but our high school students have been given special permission).

x. ***A High-Speed Trapezoid Image Sensor Design for Continuous Traffic Monitoring at Signalized Intersection Approaches***

a. A unique image sensor design technique and software for extracting dynamic properties of traffic flow was developed. This new image sensor makes extracting the dynamic properties of traffic flow easier.

b. The software for background and motion detection was successfully demonstrated on rectangular image sensors. Testing will take place during Spring 2014 semester.

xi. ***Upgrading Biomass Pyrolysis Bio-oil to Renewable Fuels -*** Nothing to report this time.

xii. ***Direct Drive AC Rim Motor for Responsive Energy Control of Alternative Electric Vehicle***
A new design technique for smooth rotor induction motors will be presented at an upcoming conference on energy conversion.

xiii. ***Daily Travel Feedback to Encourage Eco-Routing -*** Nothing to report at this time.

xiv. ***Eco-driving Modeling Environment -*** Nothing to report at this time.

B. Old Dominion University:

i. ***New Strategies for the Emergency Vehicle Routing to Reduce Response Time Using Vehicle-to-Vehicle Communications***
A preliminary paper was submitted to the *93rd Annual Meeting of the TRB.* Beneficial comments were received for which some are being implemented in the research. The paper will not be presented at this year's conference.

ii. ***Real-time Prediction of Queues at Signalized Intersections to Support Eco-driving Applications***
a. O. Unal and M. Cetin "Estimating Queue Dynamics and Delays at Signalized Intersections from Probe Vehicle Data" To be presented at the *93rd Annual meeting of the TRB*, Washington, D.C., January 12-16, 2014.
b. M. Cetin and H. Rakha "Estimating Fuel Consumption at Signalized Intersections from Probe Vehicle Trajectories" To be presented at the *93rd Annual meeting of the TRB*, Washington, D.C., January 12-16, 2014.

iii. ***Exploring Image-based Classification to Detect Vehicle Make and Model***
a. The final product unifies the components into a single application allowing for the real-time processing of traffic surveillance camera footage through internet streaming protocol and archiving data output to a MySQL database for interface with the EPA MOVES simulator for performing carbon emissions estimation. Final report: http://tranliveutc.org/engr/niatt/tranlive/projects/2012/exploring-image-based-classification.
b. A. H. Yousef, J. B. Flora, K. M. Iftekharuddin, "Highway traffic segmentation using super-resolution and Gaussian mixture model", Proceedings of SPIE Vol. 8855, 88550G (2013).

iv. ***A Study on the Impact of Parameter Uncertainty on the Emission-based Ranking of Transportation Projects***
Upon finalizing the final report, a journal paper will be submitted.

v. ***Reducing Energy Use and Emissions through Innovative Community Designs: Methodology and Application***
a. We Wang X., A. Khattak, G. Amoli, S. Son, J. Liu, What is the Level of Volatility in Instantaneous Driving Decisions? TRB Paper 14-2780, National Academies, Washington, D.C., 2014. Plenary Session Invited Talk, 13th COTA International Conference of Transportation Professionals, CICTP, Shenzhen, China, August 2013; also presented at Hong Kong University of Science and Technology and at PacTrans Seminar Series at University of Washington.
b. Bandeira, J., D. Carvalho, P. Fernandes, T. Fontes, S. Pereira, N. Rouphail, A. Khattak, M. Coelho, Empirical Assessment of Route Choice Impact on Emissions Over Different Road Types, Traffic Demands, and Driving Scenarios. Forthcoming in *International Journal of Sustainable Transportation*, 2013.

c. Bandeira J., P. Fernandes, T. Fontes, S. Pereira, A. Khattak, & M. Coelho, Assessment of eco-traffic assignment strategies in an urban corridor. Submitted (August 01, 2013) for review in Transportation Research part C.
d. Son S., A. Khattak & K. Choi, Comparing Travel Behavior Between Transit-Oriented Developments and Automobile-Oriented Developments: Matched Pair Analysis, TRB Paper 14-2327, To be presented at the TRB National Academies, Washington, D.C., 2014.

vi. ***Optimize Freight Routes and Modes to Minimize Environmental Impacts*** **-** Nothing to report at this time.

