

**Program Progress Performance Report
University Transportation Centers
Cover Page TranLIVE**

Submitted to: Office of the Assistant Secretary for Research and Technology

Federal Grant Number: DTRT12-G-UTC17

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

Program Director: Ahmed Abdel-Rahim; Director of NIATT and TranLIVE; ahmed@uidaho.edu; 208-885-2957

Submitting Official: Tami Noble; Assistant to the Director, NIATT; tnoble@uidaho.edu; 208-885-0576

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Recipient Organization: University of Idaho, Office of Sponsored Programs, 875 Perimeter Dr., MS 3020, Moscow, ID 83844-3020

Recipient Account Number: KLK900

Grant Period: January 1, 2012 to January 31, 2016

Reporting Period End Date: June 30, 2014

Report Frequency: Semi-annual

Signature of Submitting Official:

A handwritten signature in blue ink that reads "Tami Noble". The signature is written in a cursive, flowing style.

SEMI-ANNUAL REPORTING CATEGORIES
TranLIVE DTRT12GUTC17
January 1, 2014 to June 30, 2014

1. ACCOMPLISHMENTS:

A. University of Idaho:

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

- a. Developed an architecture for a Hardware-in-the-loop simulation environment for connected-vehicle applications for coordinated systems
- b. Documented the characteristics of corridor signal timing plans optimized through different optimization software using different objective functions
- c. tested the performance of corridor signal timing plans optimized using different objective functions using hardware-in-the-loop environment simulation environment
- d. Investigated the impact of corridor signal timing plans, optimized using different objective functions, on the characteristics of traffic operations for vehicle groups with different origin-destination

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

The project for this stage is complete. However, many questions remain unanswered. The overall research is still a work-in-progress. We will continue experimenting on the process and exploring further to gain better understanding. An engineering economic analysis on the process is also under consideration to develop estimates on the energy and operating costs. The final report has been posted

<http://www.uidaho.edu/~media/Files/orgs/ENGR/Research/NIATT/TranLIVE/Final%20Report%20UI%20TranLIVE%20Final%20Report%20Algal%20Biodiesel>

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

<http://www.uidaho.edu/~media/Files/orgs/ENGR/Research/NIATT/TranLIVE/Final%20Report%20UI%20TranLIVE%20Final%20Report%20Real-timeCommunication>

iv. *Developing Active Learning Materials for the Introductory Transportation Engineering Course* - Final report completed:

<http://www.uidaho.edu/~media/Files/orgs/ENGR/Research/NIATT/TranLIVE/Final%20Report%20UI%20TranLIVE%20Final%20Report%2020140203>

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

- a. Validated emission and fuel consumption models for hybrid vehicles using the GT-Suite software.
- b. Developed optimized rule-based energy management system for hybrid electric vehicles.

vi. *Pyrolysis Bio-Oil Upgrading to Renewable Fuels* - Final report completed:

<http://www.uidaho.edu/~media/Files/orgs/ENGR/Research/NIATT/TranLIVE/Final%20Report%20UI%20TranLIVE%20Final%20Report%20Pyrolysis%20Biooil%20Upgrading2>

vii. *Progress in Catalytic Ignition Fabrication, Modeling and Infrastructure* - Final report completed:

<http://www.uidaho.edu/~media/Files/orgs/ENGR/Research/NIATT/TranLIVE/Final%20Report%20UI%20TranLIVE%20Final%20Report%20CombinedPart1%20Part2%20ProgressCatalyticIgnition>

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

The entire academic school year was dedicated to bringing the vehicle up to the rules of the 2014 competition. Modifications included redesigning of the fuel system for the longer endurance event and relocation of key components to improve the vehicle dynamics, overall

appearance and packaging. At the competition this year, the team was awarded with the 1st place overall hybrid trophy as well as 2nd place in the Design competition, and a close 2nd place in the Teamwork award at the competition. The team was also awarded two other significant trophies with cash prizes from industry. The team received the 1st place Chrysler Innovative Powertrain design and the 1st place General Motors Best Engineered Hybrid Systems awards with cash prizes amounting to \$4500.

- ix. ***Curriculum Development for K-12 Sustainable Transportation Education*** - Final report completed:

[http://www.uidaho.edu/~media/Files/orgs/ENGR/Research/NIATT/TranLIVE/Final%20Reports/UI TranLIVE Final%20Report Instructor%20Guide](http://www.uidaho.edu/~media/Files/orgs/ENGR/Research/NIATT/TranLIVE/Final%20Reports/UI%20TranLIVE%20Final%20Report%20Instructor%20Guide)

- 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. Imager design composes of 40x152 scaled pixels for focal plane trapezoid image sensor array that could be able to monitor objects 250m from the stop line. Software for background and moving objects extraction was developed and demonstrated on a platform using an existing rectangular imager. The fabricated imager was received the first week of May 2014. Initial testing of the imager was performed. Testing confirms the trapezoid imager IC is working as designed generating expected signals and video stream. The initial test board was debugged and final camera board was designed and sent for fabrication. Final camera PCB was received late June 2014 and final testing will be performed in August 2014.

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

We have prepared Ni decorated nanosprings (Ni-NS) catalysts via two approaches, chemical vapor deposition (CVD) and wetness impregnation method (WIM), and are currently evaluating each method for their effectiveness as catalysts. The catalysts are also being characterized by x-ray photoelectron spectroscopy (XPS) and electron microscopy to determine the activation conditions (reduction) of NiO to Ni on the Ni-NS catalysts. We have successfully produced 500 mg quantities of Ni-NS catalyst for catalysis evaluations.

Taking all the factors into account, the Ni/NS, especially prepared by WIM, has the potential to be a good catalyst for phenol and bio-oil HDO.

