

# NIATT

## ANNUAL REPORT



PREPARED FOR UNIVERSITY TRANSPORTATION CENTERS PROGRAM

RESEARCH AND INNOVATIVE TECHNOLOGY ADMINISTRATION

U.S. DEPARTMENT OF TRANSPORTATION

FUNDING PERIOD JULY 1, 2009 THROUGH JUNE 30, 2010 - FY10



## THEME: ADVANCED TECHNOLOGY FOR SUSTAINABLE TRANSPORTATION

### MISSION

Our mission is to develop engineering solutions (knowledge and technology) to transportation problems for the state of Idaho, the Pacific Northwest, and the United States, and to prepare our students to be leaders in the design, deployment, and operation of our nation's complex transportation systems.

### VISION

Our vision is to be one of the premier transportation research and education programs in the United States.

- We are a national leader in developing technology to reduce congestion on arterials, improve the quality and economic viability of biofuels, and reduce the environmental impacts and improve the fuel economy of motorized vehicles (including passenger cars, transit vehicles, and recreational vehicles).
- NIATT faculty and students engage in multidisciplinary research to solve challenging, practical, and relevant transportation problems that have regional and national significance. We create interdisciplinary research and development teams of undergraduate and graduate students, mentored by expert faculty. To ensure our work is relevant and responsive to stakeholder needs, we seek collaborative partnerships with organizations such as the Federal Highway Administration, the Federal Transit Administration, the Idaho Transportation Department, and others committed to our values to work on problems of mutual interest. This practice engages our students in meaningful, experiential, learning-centered environments that add value to their education.
- By taking this approach, we integrate our research with the educational mission of the University. At the same time, our research results in technology that satisfies the needs of our customers, both by informing their actions and decisions and by providing them with useful products. We also provide life-long learning opportunities for transportation professionals in Idaho and the Northwest at all levels of practice.
- NIATT's work is carried out in the context of a commitment to preserving and protecting natural and pristine environments. Our research on, and development of, clean vehicles, alternative fuels, and efficient traffic control systems contributes to the sustainability of these environments.

On the cover:

Right: Undergraduate student, Sushant Kshetri, prepares the samples collected from catalytic thermochemical conversion of glycerol to alcohols for gas chromatograph analysis.

Top left: Stefan Hovik (left) and Brandon Butsick (right) watch as Cam Stefanic prepares the Yamaha YZ250 for conversion to fuel injection.

Bottom left: Cody Browne tests the new Accessible Pedestrian Button after the Minnesota Department of Transportation technician installation in February 2010, St. Paul, MN.

*Kevin Oswald (high school intern), Brad McGary (MSME candidate), and Zane Beckman (high school intern) are evaporating biodiesel in the Combustion Laboratory in Boise.*



## TABLE OF CONTENTS

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Director’s Letter .....	1
NIATT Advisory Board.....	2
Management Structure .....	5
NIATT Affiliate Faculty .....	6
NIATT UTC Research.....	7
Education .....	30
Our Students.....	35
Activities in the Region X Consortium.....	46
Financial Report.....	48
Status of UTC Projects .....	50

To access an electronic copy of this report and to read more about the research, education and outreach activities in which our students and faculty are involved, we invite you to visit <http://NIATT.org>

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Tami Noble



*Karen Den Braven, Director*



## DIRECTOR'S LETTER

Greetings from the Gem State! I am completing my first full year as Director of the University of Idaho's National Institute for Advanced Transportation Technology. I am honored to be working with such a fine group of faculty, staff, and especially, students! People, and the end effects of our work in society, are the primary impetus for our work.

As a researcher in NIATT since 2000, I have seen the direct impact that this UTC has had on the transportation industry, working professionals, and students. Lately, economic issues have been in the forefront throughout the country. Transportation is increasingly seen as a solution, not as a problem. Our researchers and students have always been focused on practical solutions to real-world problems, and the implementation of these solutions in the field, factory, and laboratory.