C. <u>Syracuse University</u>:

i. Dr. Sam Salem, Sudipta Ghorai and Dr. Baris Salman**,** *"A Decision Support Framework for "Accelerated Bridge Construction",* lectern session in the TRB 93rd Annual Meeting, January, 2014 at Washington, DC.

ii. Dr. Cliff Davidson (Co-PI) served as a chair in the development committee of the Syracuse Center of Excellence 13th Annual Symposium held on October 21st, 2013.

iii. Jeff Chen and Sudipta Ghorai attended the Syracuse COE 13th Annual Symposium and a workshop on "Introduction to Construction Material Management: LEAN Strategies for Safe, Profitable Jobsites" offered by NYS Construction Management Material Center.

iv. Sudipta Ghorai presented "Lean Construction" for the course "CIE 400/600 Construction Engineering and Project Management" offered every fall by Dr. Salem.

D. <u>Texas Southern University</u>:

i. ***A Systematic Evaluation of the Impacts of Traffic Condition Information on the Reduction of On-road Mobile Emissions***
Qi, Y., A. Padiath, and L. Yu. "Development of Operating Mode ID Distributions for Different Types of Roadways under Different Congestion Levels for Vehicle Emission Assessment Using MOVES." Accepted for 93rd TRB Annual Meeting, Washington, DC, January 12-16, 2014.

ii. ***Education and Outreach Activities*** **-** Nothing to report at this time.

iii. ***Develop an Integrated Data Management System at the Microscopic, Mesoscopic, and Macroscopic Levels to Assess the Environmental Impacts of the Transportation System***
Hill, K., F. Qiao, M. Azimi, and L. Yu. "Impacts of Restaurant Drive-Thru Configurations on Vehicle Emissions." Accepted for 93rd TRB Annual Meeting, Washington, DC, January 12-16, 2014.

iv. ***Use the Driving Simulator to Synthesize the Related Vehicle Specific Power (VSP) for Emission and Fuel Consumption Estimations***
Li, Z., F. Qiao, L. Yu. (2013). A Calibration Algorithm for Vehicle Emission Estimation Using Driving Simulator (paper # 1030). Proceedings of the 2013 ITS World Conference in Tokyo, Japan. October 14-18, 2013.

v. ***Develop Multi-scale Energy and Emission Models for Arterial Traffic Systems***
a. Lai, J, L. Yu, G. Song, P. Guo, and X. Cheng. (2013). Development of City-Specific Driving Cycles for Transit Buses Based-on VSP Distribution – A Case of Beijing. Journal of Transportation Engineering, ASCE, Vol. 139, No. 7, pp. 749-757, July 2013.
b. Qiao, F., P. Kuo, and L. Yu. Fuzzy Modeling of Pedestrian Related Conflict Events at Intersections. Presented at 93rd TRB Annual Meeting, Washington, DC, January 12-16, 2014.
c. Chen, X., L. Yu, and Y. Wang. Analyzing the Effect of Bus Rapid Transit Policy Strategies on CO_2 Emissions: Case Study of Beijing. Presented at the 93rd TRB Washington, DC, January 2014.

d. Lai, J., L. Yu, G. Song, and X. Chen. Emission Characteristics of Heavy-duty Diesel Transit Buses at Intersections of Urban Area: A Case Study in Beijing. Presented at the 93rd TRB, Washington, DC, January 12-16, 2014.
e. Song, G., L. Yu, and L. Long. Development of Speed Correction Factors based on Speed-Specific VSP Distributions for Urban Restricted Access Roadways in Beijing. Presented at the 93rd TRB, Washington, DC, January 12-16, 2014.
f. Zhou, X., G. Song, and L. Yu. Delay Correction Model for Estimating Bus Emission at Intersections based on VSP Distributions. Presented at the 93rd TRB, Washington, DC, January 12-16, 2014.

vi. ***Improve the Environment for a Livable Community: Advance the AERIS Program by Developing and Testing Eco-traffic Signal System Control Applications***

a. Qiao, F., J. Jia, D. Zai, and L. Yu. Radio Frequency Identification-Based Drivers' Smart Assistance System to Enhance Safety and Reduce Emissions in Work Zone. Presented at the 93rd TRB and considered for publication in Transportation Research Record: Journal of Transportation Research Board series, Washington, DC, January 12-16, 2014.
b. Tang, P., L. Yu, and G. Song. Effect of Driving Behaviors on Emissions in Eco-driving at Intersections. Presented at the 93rd TRB, Washington, DC, January 12-16, 2014.
c. Zhao, Q., G. Song, and L. Yu. Comparative Study of VSP Binning Methods for Estimating Fuel Consumptions of LDVS on Urban Roads. Presented at the 93rd TRB, Washington, DC, January 12-16, 2014.