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

Two design teams have been involved in the project. The first senior design team, composed of Electrical Engineering seniors, specified the battery's performance, found cells to meet those specifications, and assembled a reduced-scale prototype. The second senior design team began designing the major subsystems of the Electric Vehicle.

As a result of an extensive literature search of motor designs, our graduate student proposed a continuum rotor design. Our new design uses a continuous metal (copper or aluminum) band as a rotor. Final estimated weight of the motor is 25 lbs. Parts drawings were created so that the machine could be built.

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

a. Used the GPS data from the first experiment to create analysis algorithms. Last fall we provided a GPS app to 81 volunteer participants to collect their travel behavior for one week. We used the data to develop GIS algorithms for identifying individual trips and inferring method of travel and trip purpose.

b. Collected GPS data from a second experiment. April 28, 2014 to May 9, 2014 we provided a GPS app to 53 volunteer participants to collect their travel behavior.

- c. Conducted a before and after survey. The participants in the GPS study were asked to complete a before and after questionnaire that we created. The questionnaire asked about their perceptions of non-automobile travel (i.e. by bicycle, walking, or public transportation).
 - d. Created a webpage to collect daily travel feedback. The participants in the second experiment were asked to log on to a webpage each day to confirm information about trips from their day (method of travel and trip purpose).
- xiv. Eco-driving Modeling Environment**
- a. Developed a SimLink interface between the GT-Suite Software and the NADS MiniSim Model. The interface will facilitate the integration of the two models to create an Eco-Driving model training tool.
 - b. Validate fuel efficiency model based on a generic brake-specific fuel consumption (BSFC) map for an inline 4-cylinder. 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.
 - c. Using Windows Presentation Foundation (WPF) an EcoDash was finalized. The model will run along with other system components in real-time with MiniSim.

B. Old Dominion University:

i. New Strategies for the Emergency Vehicle Routing to Reduce Response Time Using Vehicle-to-Vehicle Communications

A microscopic simulation model was created in VISSIM to evaluate different strategies for expediting the travel times for Emergency Vehicles (EVs) through signalized intersections. These strategies involve both signal preemption and controlling movement of some vehicles within the queues to open gaps for the emergency vehicles. Based on the initial results, the proposed platoon split strategy was found to be very effective in reducing the EV travel times where there is significant congestion at the intersections.

In addition, a separate microscopic simulation model was created in VISSIM to evaluate preemption timing at signalized intersections to improve emergency vehicle travel time in a network. The strategies involve preempting signalized intersections further downstream to reduce congestion prior to the preemption of signals upstream. The preemption timing is based on queue lengths and the estimated arrival time of the emergency vehicle. This may result in signals being preempted in non-sequentially.

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

A model was developed to predict the evolution of queues at signalized intersections from the known locations of probe vehicles when they join the back of the queue. The performance of the model is being tested and evaluated based on trajectory data produced by VISSIM for both oversaturated and undersaturated traffic conditions.

iii. Exploring Image-based Classification to Detect Vehicle Make and Model – Final report completed:

<http://www.uidaho.edu/~media/Files/orgs/ENGR/Research/NIATT/TranLIVE/Final%20Report/ODU%20-%20Image%20Based%20Vehicle%20Classification>

iv. A Study on the Impact of Parameter Uncertainty on the Emission-based Ranking of Transportation Projects – Final report completed

[http://www.uidaho.edu/~media/Files/orgs/ENGR/Research/NIATT/TranLIVE/Final%20Report/ODU TranLIVE Final%20Report Study%20Impact](http://www.uidaho.edu/~media/Files/orgs/ENGR/Research/NIATT/TranLIVE/Final%20Report/ODU%20TranLIVE%20Final%20Report%20Study%20Impact)

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

Using microscopic behavioral data, modeling was done to explore association of smart growth with CO₂ emissions. We have developed a micro-simulation model for the city of Virginia Beach and will be using the trajectory data for more accurate emissions calculations compared with macroscopic models.

We are working on archiving the existing documents-literature, relevant TRB papers, and adding the conceptual framework and modeling results as they become available.

In the macro model, we worked on running the 1) Business-As-Usual Scenario, 2) Smart growth scenario, & 2) smart growth + tech scenario (using stochastic assignment) with TransCAD software (4-step model). Note Transit Oriented Developments will be a key portion of this work.

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

- a. Focus has shifted to a methodology supporting iterative application of the Frank-Wolfe algorithm with the inclusion of emissions results.
- b. Use of a binning approach has produced results using emissions based truck route assignments in a much shorter period of time than would be required to run the MOVES model.

C. **Syracuse University:**

- 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 has completed the life cycle assessment and life cycle cost analysis for TSM&O strategies and reported it to Dr. Salem. The goal of this study is to estimate and evaluate the life cycle benefits and costs of existing and alternative TSM&O strategies. Besides life cycle cost analysis, the benefit/cost (B/C) framework covers several benefits such as travel time saving, energy consumption reduction, and safety improvement and thus, addresses the triple bottom line of sustainability. Jeff is now in the process of validating the models and finalizing the report.
 - b. Project 2: *Assessing Social and Environmental Impacts of Work-Zones in Arterial Improvement Projects*; Sudipta Ghorai working with Dr. Salem has completed the project and is preparing the final report.
 - c. Project 3: *Assessing Environmental Impacts of Traffic Congestion and Vehicular Emissions on Groundwater and Fresh Water Supplies*; Jeremy Tamargo is working on the issues of contamination of Urban Surface Water by Vehicle Emissions. Since July 2013, Jeremy has developed samples extraction and analytical methods for PAH analysis. He has also developed methods for collecting rain runoff samples and extracting the PAH. Mallory Squier is working on the performance of the Green infrastructures to reduce storm water runoff. Since July 2013, Mallory 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. **Texas Southern University:**

- i. ***A Systematic Evaluation of the Impacts of traffic Condition Information on the Reduction of On-road Mobile Emissions***
 - a. What we have done:
 - 1) Collected more GPS based speed profile data from the arterial road sections under very congested traffic conditions in Houston, Texas.