Former Director Michael Kyte has returned to active duty in the civil engineering department, where he is continuing to spearhead regional and national efforts in transportation education for both students and practicing professionals.

Dr. Kyte's efforts in his career garnered him one of the highest honors: the award for Distinguished Contribution to University Transportation Education & Research Award at the 2010 CUTC Awards Banquet in Washington, DC in January 2010. The award has been given annually since 1998 to honor individuals who have had a long history of outstanding contributions to university transportation education and research.

NIATT and its researchers continue to earn other national awards, and impact people's lives. Our clean snowmobile team again achieved Third Place in the Clean Snowmobile Challenge, bringing back several other awards in the process. In February, 2010 at a temperature below 10 degrees, a new Smart Signals Technology design for Accessible Pedestrian Signals (APS) was installed at a public intersection in a suburb of St. Paul, MN. A team of UI researchers observed technicians with the Minnesota Department of Transportation install the systems at two intersections.

NIATT researchers continue to be guided by our theme of "Advanced Technology for Sustainable Transportation". In this report, you will see an emphasis on "People, Products, and Processes". What we do as a University Transportation Center is to focus on people and their needs. The Department of Transportation continues an emphasis on workforce development and livability as part of a meaningful strategy.

We continue to be guided by our UTC Strategic Plan approved in 2007. But beyond that, we still believe in the principles as elucidated in our UTC Vision statement:

"NIATT's work is carried out in the context of a commitment to preserving and protecting natural and pristine environment. Our research on and development of clean vehicles, alternative fuels, and efficient traffic control systems contributes to the sustainability of these environments."

We continue to be passionate about helping to solve state, regional and national transportation problems. We welcome your interest and involvement in our work. Please feel free to let us know your thoughts or concerns either by mail, telephone, email or at our website.

Sincerely yours,

Karen Den Braven, Director



*The Advisory Board Banquet was not only a time for introductions and presentations, but also served as an informal meet and greet. Shown in the picture are Christopher DeLorto, David Sherman, Jorge Jordan Zamalloa (civil engineering graduate students); right - Dr. Ahmed Abdel-Rahim (faculty); Bruce Christensen (advisory board member from Idaho Transportation Department); in back Becky Christensen (guest); and Jim Bloodgood (Snohomish County).*

## NIATT ADVISORY BOARD

Bruce Christensen  
*Traffic Engineer, District 4  
 Idaho Transportation Department*

James Colyar  
*Highway Research Engineer  
 Federal Highway Administration*

John Crockett  
*Idaho Bioenergy Program  
 Idaho Office of Energy Resources*

Gregory W. Davis  
*Professor, Mechanical Engineering  
 Kettering University*

Gary Duncan  
*Sr. Vice President and Chief Technology Officer  
 Econolite Control Products, Inc.*

Jim Evanoff  
*Environmental Protection Specialist  
 Yellowstone National Park*

Peter Koonce  
*Principal Engineer  
 City of Portland*

Tom LaPointe  
*Executive Director  
 Valley Transit*

Jim Larsen  
*Congestion Management Supervisor  
 Ada County Highway District*

George F. List  
*Professor and Head of Construction  
 and Environmental Engineering  
 North Carolina State University*

Paul Olson  
*ITS Technology Engineer  
 Federal Highway Administration*

Ned Parrish  
*Research Manager  
 Idaho Transportation Department*

Zong Tian  
*Associate Professor, Civil and  
 Environmental Engineering  
 University of Nevada, Reno*

## NIATT'S ANNUAL ADVISORY BOARD MEETING

NIATT's annual Advisory Board meeting was held over two days in April 2010, allowing the Board members to attend and/or judge the Annual University of Idaho Engineering Exposition held on Friday, April 30, 2010.

The Center for Traffic Operations and Control (CTOC) invited an additional traffic professional to attend: Jim Bloodgood, Snohomish County, WA, Traffic Engineering.