vii. ***Developing Short Range Vehicle-to-Infrastructure Communication Systems***

a. Qiao F., Y. Qiao, X. Wang, and L. Yu (2013), Developing Wireless Warning System to Enhance the Workers Safety in Work Zone Area, Publication in the proceedings of The XIII World Conference on Transport Research (WCTR), July 15-18, 2013, Rio de Janeiro, Brazil.
b. Qiao, F., J. Jia, and L. Yu (2013), An RFID Based Smart Warning System at Signalized Intersection, Publication in the proceedings of The XIII World Conference on Transport Research (WCTR), July 15-18, 2013, Rio de Janeiro, Brazil.
c. Li, Q., F. Qiao, X. Wang. and L. Yu (2013). Impacts of P2V Wireless Communication on Safety and Environment in Work Zones through Driving Simulator Tests (paper # 26-179). Publication in the proceedings of the 26th Annual Conference of the International Chinese Transportation Professionals Association (ICTPA), May 24-26, 2013, Tampa, Florida.
d. Qiao, F., X. Wang, and L. Yu. (2013). Short-range Wireless Systems for Vehicle-to-Infrastructure Communications (paper # 26-180). Publication in the proceedings of the 26th Annual Conference of the International Chinese Transportation Professionals Association (ICTPA), May 24-26, 2013, Tampa, Florida.
e. Qiao, F., X. Wang, L. Yu, and J. Jia (2013). Using RFID to Improve Drivers Awareness of STOP Sign at Unsignalized Intersections. Publication in the proceedings of the 92nd TRB, Washington, DC, January 2013.
f. Qiao, F., J. Jia, L. Yu. (2013). A Short Range Vehicle to Infrastructure System at Work Zones and Intersections (paper # 1027). Publication in the proceedings of and win the "Best Paper Award" in the 2013 ITS World Conference in Tokyo, Japan. October 14-18, 2013.

E. <u>Virginia Tech</u>:

i. ***Develop Eco-adaptive Cruise Control Systems***

a. Park S., Rakha H., Ahn K., and Moran K. (2013), "Fuel Economy Impacts of Manual, Conventional Cruise Control, and Predictive Eco-Cruise Control Driving," *International Journal of Transportation Science and Technology*, Vol. 2, no. 3, pp. 227-242.

b. Ahn K. and Rakha H. (2014), "Eco-Lanes Applications: Preliminary Testing and Evaluation," Presented at the 93rd Transportation Research Board Annual Meeting, Washington, DC, January 12-16, CD-ROM [Paper # 14-3784].

ii. ***Develop Green Cooperative Adaptive Control Systems in the Vicinity of Signalized Intersections***

a. Kamalanathsharma R. and Rakha H. (2013), "Multi-stage Dynamic Programming Algorithm for Eco-Speed Control at Traffic Signalized Intersections," 16th IEEE Conference on ITS, – ITSC 2013, Hague, Netherlands, October 7-9 [Paper 43].
b. Kamalanathsharma R. and Rakha H. (2013), "Fuel-Optimal Vehicle Throttle Control: Model Logic and Preliminary Testing," 20th ITS World Congress, Tokyo, Japan, October 14-18 [Paper: 4136].
c. Kamalanathsharma R. and Rakha H. (In press), "Leveraging Connected Vehicle Technology and Telematics to Enhance Vehicle Fuel Efficiency in the Vicinity of Signalized Intersections," *Journal of ITS: Technology, Planning, and Operations*.
d. Kamalanathsharma R. and Rakha H. (2014), Agent-Based Simulation of Eco-Speed Controlled Vehicles at Signalized Intersections," Presented at the 93rd TRB Annual Meeting, Washington, DC, January 12-16, CD-ROM [Paper # 14-1028].
e. Kamalanathsharma R. and Rakha H. (2014), "Fuel-Optimal Vehicle Throttle Control: Model Logic and Preliminary Testing," Presented at the 93rd TRB Annual Meeting, Washington, DC, January 12-16, CD-ROM [Paper # 14-0433].
f. Kamalanathsharma R., Rakha H., and (2014), "Simulation Testing of Connected Vehicle Applications in a Cloud-based Traffic Simulation Environment," Presented at the 93rd TRB Annual Meeting, Washington, DC, January 12-16, CD-ROM [Paper # 14-4260].