- 2) Developed a framework for estimating the effects of ATIS on air quality.
- 3) Modified the case study according to the developed framework.
- b. What we have learned:

The results of this study demonstrate the benefits of using ATIS in terms of total system travel time and total emission levels. It also illustrates the usefulness of the framework developed in this study. Practitioners can use the operating mode ID distribution developed in this study to carry out similar evaluation studies.
- ii. **Education and Outreach Activities**

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

 - a. Successfully organized the summer transportation academy at TSU in June, 2014 for two sessions of high school students (minority). This summer academy is a continuation from Summer 2012 and 2013. Most of the students are minority students.
 - b. Support three undergraduate students for summer internship 2014. One of them is sponsored by TSU matching. The other two use UTC funds.
 - c. Provided scholarships to support graduate students for their studies in transportation. All are U.S. citizens.
 - d. Supported or to support student travels to present research papers or receive awards in academic conferences such as:
 - 1) The 2014 International Conference of Environmental Science and Technology, Houston, TX, June 9-13, 2014.
 - 2) The 2014 ITE Texas Spring 60th Annual Meeting in Austin, TX, May 28-30, 2014.
 - 3) The 2014 Transportation Research Board Annual Meeting, Washington DC, January 12-16, 2014.
- 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**

Used the driving simulator to test driving performance in work zones when the Drivers' Smart Advisory System (DSAS) message is provided.
- 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 CO₂ emissions.
 - e. Analyzed effect of driving behaviors on emissions in eco-driving at intersections.
- 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.
 - c. Tested the effect of driving behaviors on emissions in eco-driving at intersections.
 - d. Further simulated and tested the V2I system in the 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. More scenarios tested in driver simulator and extensive analyses were conducted considering multiple performance measures and human factors.

E. Virginia Tech:

- i. **Develop Mesoscopic Fuel Consumption and CO₂ Emission Models**
 - a. Develop the mesoscopic modeling framework
 - b. Validate the mesoscopic model against microscopic model estimates and field measurements
 - c. Implement the system on mesoscopic data.
 - d. Validate the mesoscopic modeling approach by comparing the model results in Task 3 against results obtained from a microscopic approach and field observations for sample networks.
- 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.
 - c. Conducted a survey of user acceptance of technology.
 - d. Integrated the software with microscopic traffic simulation software.
- iii. **Develop Macroscopic Fuel Consumption and CO₂ Emission Models**
 - a. Gather field data to characterize drive cycles on typical roadways as a function of the roadway speed limit, level of congestion, type of intersection control (stop, yield or traffic signal).
 - b. Develop macroscopic models to estimate vehicle fuel consumption levels using the drive cycles constructed in Task 1.
 - c. Validate the models developed in Task 2 against field observations.
 - d. Implement the models developed in Task 2 in a planning model framework.
 - e. Develop the framework developed in Task 4 against the use of a microscopic modeling framework for different networks.
- iv. **Develop Dynamic Eco-routing Systems** - Final report completed:
[http://www.uidaho.edu/~media/Files/orgs/ENGR/Research/NIATT/TranLIVE/Final%20Report s/VT TranLIVE Final Eco-Routing](http://www.uidaho.edu/~media/Files/orgs/ENGR/Research/NIATT/TranLIVE/Final%20Report%20VT%20TranLIVE%20Final%20Eco-Routing)
- v. **Develop Eco-adaptive Cruise Control Systems** – Final report completed:
[http://www.uidaho.edu/~media/Files/orgs/ENGR/Research/NIATT/TranLIVE/Final%20Report s/VT TranLIVE Final Eco-Driving](http://www.uidaho.edu/~media/Files/orgs/ENGR/Research/NIATT/TranLIVE/Final%20Report%20VT%20TranLIVE%20Final%20Eco-Driving)

- vi. **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.

F. Multi-institution:

- i. **Developing and Field Implementing a Dynamic Eco-routing System –Virginia Tech, lead; University of Idaho and Old Dominion University, partners**
 - a. Developing an Eco-routing system.
 - b. Conduct field tests
- ii. **Smartphone-based Solutions to Monitor and Reduce Fuel Consumption and Co₂ Footprint – Old Dominion University, lead; Virginia Tech and Texas Southern University, partners**
The following tasks are completed:
 - a. An Android App (called GoGreen) was developed to collect acceleration, gyroscope, magnetometer, and GPS data from smartphones. The App can also connect to an OBD device on the vehicle if available. Speeds from GPS and OBD are used for model development and testing.
 - b. An SQL database was created to store the raw data collected by smartphones. The GoGreen App uploads the data automatically to the database when connected via WiFi.
 - c. A MatLab program was written to process data and to develop algorithms to estimate whether the vehicle is in motion or stopping. Modeling is underway to estimate vehicle speed from accelerometer data. Algorithms are being developed to map the accelerometer readings from smartphones to the orientation/direction of travel of the vehicle.
 - d. A user interface is being developed for the GoGreen App.
 - e. Algorithms have been developed to predict the mode of travel based on sensor data from smartphones.
 - f. Various algorithms have been developed to determine the eco-friendly shortest paths.
- iii. **Studying the impact of accelerated construction methods in work zones using micro-simulation, on vehicle emissions and the environment – Syracuse University, lead; Virginia Tech and University of Idaho, partners** - A comprehensive literature review on traffic management plans for work-zones, traffic simulation tools and different work-zone best practices is in progress. Also working on identifying case-studies to model and calibrate the proposed work zone environmental assessment framework.
- iv. **Eco-traffic Signal System – University of Idaho, lead; Virginia Tech and Syracuse University, partners** – Budget set up at the end of June with work to begin in July.