On Wednesday, April 28, 2010, a banquet was held to welcome the board members and other guests. Howard Cooley, NIATT's 2009 Student-of-the-Year and PhD candidate in civil engineering, and Randy Maglinao, PhD candidate in biological and agricultural engineering, made presentations on their experiences working in NIATT and their current project work.



*Jack McIver, UI Vice-President of Research and Economic Development, addressed the Advisory Board about the status of research institutes on campus.*



*Members of the Advisory Board and faculty discuss specifics of presentations from earlier in the day (left to right) Gary Duncan, Econolite Controls, Dr. Richard Wall; Dr. Greg Davis, Kettering University; Dr. Karen Den Braven; Tom LaPointe, Valley Transit; and John Crockett, Idaho Office of Energy Resources.*

Date	ADVISORY BOARD AGENDA	
	Center for Traffic Operations and Control	Center for Clean Vehicle Technology
Wednesday, April 28	NIATT Banquet	
Thursday, April 29	Continental Breakfast Welcome, College of Engineering Dean, Don Blackketter Introductions/Agenda Overview	
	Assessing our Current Work	Assessing our Current Work
	Lunch	
	Questions for the Future	Questions for the Future
	Joint discussions; Synthesis of Ideas Future of research at University of Idaho, Jack McIver, Vice President, Research Closing session: Next steps to take	
	College of Engineering Dean's Reception	
Friday, April 30	Engineering Expo	

On Thursday, the meeting was in full swing with presentations throughout the day by NIATT researchers seeking funding for the 2010 academic year. The board members interacted with presenters and made recommendations for funding for the next fiscal year.

MANAGEMENT STAFF



**Karen Den Braven**  
*Director, NIATT*  
*Professor, Mechanical Engineering*



**Tamara Noble**  
*Assistant to the Director, NIATT*



**Deborah Foster**  
*Financial Technician, NIATT*

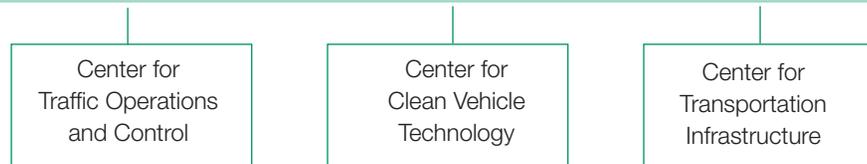


**Victor House**  
*ITS Integration Analyst, NIATT*

MANAGEMENT STRUCTURE AND PRINCIPAL CENTER STAFF

The National Institute for Advanced Transportation Technology (NIATT) is one of six research institutes on the University of Idaho campus. Institute status was granted to NIATT in July 1998 in recognition of its university-wide, multidisciplinary activities. The institute, originally known as NCATT, was established in 1991 under the Intermodal Surface Transportation Efficiency Act (ISTEA).

NATIONAL INSTITUTE FOR ADVANCED TRANSPORTATION TECHNOLOGY



Although the University Transportation Centers (UTC) program primarily supports the work of NIATT's Center for Traffic Operations and Control and the Center for Clean Vehicle Technology, the UTC funding has a positive impact on the entire institute and our ability to deliver transportation technology. UTC funds are supplemented from a variety of sources, including the Idaho Transportation Department (ITD), Idaho Department of Water Resources, the U.S. Departments of Energy and Defense, and the Federal Highway Administration. The research in the Center for Transportation Infrastructure is supported mainly by the cooperative agreement between NIATT and ITD.