iii. ***Develop Dynamic Eco-routing Systems***

Ahn K. and Rakha H. (2013), "Network-wide Impacts of Eco-routing Strategies: A Large-scale Case Study," *Transportation Research Part D: Transport and Environment.* Vol. 25, December, pp. 119-130. DOI: 10.1016/j.trd.2013.09.006.

iv. ***Develop Multi-scale Energy and Emission Models***

a. Park S., Rakha H., Ahn K., and Moran K. (In press), "Virginia Tech Comprehensive Power-based Fuel Consumption Model (VT-CPFM): Model Validation and Calibration Considerations," *International Journal of Transportation Science and Technology*.
b. Faris W., Rakha H.A., Kafafy R., Idres M., and Elmoselhy S. (In press), "Supercharged Diesel Powertrain Intake Manifold Analytical Model," *International Review on Modelling and Simulations* (IREMOS).
c. Faris W., Rakha H., and Elmoselhy S. (In press), "Analytical model of diesel engines exhaust NO_x emission rate", *International Journal of Vehicle Systems Modelling and Testing*.
d. Edwardes W. and Rakha H. (2014), "Virginia Tech Comprehensive Power-Based Fuel Consumption Model: Modeling Diesel and Hybrid Buses," Presented at the 93rd TRB Annual Meeting, Washington DC, January 12-16, CD-ROM [Paper # 14-3863].

3. <u>PARTICIPANTS & OTHER COLLABORATING ORGANIZATIONS</u>:

A. <u>University of Idaho:</u>

UI has been working with the Idaho Transportation Department and Econolite Controls and has held various meetings to collaborate on projects and hold training.

i. ***Developing and Testing Eco-Traffic Signal System Applications*** **-** Nothing to report at this time.

ii. ***In situ Transesterification of Microalgal Oil to Produce Algal Biodiesel*** **-** Nothing to report at this time.

iii. ***Security and Survivability of Real-Time Communication Architecture for Connected-Vehicle Eco-Traffic Signal System Applications*** - Nothing to report at this time.

iv. ***Developing Active Learning Materials for the Introductory Transportation Engineering Course***
   a. External reviewers reviewed the module drafts and provided helpful comments that were used in the final version: Tom Urbanik, Kittelson and Associates; Paul Olson, Federal Highway Administration; Ed Smaglik, Northern Arizona University; David Hurwitz, Oregon State University; and Kevin Chang, University of Idaho.
   b. Work is now underway to integrate work by David Hurwitz and Shane Brown of Oregon State University on ranking tasks and conceptual understanding problems.

v. ***Calibration of Multi-Scale Energy and Emissions Models*** - Nothing to report at this time.

vi. ***Pyrolysis Bio-Oil Upgrading to Renewable Fuels*** - Nothing to report at this time.

vii. ***Progress in Catalytic Ignition Fabrication, Modeling and Infrastructure*** - Nothing to report at this time.

viii. ***Design Improvements and Performance Validation of a Competitive Hybrid FSAE Vehicle*** - Nothing to report at this time.

ix. ***Curriculum Development for K-12 Sustainable Transportation Education***
The following individuals participated in our summer camp either on campus or during our visit to Washington, DC: Dale Moore, Idaho Transportation Department, Lewiston, Idaho; Jared Hopkins, Idaho Transportation Department, Lewiston, Idaho; Representative Raul Labrador, US House of Representatives, Washington, DC; Senator Mike Crapo, US Senate, Washington, DC; Senator Maria Cantwell, US Senate, Washington, DC; Rochelle Carpenter, Transportation for America, Washington, DC; Christy Gerencher, Transportation Research Board, Washington, DC; Fionnuala Quinn, Alta Planning, Washington, DC; Eric Gilliland, Capital Bikeshare, Washington, DC; Tracy Loh, Rails-to-Trails Conservancy, Washington, DC; Mark Harris, USDOT, Washington, DC; and Shana Baker, USDOT, Washington, DC.

x. ***A High-Speed Trapezoid Image Sensor Design for Continuous Traffic Monitoring at Signalized Intersection Approaches*** - Nothing to report at this time.

xi. ***Upgrading Biomass Pyrolysis Bio-oil to Renewable Fuels*** - Nothing to report at this time.

xii. ***Direct Drive AC Rim Motor for Responsive Energy Control of Alternative Electric Vehicle*** - Nothing to report at this time.

xiii. ***Daily Travel Feedback to Encourage Eco-Routing*** - Nothing to report at this time.

xiv. ***Eco-driving Modeling Environment*** - Nothing to report at this time.