2. PRODUCTS:

A. University of Idaho:

i. Developing and Testing Eco-Traffic Signal System Applications

Christopher Davidson, Sherief Elbassuoni, and Ahmed Abel-Rahim “Actuated Control Parameters to Reduce Vehicle Emissions and Fuel Consumption at Isolated Intersections,” Paper submitted for presentation at the Transportation Research Board (TRB) 94th Annual Meeting.

- ii. ***In situ Transesterification of Microalgal Oil to Produce Algal Biodiesel*** – Nothing to report
 - iii. ***Calibration of Multi-Scale Energy and Emissions Models*** - Nothing to report
 - iv. ***Design Improvements and Performance Validation of a Competitive Hybrid FSAE Vehicle***
 - a. Mostafa Asfor, “Development and Optimization of a Rule-Based Energy Management Strategy for Fuel Economy Improvements in Hybrid Electric Vehicles”, Ph.D. Dissertation, University of Idaho, June 2014.
 - b. A two phase engine model using Matlab was produced to accurately predict the Brake Specific Fuel Consumption map for the engine used in the vehicle.
 - c. The program has also produced a drive cycle model which encompasses the newly developed Energy Management System using GT Suite.
 - x. ***A High-Speed Trapezoid Image Sensor Design for Continuous Traffic Monitoring at Signalized Intersection Approaches***
 - a. A senior undergraduate design team composing of 2 electrical engineering, 1 computer engineering, and 2 computer science students were recruited during fall 2013 and spring 2014 semesters to develop algorithms for the trapezoid imager. Their detailed work and reports are listed on following web link:
http://mindworks.shoutwiki.com/wiki/Team_New_Perspective .
 - b. Academic conference paper(s) will be sent for publication after testing and system development are completed in late summer 2014.
 - c. Ismail Cevik, “Energy Autonomous CMOS Image Sensors,” Ph.D. Dissertation, University of Idaho, May 2014.
 - xi. ***Upgrading Biomass Pyrolysis Bio-oil to Renewable Fuels*** –
 - a. Presentation 1: Armando McDonald, Mark Coleman (2014) “Utilization of Forest Biomass through Mobile Fast Pyrolysis” presented at the Northwest Wood Energy Team Forum held in Stevenson, WA, May 7th.
 - b. Poster 1: Armando McDonald, Randy Brooks, Mark Coleman (2014) “Utilization of Forest Biomass through Mobile Fast Pyrolysis” presented at the Washington State Department of Natural Resources-Mobile Pyrolysis Demonstration, at Bingen, WA, May 8-9th.
 - xii. ***Direct Drive AC Rim Motor for Responsive Energy Control of Alternative Electric Vehicle***
 - a. Senior design team outcomes: report, presentation, and poster to be presented at the UI College of Engineering Expo May 2, 2014.
 - b. Parts drawing for production of a smooth rotor induction motor.
 - c. One Master’s thesis to be completed over the summer.
 - xiii. ***Daily Travel Feedback to Encourage Eco-Routing***
 - a. GIS tools to process GPS data.
 - b. Webpage for collecting daily travel feedback.
 - c. We are currently preparing a research paper and conference presentation for TRB.
 - 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-*** The results of the testing are currently being compiled for inclusion in a paper to be submitted to the TRB national meeting.
 - 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” 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” Presented at the 93rd Annual meeting of the TRB, Washington, D.C., January 12-16, 2014.
- iii. **Reducing Energy Use and Emissions through Innovative Community Designs: Methodology and Application**
 - a. J. Liu, Wang X., A. Khattak, Providing Real-Time Driving Volatility Information, has been submitted and accepted for presentation at ITS World Congress 2014 conference (Detroit, Sep 7-11).
 - b. Son S., A. Khattak & K. Choi, Comparing Travel Behavior Between Transit-Oriented Developments and Automobile-Oriented Developments: Matched Pair Analysis, TRB Paper 14-2327, Presented at the Transportation Research Board, National Academies, Washington, D.C., 2014.
 - c. Jorge M. Bandeira, Sérgio R. Pereira, Tânia Fontes, Paulo Fernandes, Asad J. Khattak, Margarida C. Coelho, An Eco-Traffic Management Tool, Computer-based Modelling and Optimization in Transportation, Advances in Intelligent Systems and Computing, Volume 262, 2014, pp 41-56.
- iv. **Optimize Freight Routes and Modes to Minimize Environmental Impacts** - Paper being prepared for submission to the TRB 2015 Annual Meeting.

C. Syracuse University:

- i. Dr. Davidson presented “Three Case Studies of Atmosphere- Surface Exchange” in a seminar at SUNY Albany (Air Pollution Group) on March 10, 2014.
- ii. Dr. Davidson gave a talk entitled “Metrics of Sustainability in Human Development: How Well Do People Understand the Impacts of their Activities?” at the Workshop on Measurement Science for Sustainable Construction and Management in Reston, Virginia on June 12-13, 2014 sponsored by NIST and ASCE.
- iii. Dr. Salem, Sharareh Pirzadeh, Sudipta Ghorai and Dr. Abdel Rahim (of University of Idaho) published a conference paper titled “ Reducing Environmental, Economic, and Social Impacts of Work Zones by Implementing Lean Construction Techniques” at the 22nd Annual Conference of the International Group of Lean Construction held in Oslo, Norway from June 25th- 27th 2014.
- iv. Jeff Chen, Sudipta Ghorai and Sharareh Pirzadeh attended the poster presentation session on the Nunan Lecture and Research Day organized by Syracuse University on April 3rd, 2014 at the Syracuse Center of Excellence. Their respective poster topics were “LCA and LCCA of TSMO Strategies”, “A Decision Support Framework for Accelerated Bridge Construction” and “Improving Sustainability of Work Zones by implementing Lean Construction Techniques.”