*A leadership transition – (left to right) Judy LaLonde (retired Assistant to the Director), Karen Den Braven (Director), Michael Kyte (retired Director), and Tami Noble (Assistant to the Director).*

## NIATT AFFILIATE FACULTY

Ahmed Abdel-Rahim  
*Associate Professor, Civil Engineering*

Fouad Bayomy  
*Professor, Civil Engineering*

Steven Beyerlein  
*Professor, Mechanical Engineering*

Donald Blackketter  
*Dean of Engineering*

Ralph Budwig  
*Professor, Mechanical Engineering*  
*Director, Boise Engineering*

Anthony Davis  
*Assistant Professor, Forest Resources*

Karen DenBraven  
*Professor, Mechanical Engineering*

Michael Dixon  
*Associate Professor, Civil Engineering*

Brian He  
*Associate Professor, Biological and*  
*Agricultural Engineering*

Brian Johnson  
*Chair, Electrical and Computer Engineering*

S. J. Jung  
*Professor, Civil Engineering*

James Kingery  
*Professor Emeritus, Range Resources*

Michael Kyte  
*Professor, Civil Engineering*

Joseph Law  
*Professor, Electrical and Computer Engineering*



*Dr. Ahmed Abdel-Rahim talks with Ned Parrish and Bruce Christensen (advisory board members) about his new project proposal for the Center for Traffic Operations and Control during a break at the advisory board meeting.*

Michael Lowry  
*Assistant Professor, Civil Engineering*

Stanley M. Miller  
*Professor, Geological Engineering*

Richard J. Nielsen  
*Chair, Civil Engineering*

Edwin Odom  
*Professor, Mechanical Engineering*

Judi Steciak  
*Professor, Mechanical Engineering*

Jon Van Gerpen  
*Chair, Biological and Agricultural*  
*Engineering*

Richard Wall  
*Professor, Electrical and Computer*  
*Engineering*

Thomas Weaver  
*Assistant Professor, Civil Engineering*

# NIATT UTC RESEARCH

As do all University Transportation Centers, NIATT uses its strategic plan to set the framework for research selection and implementation. NIATT's most recent Strategic Plan, approved in 2007 by US DOT, describes four objectives, two of which are directly related to research

**Objective 1:** Develop arterial traffic management tools that can be used by practitioners and researchers to manage congestion and improve safety.

**Objective 2:** Improve the quality and economic viability of biofuels and reduce the environmental impacts and improve the fuel economy and safety of motorized vehicles (including passenger cars, transit vehicles, and recreational vehicles) to protect the natural and built environment.

Objective 1 directs the research activities of NIATT's Center for Traffic Operations and Control (CTOC), while Objective 2 guides the research for NIATT's Center for Clean Vehicle Technology (CCVT).

The *Strategic Plan* outlines several strategies under each objective of the *Strategic Plan*, defining the way we plan to meet those objectives.

For this annual report, each principal investigator was asked to describe how their results affect "People, Products, and Processes." They review the end products of their work with an emphasis on real-world applications.

The research conducted at NIATT relies on the knowledge and strengths of the researchers involved. Each project, as well, involves both graduates and undergraduates, who have the opportunity to conduct basic and/or applied research, the products of which are judged by experts, knowing that they helped contribute to the body of knowledge in transportation while earning degrees.

# PRINCIPAL INVESTIGATOR PROJECTS

## CENTER FOR TRAFFIC CONTROL OPERATIONS

**Principal Investigator:** Dr. Ahmed Abdel-Rahim

**Project:** Improved Simulation of Driver Behavior: Modeling Protected and Permitted Left-Turn Operations at Signalized Intersections (KLK716)