B. <u>Old Dominion University:</u>

Working with Caliper to develop a micro-simulation model for Virginia Beach and then use trajectory data to calculate emissions.

C. <u>Syracuse University:</u>

Nothing to report at this time.

D. <u>Texas Southern University:</u>

i. Dr. Xumei Chen from Beijing Jiatong University in China wrote a joint proposal with Dr. Yi Qi (TSU) to a Chinese funding agency.

ii. Professor Haibo Zou from Chang-an University, and Professor Kaichang Sun from Three Gorge University (both from China) worked as visiting scholars at TSU.

iii. Conducted collaborative research with National Science Foundation (NSF) CREST center on complex network, especially its subcenter on wireless communications at TSU.

E. Virginia Tech:

i. ***Develop Eco-adaptive Cruise Control Systems*** **-** Nothing to report at this time.

ii. ***Develop Green Cooperative Adaptive Control Systems in the Vicinity of Signalized Intersections*** **-** Nothing to report at this time.

iii. ***Develop Dynamic Eco-routing Systems*** **-** Nothing to report at this time.

iv. ***Develop Multi-scale Energy and Emission Models***
The research team collaborated with researchers from the International Islamic University of Malaysia (IIUM).

4. IMPACT:

A. University of Idaho:

i. ***Developing and Testing Eco-Traffic Signal System Applications***

a. Education:
   1) One Master of Science in Civil Engineering student graduated and joined the transportation workface in the private sector.
   2) One Bachelor of Science in Civil Engineering student graduated and joined the transportation engineering graduate program at the University of Idaho.
   3) One undergraduate student continues working as undergraduate research intern and has applied to join the transportation engineering graduate program at the University of Idaho starting fall 2014.

b. Research:
   1) Guidelines for actuated control parameters to minimize fuel consumption and vehicle emissions for fully actuated signaled intersections operating on isolated or free mode of operation.
   2) Architecture for a hardware-in-the-loop simulation environment for connected-vehicle applications at isolated intersections.
   3) Tech Transfer includes publication of results at meetings and conferences.

ii. ***In situ Transesterification of Microalgal Oil to Produce Algal Biodiesel***

a. Lipid-bearing microalgae have proven to be a promising feedstock for biofuel production. This project is proposed to respond to the demand for advanced processing technologies for microalgae conversion for biofuels.

b. Through participation in the project, undergraduate and graduate researchers have opportunity to integrate their education with research in the areas of biofuels.

iii. ***Security and Survivability of Real-Time Communication Architecture for Connected-Vehicle Eco-Traffic Signal System Applications***

a. The first results have been presented at the International Conference on Connected Vehicles and Expo, Dec. 2-6, 2013, in Las Vegas.

b. The project has opened up many research ideas and we are currently in the process of establishing a DSRC test bed, which will be used to experimentally validate the findings and conduct future research in the subject.

iv. ***Developing Active Learning Materials for the Introductory Transportation Engineering Course***
This module, consisting of nine chapters, 108 pages, 71 figures, 22 tables, and 19 example problems, will be published through CreateSpace, an online publisher in 2014. The module will then be available through Amazon.com. The module will be used in the University of Idaho's Fundamentals of Transportation Engineering course in the spring semester 2014.

v. ***Calibration of Multi-Scale Energy and Emissions Models***
Research results include:

a. Field-based vehicle emission data for vehicle operations at signalized intersection approaches.
b. Fuel consumption and vehicle emission data for different engine types under different operations.

vi. ***Pyrolysis Bio-Oil Upgrading to Renewable Fuels***
a. The main impact is the improvement of bio-fuels production to reduce the reliance on fossil fuels used in the transportation sector.
b. This project has supported the training two graduate students and participation in technology transfer forums by presenting and publishing our research.

vii. ***Progress in Catalytic Ignition Fabrication, Modeling and Infrastructure -*** Nothing to report at this time.