D. Texas Southern University:

- 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. Presented at the 93rd TRB Annual Meeting, Transportation Research Board of the National Academies Washington, DC, January 12-16, 2014.
- ii. **Education and Outreach Activities** - A series of education programs are in production, covering all range of students (K-12 and college). These include the summer transportation academy for high school students and the transportation club for primary school students.

- iii. ***Develop an Integrated Data Management System at the Microscopic, Mesoscopic, and Macroscopic Levels to Assess the Environmental Impacts of the Transportation System***
 - a. Hill, K., F. Qiao, M. Azimi, and L. Yu. Impacts of Restaurant Drive-Thru Configurations on Vehicle Emissions. Presented at the 93rd Transportation Research Board Annual Meeting, Transportation Research Board of the National Academies, Washington, DC, Jan 12-16, 2014.
 - b. Po-Hsien Kuo, Fengxiang Qiao, and Lei Yu. Development Of Vehicle Emission Database For Air Quality Analyses. Proceedings of the 2014 International Conference of Environmental Science and Technology (IC EST2014) by American Academy of Sciences, June 9 -13, 2014, Crowne Plaza, Houston, Texas, USA. Paper Number: IC EST2014 # 944.
- iv. ***Use the Driving Simulator to Synthesize the Related Vehicle Specific Power (VSP) for Emission and Fuel Consumption Estimations***

Qiao, F., Q. Li, and L. Yu. (2014). Testing Impacts of Work Zone X2V Communication System on Safety and Air Quality in Driving Simulator. Accepted for presentation and publication in the proceedings of the 2014 Intelligent Transportation Society (ITS) World Conference, Detroit, USA. September 7-11, 2014.
- v. ***Develop Multi-scale Energy and Emission Models for Arterial Traffic Systems***
 - a. Tang, P., L. Yu, and G. Song. Effect of Driving Behaviors on Emissions in Eco-driving at Intersections. Proceedings of the 93rd Transportation Research Board Annual Meeting, Transportation Research Board of the National Academies, Washington, DC, Jan 12-16, 2014.
 - 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 CO₂ 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." Publication in Transportation Research Record: Journal of Transportation Research Board series, Washington, DC, January 12-16, 2014. In print.
 - b. Tang, P., L. Yu, and G. Song. Effect of Driving Behaviors on Emissions in Eco-driving at Intersections. Proceedings of the 93rd TRB, Transportation Research Board of the National Academies, 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, Transportation Research Board of the National Academies, Washington, DC, January 12-16, 2014.

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

- a. Qiao, F., J. Jia, L. Yu, Q. Li, and D. Zai. "Radio Frequency Identification-Based Drivers' Smart Assistance System to Enhance Safety and Reduce Emissions in Work Zone". Publication in Transportation Research Record: Journal of Transportation Research Board series, Washington, DC, January 12-16, 2014. In print.
- b. Qiao, F., Q. Li, and L. Yu. (2014). Testing Impacts of Work Zone X2V Communication System on Safety and Air Quality in Driving Simulator. Accepted for presentation and publication in the proceedings of the 2014 Intelligent Transportation Society (ITS) World Conference, Detroit, USA. September 7-11, 2014.
- c. Qing Li, Fengxiang Qiao, and Lei Yu. Impacts of Vehicle to Infrastructure Communication Technologies on Vehicle Emissions. Proceedings of the 2014 International Conference of Environmental Science and Technology (IC EST2014) by American Academy of Sciences, June 9 -13, 2014, Crowne Plaza, Houston, Texas, USA. Paper Number: IC EST2014 # 946.

E. Virginia Tech:

- i. ***Develop Mesoscopic Fuel Consumption and CO₂ Emission Models*** – Nothing to report
- ii. ***Develop Macroscopic Fuel Consumption and CO₂ Emission Models*** – Nothing to report
- iii. ***Develop Green Cooperative Adaptive Control Systems in the Vicinity of Signalized Intersections***
 - a. Kamalanathsharma R. and Rakha H. (In press), Agent-Based Simulation of Eco-Speed Controlled Vehicles at Signalized Intersections," Transportation Research Record: Journal of the Transportation Research Board.
 - b. 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*.
 - c. 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].
 - d. 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].
 - e. Kamalanathsharma R. and Rakha H., (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].
- iv. ***Develop Multi-scale Energy and Emission Models***
 - a. Edwardes W. and Rakha H. (In press), "Virginia Tech Comprehensive Power-Based Fuel Consumption Model: Modeling Diesel and Hybrid Buses," Transportation Research Record: Journal of the Transportation Research Board.
 - b. Elmoselhy S., Faris W. and Rakha H. (In press), "Experimentally validated analytical modeling of diesel exhaust HC emission rate," *The Journal of Mechanical Science and Technology*.
 - c. Faris W., Rakha H.A., and Elmoselhy S. (2014), "Supercharged Diesel Powertrain Intake Manifold Analytical Model," *International Journal of Vehicle Systems Modelling and Testing*, 9(1), pp. 1-35.
 - 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].