**Co-Investigators:** Dr. Michael Kyte and Dr. Michael Dixon

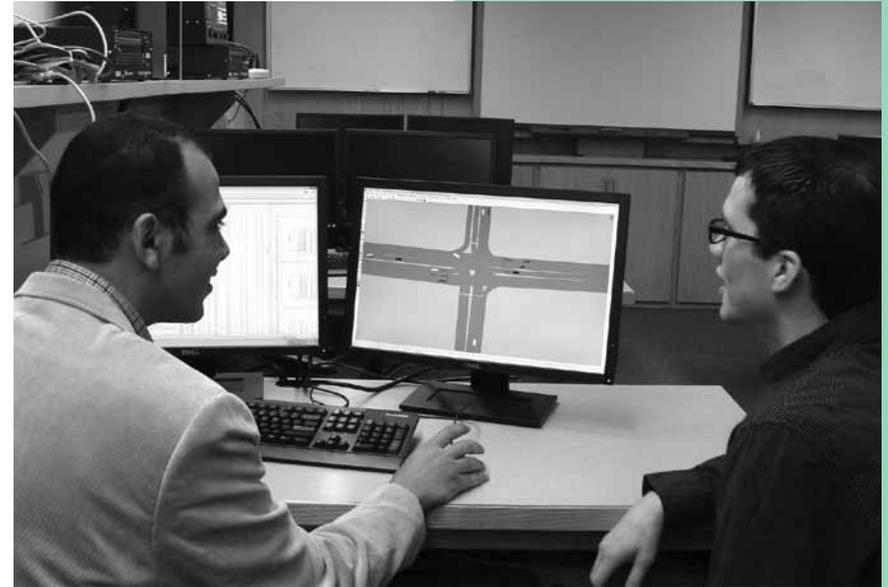
**Student Involvement:** Sherief El Bassuoni (PhD civil engineering student); Jorge Jordon Zamalloa; Golam Sarwar, Lionel Starchman, and Asma Tuly (graduate civil engineering students)

**University Transportation Center Funding:** \$75,895.90

### STRATEGY INVOLVED:

**Strategy 1.2:** Develop improved driver behavior algorithms for congested and uncongested conditions on arterials in support of FHWA's NGSIM program and develop improved modeling capabilities for arterial operations for TRANSIMS program.

The characteristics of left-turn operations at signalized intersections are influenced by several factors such as the type of control, lane configuration, vehicle mix, turning radius, and opposing traffic. Left-turning vehicles can use a designated left-turn phase (protected, protected-permitted, or permitted-protected) or can be served with permitted only operations with vehicles. They can use exclusive left-turn lanes or share the same lane with the through and/or the right turning traffic. While protected left-turning vehicles share some characteristics with through-moving vehicles at the beginning and end of the green interval, they have different saturation headway distributions and speed and acceleration profiles along the turning path. The mechanism of a permitted left-turn movement involves different stages of motion. In the first stage, the vehicle waiting to make the left-turn moves forward to a point at which it stops, waiting for an opportunity to turn. In the second stage, the vehicle stops at the waiting location and monitors the opposing traffic, looking for an acceptable gap to make the turn. The third and final stage involves the turning movement once an acceptable gap is available in the opposing traffic stream. The vehicle waiting time and the availability of an acceptable gap will depend on the characteristics of the headway distribution in the opposing traffic. In a typical traffic stream, three distinct headway-distribution periods can be identified: 1) the *queue discharge period* where headways are uniformly distributed with an average equal to the saturation headway, 2) the *delayed vehicle period* that includes vehicles arriving during green but delayed by the queue, and 3) the *free-flow period* with randomly distributed headways.



*Sherief El Bassuoni (left) and Lionel Starchman (right) work on microscopic modeling of left-turn vehicles.*

The project used high-resolution vehicle trajectory data from the FHWA's NGSIM datasets to identify and document the characteristics of left-turn operations at signalized intersection approaches. Two different left-turn modes of operation were considered: protected and permitted operations. Parameters such as start-up response time, start-up lost time, follow-up time, distance headway, safe following distance at different speeds, speed and acceleration profiles along the turning path, and vehicle path prior to turning and location of waiting point were investigated as part of the analysis. Findings from the project showed that the average start-up response time and the average start-up lost time for left-turning vehicles are not statistically significant than those for through-moving vehicles. The speed and acceleration profiles for left-turning vehicles, however, were different than through-moving vehicles. For the same distance from the stop bar, the average speed of left-turning vehicles is consistently lower than the average speed of through moving vehicles. This highlights the need to use signal control parameters for left-turn phases, such as minimum green time, vehicle extension time, and clearance time different than those for through traffic.