viii. ***Design Improvements and Performance Validation of a Competitive Hybrid FSAE Vehicle***
The impact of this program is threefold.
a. Education: Young engineers investigate, design, and experiment with hybrid automotive technologies. Team members gain an advantage when entering industry. Experience with hybrid technology is in ever increasing demand from auto companies.
b. Exposure: The Formula Hybrid competition is part of the collegiate design series sanctioned by the Society of Automotive Engineers. It gives important exposure for Idaho to representatives from Ford, GM, and other auto-makers and vehicle manufacturers.
c. Technology Advancement: The modeling simulation provided an in-house way to analyze various designs and predict vehicle performance. PhD research is also being conducted towards management of energy and distribution of torque (power).

ix. ***Curriculum Development for K-12 Sustainable Transportation Education***
a. Instructor's Guide. Universities across the country can use our instructor's guide to deliver a summer camp. The 10 modular sections can be adapted and improved to fit the needs of any institution.
b. Successful summer camp. Twenty-one high school students gained an appreciation and understanding of transportation. These students have a much greater likelihood of entering a career in transportation.
c. Collaboration network. Our visit to Washington DC provided the opportunity to network with other transportation professionals. We were able to share information about our research and University program. Our visit with the Rails to Trails Conservancy has developed into a million dollar collaborative research project.

x. ***A High-Speed Trapezoid Image Sensor Design for Continuous Traffic Monitoring at Signalized Intersection Approaches***
We are developing a unique image sensor and camera system specifically designed for continuously monitoring incoming traffic to an intersection once the project is completed. It will extract the vehicle location, speed and acceleration information continuously allowing dynamic traffic control with reduced communication bandwidth and complexity providing only necessary information without requiring high performance backend processors. Dynamic traffic monitoring has potential benefits for national economy and environment by reducing fuel consumption of city vehicles and reducing CO_2 emission.

xi. ***Upgrading Biomass Pyrolysis Bio-oil to Renewable Fuels -*** Nothing to report at this time.

xii. ***Direct Drive AC Rim Motor for Responsive Energy Control of Alternative Electric Vehicle***
a. Creation of a volunteer Formula Electric Vehicle team. Impact on education of more than 20 students as they design and build an electric vehicle.
b. By determining that existing linear induction motor design equations are inadequate, new design equations advance the art significantly.

xiii. ***Daily Travel Feedback to Encourage Eco-Routing -*** Nothing to report at this time.

xiv. ***Eco-driving Modeling Environment***
An Eco-Driving modeling environment within the NADS MiniSim model.

B. Old Dominion University:

i. ***New Strategies for the Emergency Vehicle Routing to Reduce Response Time Using Vehicle-to-Vehicle Communications -*** Nothing to report at this time.

ii. ***Real-time Prediction of Queues at Signalized Intersections to Support Eco-driving Applications -*** Nothing to report at this time.

iii. ***Exploring Image-based Classification to Detect Vehicle Make and Model***
The program educates two graduate students in ITS research. It is also expected that one MS thesis will be generated from this research. Additionally, two conference publications have been completed through partial funding of this project. It is expected to complete one journal and an additional conference publication by the end of the work on this project.

iv. ***A Study on the Impact of Parameter Uncertainty on the Emission-based Ranking of Transportation Projects***
This research is complementing existing literature by providing valuable insights into the impact of capacity, demand and emission uncertainty on the ranking of capacity expansion projects. The problem considered has served as an example transportation problem to illustrate the various theoretical concepts in a simulation course at ODU.

v. ***Reducing Energy Use and Emissions through Innovative Community Designs: Methodology and Application***
   a. This project is training a post-doc (Dr. X. Wang) and 3 graduate students (G. Amoli, S. Son, and J. Liu) who are working on smart growth land use strategy, microscopic driving decisions, energy use and emissions issues.
   b. The project has generated research papers that are being presented at national and international forums, e.g., TRB and Chinese Overseas Transportation Association conference in Shenzhen on the state of the art in emissions modeling.
   c. The work is being disseminated via refereed journals, conference presentations, and invited talks nationally and internationally.
   d. The study hopes to contribute toward greater consciousness about the energy and environmental issues.

vi. ***Optimize Freight Routes and Modes to Minimize Environmental Impacts -*** Nothing to report at this time.