F. Multi-institution:

- i. ***Developing and Field Implementing a Dynamic Eco-routing System –Virginia Tech, lead; University of Idaho and Old Dominion University, partners*** – Nothing to report
- ii. ***Smartphone-based Solutions to Monitor and Reduce Fuel Consumption and Co2 Footprint – Old Dominion University, lead; Virginia Tech and Texas Southern University, partners***
 - a. The following presentation was given at the VASITE (Virginia Section of the Institute of Transportation Engineers) Annual Meeting:
 - 1) “Collecting Vehicle Trajectory Information by Smartphones when GPS Signal is Lost”
M. Cetin, T. Nadeem, I. Ustun, A. Alasaadi, M. Orensky, June 25-27, 2014.
 - b. The following paper will be presented at the ITS World Congress:
 - 1) Ustun, A. Alasaadi, T. Nadeem, M. Cetin, “Detecting Vehicle Stops from Smartphone Accelerometer Data”, To be presented at the 21st ITS World Congress, Detroit, MI, Sept 7-11, 2014.
 - 2) Dr. Rakha and A. Jahangiri (PhD Student) submitted a paper to the IEEE Transactions on ITS and are now addressing the reviewers’ comments.
 - c. The following three papers are being prepared for submission to the upcoming TRB 2015 conference:
 - 1) G. Bakhtyar, V. Nguyen, N. Pham, P. Johnson, M. Cetin, M. Ng, and D.T. Nguyen “Theoretical Development of Simple Shortest Paths Time-Dependent Bi-Direction Step-by-Step Algorithm”.
 - 2) P. Johnson, G. Bakhtyar, V. Nguyen, M. Cetin, M. Ng, and D.T. Nguyen “Theoretical Development of Domain Decomposition Shortest Paths Step-by-Step Algorithm”.
 - 3) Ustun, Cetin, Nadeem, Alasaadi “Predicting Fuel Consumption based on smartphone data.”
 - d. The following two papers are being prepared to be submitted to TRB or similar conference.
 - 1) J. Wright, I. Makohon, M. Cetin, M. Ng, and D.T. Nguyen “JAVA Computer Animation for Teaching Bi-direction Shortest Paths of Statics Networks”.
 - 2) Makohon, J. Wright, M. Cetin, M. Ng, and D.T. Nguyen “JAVA Computer Animation for Teaching the Hungarian Algorithm”.
- iii. ***Eco-traffic Signal System – University of Idaho, lead; Virginia Tech and Syracuse University, partners*** – Nothing to report
- iv. ***Studying the impact of accelerated construction methods in work zones using micro-simulation, on vehicle emissions and the environment – Syracuse University, lead; Virginia Tech and University of Idaho, partners*** - Nothing to report

3. PARTICIPANTS & OTHER COLLABORATING ORGANIZATIONS:

A. University of Idaho:

UI has been working with the Idaho Transportation Department, Decagon Devices, Inc., and Econolite Controls holding various meetings to collaborate on projects and holding training meetings.

- i. ***Developing and Testing Eco-Traffic Signal System Applications*** - Nothing to report
- ii. ***In situ Transesterification of Microalgal Oil to Produce Algal Biodiesel*** - Nothing to report
- iii. ***Calibration of Multi-Scale Energy and Emissions Models*** - Nothing to report
- iv. ***Design Improvements and Performance Validation of a Competitive Hybrid FSAE Vehicle***
Assistance to the Formula Hybrid SAE program has come from various entities within the university and outside the university. The design work and labor came from mechanical

engineering graduate students, mechanical and electrical engineering senior design students, and other undergraduate student club support. Financial support has come from TranLIVE (USDOT), the Mechanical Engineering Department, the College of Engineering, Associated Student University of Idaho, and alumni donations. In-kind support has come from Nelson Metals Inc. (Payette, Idaho), Janicki Industries (Sedro Woolley, Washington), Performance Coatings (Auburn, Washington), Bay Shore systems (Rathdrum, Idaho), Novax, Reliable Carriers Inc. (Canton, MI), and Inland Northwest Metallurgical (Spokane, Washington). Further support has come in the form of discounts from Fastenal (Moscow, Idaho), Aurora Bearing Company, Premier Gear and Machine Works (Portland, Oregon), Allsport (Spokane, Washington), Motec (Huntington Beach, California), Pyrotect (Redmond, Oregon) and Cartesian Tube Profiling (Stratford Ontario).

- x. ***A High-Speed Trapezoid Image Sensor Design for Continuous Traffic Monitoring at Signalized Intersection Approaches*** - Nothing to report
- xi. ***Upgrading Biomass Pyrolysis Bio-oil to Renewable Fuels*** - Nothing to report
- xii. ***Direct Drive AC Rim Motor for Responsive Energy Control of Alternative Electric Vehicle*** - Nothing to report
- xiii. ***Daily Travel Feedback to Encourage Eco-Routing*** - Nothing to report
- xiv. ***Eco-driving Modeling Environment*** - Nothing to report

B. Old Dominion University:

Dr. Khattak worked collaboratively with foreign collaborators at University of Aveiro, Portugal (J. Bandeira, T. Almeida, & M. Coelho) on research papers that are related to the TranLIVE theme and were submitted for review in refereed journals.

C. Syracuse University:

Dr. Salem has worked with Dr. Tran of University of Kansas to submit a research need statement titled "A Guidebook on Accelerated Construction Methods and Technologies for Transportation Infrastructures" as a part of TRB Construction Management Committee's (AFH10) research endeavors.

D. Texas Southern University:

- i. Dr. Xumei Chen from Beijing Jiatong University in China wrote a joint proposal with Dr. Yi Qi (TSU) to a Chinese funding agency based on some results of this project.
- ii. Two Ph.D. international exchange students are visiting TSU-one from Australia and one from China. They are exchanging research ideas and activities with TSU graduate and undergraduate students.
- iii. Exchanged ideas and potential collaborative work with researchers at the University of Texas, El Paso.
- 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 Mesoscopic Fuel Consumption and CO₂ Emission Models*** – Nothing to report
- ii. ***Develop Macroscopic Fuel Consumption and CO₂ Emission Models*** – Nothing to report
- iii. ***Develop Green Cooperative Adaptive Control Systems in the Vicinity of Signalized Intersections*** - Nothing to report

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

The research team collaborated with researchers from the International Islamic University of Malaysia (IIUM).