C. Syracuse University:

i. The literature search helped to develop a comprehensive database on all the projects and increased the understanding of the students.

ii. The tools identified by the researchers are helping them to run various analyses and get conclusive results on the environmental performance of various aspects of transportation such as TSMO strategies and arterial improvement projects.

iii. The Syracuse COE 13th Annual Symposium provided insight on sustainable practices such as energy management innovations, technology for urban resilience, and urban ecosystems.

iv. The LEAN Construction presentation educated students on ways to reduce waste on a construction site.

D. Texas Southern University:

i. ***A Systematic Evaluation of the Impacts of traffic Condition Information on the Reduction of On-road Mobile Emissions***

This project provides transportation planners or environmental analysts with qualitative assessments of the impacts on air quality of different types of traffic condition information. It will also help the traffic engineer to appropriately deploy the most effective traveler information systems to achieve more environmental benefits. The operating mode ID distributions developed by this study can be used as input to run MOVES and obtain the emission level of any pollutants.

ii. ***Education and Outreach Activities***
The education program helps to promote interests of K-12 and college students in STEM programs, especially in transportation and environment related areas. The developed curricula and experiences can be easily further expanded and applied to other schools.

iii. ***Develop an Integrated Data Management System at the Microscopic, Mesoscopic, and Macroscopic Levels to Assess the Environmental Impacts of Transportation System***
Nothing to report at this time.

iv. ***Use the Driving Simulator to Synthesize the Related Vehicle Specific Power (VSP) for Emission and Fuel Consumption Estimations***
   a. The developed algorithm will help to calibrate the simulation results from the driving simulator, which will thus make better use of the driving simulator for vehicle emission and fuel consumption analyses.
   b. The test procedure is good material for the development of a lab test for graduate students in courses such as Quantitative Analyses of Vehicle Emissions.

v. **Develop Multi-scale Energy and Emission Models for Arterial Traffic Systems**
The developed models are important to further research in developing suitable urban transportation management system and vehicle emission reduction strategies.

vi. ***Improve the Environment for a Livable Community: Advance the AERIS Program by Developing and Testing Eco-traffic Signal System Control Applications***
The developed V2I communication system can help to provide more and timely information to drivers, enhancing the safety and air quality of the eco-driving traffic operations.

vii. ***Developing Short Range Vehicle-to-Infrastructure Communication Systems***
The developed system can help to not only enhance safety, but also reduce vehicle emissions. With more tests, it can be widely used in research, industry and for education purposes.

E. <u>Virginia Tech:</u>

i. ***Develop Eco-adaptive Cruise Control Systems***
   a. Research: Development of an eco-cruise control and eco-drive system.
   b. Technology Transfer: Publication of results at various conferences.

ii. ***Develop Green Cooperative Adaptive Control Systems in the Vicinity of Signalized Intersections***
   a. Education: The funding of a graduate student assistantship.
   b. Research: Development of an eco-cruise control in the vicinity of traffic signalized intersections and the development of a cloud-based testing environment.
   c. Technology Transfer: Publication of results at various conferences.

iii. ***Develop Dynamic Eco-routing Systems***
   a. Education: The funding of a graduate student assistantship.
   b. Research: Development of an eco-routing system.
   c. Technology Transfer: Publication of results at various conferences.

iv. ***Develop Multi-scale Energy and Emission Models***
   a. Education: The funding of a graduate student assistantship.
   b. Research: Development of fuel consumption models for light duty cars and buses.
   c. Technology Transfer: Publication of results at various conferences.

5. CHANGES/PROBLEMS

A. University of Idaho:

i. ***Developing and Testing Eco-Traffic Signal System Applications -*** Nothing to report at this time.

ii. ***In situ Transesterification of Microalgal Oil to Produce Algal Biodiesel***
The project was delayed due to the large amounts of experiments to be conducted. Statistical analysis will be performed on the data before the optimization can be concluded. Therefore, the final report of this project will be delayed until around May 2014.

iii. ***Security and Survivability of Real-Time Communication Architecture for Connected-Vehicle Eco-Traffic Signal System Applications -*** Nothing to report at this time.

iv. ***Developing Active Learning Materials for the Introductory Transportation Engineering Course -*** Nothing to report at this time.

v. ***Calibration of Multi-Scale Energy and Emissions Models -*** Nothing to report at this time

vi. ***Pyrolysis Bio-Oil Upgrading to Renewable Fuels***
We have found an issue with the current reactor setup which used low H_2 pressure (250 psi) and plan to increase to 750-1000 psi to drive the hydrogenation/HDO reactions, improve conversion yields, and minimize coke formation.

vii. ***Progress in Catalytic Ignition Fabrication, Modeling and Infrastructure -*** Nothing to report at this time.

viii. ***Design Improvements and Performance Validation of a Competitive Hybrid FSAE Vehicle***
There have been a few changes to the rules since 2013 that the team is addressing.

ix. ***Curriculum Development for K-12 Sustainable Transportation Education -*** Nothing to report at this time.

x. ***A High-Speed Trapezoid Image Sensor Design for Continuous Traffic Monitoring at Signalized Intersection Approaches***
The absolute trapezoidal pixel array would require pixel size scaling exactly as the road appears due to perspective. In such a pixel array, the distance covered per pixel would be the same for all pixels. However, this is not possible in practice. Such a pixel size scaling would require the largest pixel to be very large (up to a hundred times larger depending on the distance to be viewed) compared to the smallest pixel. Therefore, in the design, the FOV had to be divided into 6 regions and each region covers a different distance per pixel. This way the pixel sizes are kept reasonable while the benefits of using trapezoidal pixel array are still maintained.

xi. ***Upgrading Biomass Pyrolysis Bio-oil to Renewable Fuels***
We have developed the protocols for producing Ni-NS at the mg level for characterization studies and preliminary catalysis trials. To better assess the catalyst we need to produce larger quantities of the Ni-NS catalysts for bio-oil conversion studies.

We are in the process of modifying the hydrogenation reactor (300 mL) set-up to accommodate higher H_2 pressures to improve bio-oil conversions. We have just constructed a small continuous flow through reactor which can use small quantities of Ni-NS catalyst and be more efficient than the batch reactor for catalytic conversion studies.

xii. ***Direct Drive AC Rim Motor for Responsive Energy Control of Alternative Electric Vehicle***
Existing design equations for smooth rotor induction machines were found to be inadequate. A new set of design equations was derived through the continuum electromechanics theory of James Melcher. The new design equations will be verified by finite element analysis early in the spring semester 2014.

xiii. ***Daily Travel Feedback to Encourage Eco-Routing -*** Nothing to report at this time.

xiv. ***Eco-driving Modeling Environment*** **-** Nothing to report at this time.

B. Old Dominion University:

i. ***New Strategies for the Emergency Vehicle Routing to Reduce Response Time Using Vehicle-to-Vehicle Communications*** **-** Nothing to report at this time.

ii. ***Real-time Prediction of Queues at Signalized Intersections to Support Eco-driving Applications*** **-** Nothing to report at this time.

iii. ***Exploring Image-based Classification to Detect Vehicle Make and Model*** **-** Nothing to report at this time.

iv. ***A Study on the Impact of Parameter Uncertainty on the Emission-based Ranking of Transportation Projects*** **-** Nothing to report at this time.

v. ***Reducing Energy Use and Emissions through Innovative Community Designs: Methodology and Application***
Due to Dr. Khattak's move to the University of Tennessee, the project will be extended another year.

vi. ***Optimize Freight Routes and Modes to Minimize Environmental Impacts*** **-** Nothing to report at this time.

C. Syracuse University:
Nothing to report at this time.

D. Texas Southern University:
Nothing to report at this time.

E. Virginia Tech:

i. ***Develop Eco-adaptive Cruise Control Systems*** **-** Nothing to report at this time.

ii. ***Develop Green Cooperative Adaptive Control Systems in the Vicinity of Signalized Intersections***
There have been delays in getting the cloud simulation environment running.

iii. ***Develop Dynamic Eco-routing Systems*** **-** Nothing to report at this time

iv. ***Develop Multi-scale Energy and Emission Models***
The scope of the project has been reduced from multi-level modeling to expanding the microscopic modeling framework to consider: (1) buses; (2) trucks; and (3) hybrid vehicles. We are still collecting data on buses and are hoping to get truck data from West Virginia University.

6. SPECIAL REPORTING REQUIREMENTS

Financials will be sent by the University of Idaho's Office of Sponsored Programs as needed.

Completed by:
University of Idaho: Karen R. Den Braven
Old Dominion University: Mecit Cetin
Syracuse University: O. Sam Salem
Texas Southern University: Fengxiang Qiao
Virginia Tech: Hesham Rakha