F. **Multi-institution:**

- i. **Developing and Field Implementing a Dynamic Eco-routing System** –Virginia Tech, lead; University of Idaho and Old Dominion University, partners – Nothing to report
- ii. **Smartphone-based Solutions to Monitor and Reduce Fuel Consumption and Co2 Footprint** – Old Dominion University, lead; Virginia Tech and Texas Southern University, partners – Nothing to report
- iii. **Eco-traffic Signal System** – University of Idaho, lead; Virginia Tech and Syracuse University, partners – Nothing to report
- iv. **Studying the impact of accelerated construction methods in work zones using micro-simulation, on vehicle emissions and the environment** – Syracuse University, lead; Virginia Tech and University of Idaho, partners – Nothing to report

4. **IMPACT:**

A. **University of Idaho:**

- i. **Developing and Testing Eco-Traffic Signal System Applications**
 - a. Education:
 - 1) One Bachelor of Science in Civil Engineering student graduated and joined the transportation engineering graduate program at the University of Idaho.
 - 2) Two undergraduate Civil Engineering students joined as undergraduate research intern.
 - 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.
 - c. Tech Transfer
 - 1) Publication of results at various meetings and conferences.
- ii. **In situ Transesterification of Microalgal Oil to Produce Algal Biodiesel** – Nothing to report
- iii. **Calibration of Multi-Scale Energy and Emissions Models**
 - a. Education:
 - 1) One Ph.D. student in Mechanical Engineering graduated.
 - 2) One undergraduate electrical engineering student continued working as undergraduate research intern.
 - b. Research
 - 1) Validated emission and fuel consumption models for hybrid vehicles.
 - 2) Optimized rule-based energy management system for hybrid electric vehicles that improves their fuel economy.
- iv. **Design Improvements and Performance Validation of a Competitive Hybrid FSAE Vehicle**

The impact of this program is threefold.

 - a. Education: It provides an opportunity for young engineers to investigate, design, and experiment with hybrid automotive technologies. This exposes them to a vital and ever more important part of transportation technology. Having this experience gives team

members 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. Being involved in this competition puts the University of Idaho head-to-head against engineering schools from around the world. Not only does the competition give us the opportunity to share the stage with other universities such as Yale, Dartmouth, BYU, and McMaster, but also gives important exposure to representatives from Ford, GM, and other auto-makers.
- c. Technology Advancement: Graduate students conducted the majority of the research that supports the design work. Mostafa Asfoor, Jeremy Cuddihy, Rory Lilley, John Teske, and Phil Peterson each have or are currently conducting research specifically based upon the Formula Hybrid Program. "A User-Friendly, Two-Zone Heat Release Model for Predicting Spark-Ignition Engine Performance and Emissions" created by Jeremy Cuddihy was used to create the engine model used to predict the Brake Specific Fuel Consumption map.

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

Traditional image sensors have rectangular pixel arrays. When rectangular pixel arrays are monitoring intersections for incoming traffic, the resolution of the camera is set by the objects at the far end of the field of view (FOV) since the objects at the far end appear much smaller than those near the image sensor. This means the pixels should be small enough to capture the image at the far end with enough detail. This results in resolution redundancy for the near field.

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

- a. The main impact is the improvement of bio-fuels production so as to reduce the reliance on fossil fuels largely used in the transportation sector.
- b. This project has supported the training of two graduate students in the area of catalyst development and catalytic conversion of biomass into fuels.
- c. We have participated in technology transfer forums by presenting our research at technical and scientific meetings.

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

New design equations allow for standard motor design techniques to be used to design radial linear motors.

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

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

- a. Research
 - 1) An Eco-Driving modeling environment that integrates the NADS MiniSim driver simulator model and the GT-Suite advanced engine modeling tool
- b. Education
 - 1) One computer science undergraduate student

B. Old Dominion University:

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

- ii. ***Real-time Prediction of Queues at Signalized Intersections to Support Eco-driving Applications*** - Two papers were presented in January 2014 at the TRB's Annual Meeting based on the research conducted. Data collected from the project and the developed methods were presented at graduate-level transportation courses at ODU.

- iii. ***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 modeling and 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.
 - e. Various products and applications are being envisioned and developed in order to support more eco-friendly driving decisions.
- iv. ***Optimize Freight Routes and Modes to Minimize Environmental Impacts*** - Nothing to report

C. Syracuse University:

- i. The results of the project “Enhancing TSM&O Strategies through User Cost Analysis and Life Cycle Assessment” offers a comprehensive ITS benefit/cost analysis study which will assist decision maker to select sustainable TSM&O alternatives.
- ii. The results presented in the final report of the project “Assessing Environmental Impacts of Work Zones in Arterial Improvement Projects” will assist highway construction management professionals to select environmentally sustainable maintenance, repair and rehabilitation solutions.
- iii. 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.

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. In addition, since very few studies have been performed to directly investigate the impacts of the traveler information on on-road mobile emissions, the proposed research will fill this gap and will help the researchers and practitioners to better understand the related issues in the future.

ii. *Education and Outreach Activities*

- a. 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.
- b. The education program has brought awareness to students, teachers, community organizers, organizations and families about the impact of transportation on the environment. In addition, these groups have come to understand that their personal decisions regarding transportation impact the quality of their environment.

- c. The students learned new transportation and environmental concepts and terms. They made a connection to how goods, services and people are transported efficiently through various modes and networks of transportation infrastructure.
- iii. ***Develop an Integrated Data Management System at the Microscopic, Mesoscopic, and Macroscopic Levels to Assess the Environmental Impacts of Transportation System***
Once the emission and activity database is fully developed, researchers, students at different levels (graduate students, undergraduate students, K-12 students) from different geographic areas (within or outside the consortium, within or outside the country) can utilize this database easily for various transportation and environment related research and education purposes through web access.
- 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. They also provide very good examples for undergraduate and graduate level courses. The developed techniques can be expanded for direct use by industry and government.
- vi. ***Improve the Environment for a Livable Community: Advance the AERIS Program by Developing and Testing Eco-traffic Signal System Control Applications***
 - a. The developed eco-driving strategy can reduce emissions at intersections.
 - b. The simulation of the V2I communication system in driving simulator provides a test platform for safer tests with more scenarios designed.
 - c. The developed system and the simulation in driving simulator are good teaching materials for students to understand the effects and components of V2I and ITS.
- 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. Virginia Tech:

- i. ***Develop Mesoscopic Fuel Consumption and CO₂ Emission Models***
 - a. Education: The funding of a graduate student assistantship.
 - b. Research: Development of mesoscopic fuel consumption models for light duty cars and buses.
- ii. ***Develop Macroscopic Fuel Consumption and CO₂ Emission Models***
 - a. Education: The funding of a graduate student assistantship.
 - b. Research: Development of macroscopic fuel consumption models for light duty cars and buses.
- iii. ***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.
- 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.

F. Multi-institution:

- i. ***Developing and Field Implementing a Dynamic Eco-routing System –Virginia Tech, lead; University of Idaho and Old Dominion University, partners***
 - a. Education: The funding of a graduate student assistantship.
 - b. Research: Development of eco-routing prototype.
- ii. ***Smartphone-based Solutions to Monitor and Reduce Fuel Consumption and Co2 Footprint – Old Dominion University, lead; Virginia Tech and Texas Southern University, partners*** - The results of the research are being disseminated through journal publications and presentations at international conferences.
- iii. ***Eco-traffic Signal System – University of Idaho, lead; Virginia Tech and Syracuse University, partners*** – Nothing to report at this time
- iv. ***Studying the impact of accelerated construction methods in work zones using micro-simulation, on vehicle emissions and the environment – Syracuse University, lead; Virginia Tech and University of Idaho, partners*** – Nothing to report

5. CHANGES/PROBLEMS

A. University of Idaho:

- i. ***Developing and Testing Eco-Traffic Signal System Applications*** - Nothing to report
- ii. ***In situ Transesterification of Microalgal Oil to Produce Algal Biodiesel*** – Nothing to report
- v. ***Calibration of Multi-Scale Energy and Emissions Models*** - Nothing to report at this time
- vi. ***Design Improvements and Performance Validation of a Competitive Hybrid FSAE Vehicle*** – Nothing to report
- x. ***A High-Speed Trapezoid Image Sensor Design for Continuous Traffic Monitoring at Signalized Intersection Approaches***
 One critical design choice or assumption we had was to focus the imager on the middle distance of 250m road using a single optical lens system, and this is sufficient to see all vehicles in the full 250m. Initial measurements showed that the blurring caused by out of focus could reduce the resolution in far distances.
- xi. ***Upgrading Biomass Pyrolysis Bio-oil to Renewable Fuels***
 We have just developed new protocols for producing Ni-NS at the 100-300 mg level per batch for characterization studies and preliminary catalysis trials. The adapted WIM process will provide larger quantities of Ni-NS catalysts for bio-oil conversion studies however, we still need to increase the Ni content from 20 to 60% and this will be the focus of our continuing studies. We have modified the hydrogenation reactor (300 mL) set-up to accommodate higher H₂ pressures to improve bio-oil conversions and these current trials have shown positive results. Ongoing studies will use this modified system to conduct bio-oil conversion studies using the higher Ni loading NS catalysts.
- 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 during the 2014 summer. This focus on a correct theoretical presentation has shifted the graduate student's progress. Production and testing of the motor will take place at a future date.
- xiii. ***Daily Travel Feedback to Encourage Eco-Routing*** - Nothing to report

xiv. ***Eco-driving Modeling Environment*** - Nothing to report

B. Old Dominion University:

- i. ***New Strategies for the Emergency Vehicle Routing to Reduce Response Time Using Vehicle-to-Vehicle Communications*** - Nothing to report
- ii. ***Real-time Prediction of Queues at Signalized Intersections to Support Eco-driving Applications*** - Nothing to report
- iii. ***Reducing Energy Use and Emissions through Innovative Community Designs: Methodology and Application***- Nothing to report
- iv. ***Optimize Freight Routes and Modes to Minimize Environmental Impacts*** - Nothing to report

C. Syracuse University:

Nothing to report

D. Texas Southern University:

Nothing to report

E. Virginia Tech:

- i. ***Develop Mesoscopic Fuel Consumption and CO₂ Emission Models*** - Nothing to report
- ii. ***Develop Macroscopic Fuel Consumption and CO₂ Emission Models*** - Nothing to report
- iii. ***Develop Green Cooperative Adaptive Control Systems in the Vicinity of Signalized Intersections*** - There have been delays in getting the cloud simulation environment running.
- 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.

F. Multi-institution:

- i. ***Developing and Field Implementing a Dynamic Eco-routing System*** –Virginia Tech, lead; University of Idaho and Old Dominion University, partners – Nothing to report
- ii. ***Smartphone-based Solutions to Monitor and Reduce Fuel Consumption and Co2 Footprint*** – Old Dominion University, lead; Virginia Tech and Texas Southern University, partners – Nothing to report
- iii. ***Eco-traffic Signal System*** – University of Idaho, lead; Virginia Tech and Syracuse University, partners – Nothing to report
- iv. ***Studying the impact of accelerated construction methods in work zones using micro-simulation, on vehicle emissions and the environment*** – Syracuse University, lead; Virginia Tech and University of Idaho, partners – Nothing to report

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: Ahmed Abdel-Rahim

Old Dominion University: Mecit Cetin

Syracuse University: O. Sam Salem

Texas Southern University: Fengxiang Qiao

Virginia Tech: Hesham Rakha