**Other Projects** Dr. Abdel-Rahim is Co-PI on: KLK717 page 10 with Lead PI: Dr. Michael Dixon.

**Principal Investigator: Dr. Michael Dixon**

**Project:** An Architecture for Implementing Improved Queue Spillback Control Strategies (KLK717)

**Co-Investigators:** Dr. Ahmed-Abdel-Rahim and Dr. Richard Wall

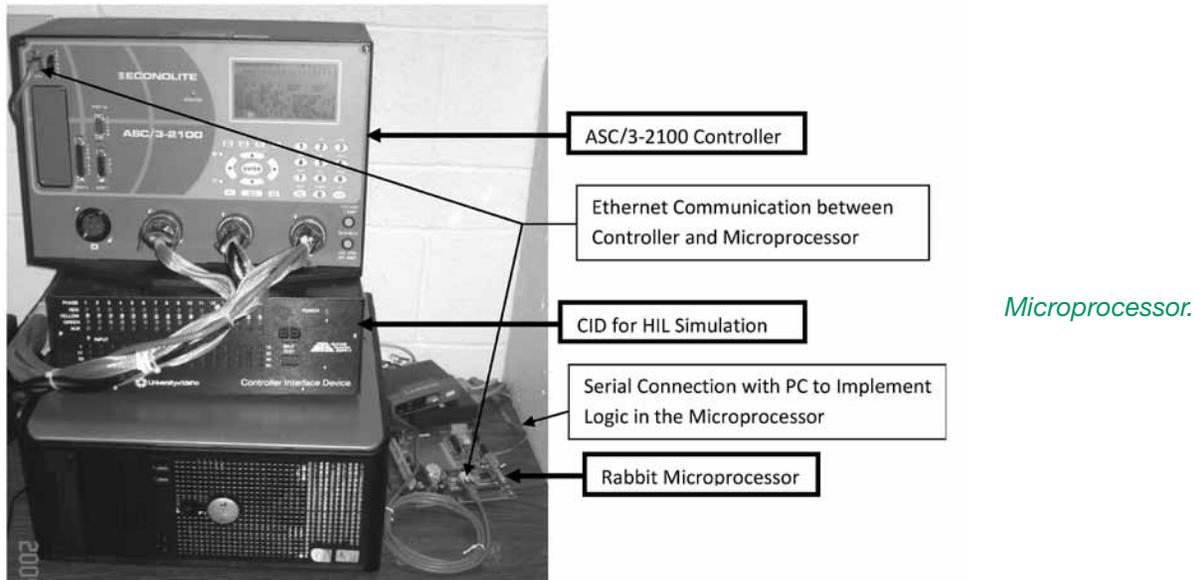
**Student Involvement:** Mohammad Rabiul Islam, Kevin Kingsbury, Syed Zillur Rahman, Golam Sarwar, Asma Tuly (graduate students, civil engineering); Justin Clark, Kenneth Wadley, and Sean Wagoner (undergraduate students, electrical engineering)

**University Transportation Center Funding:** \$148,930

**STRATEGY INVOLVED:**

**Strategy 1.3:** Develop practical traffic control strategies to better manage congested arterial flow using our innovative and widely used hardware-in-the-loop traffic simulation system.

The NIATT research team developed the ability to monitor and diagnose traffic and controller operations externally using a microprocessor and an Ethernet connection to a NTCIP compliant traffic controller. While this development has many prototyping applications, the focus for this research was to prototype two queue spillback detection algorithms and respond to them to improve traffic operations. Hardware in the loop simulation (HILS) was used as the testing environment (figure below), simulating operations on a pair of closely spaced intersections (figure on next page). Within this environment, detector information was used together with phase status to determine if a queue is held back by a downstream disruption. Testing found that the microprocessor can effectively respond to reduce simulated queue spillback occurrence and symptoms.



*Traffic control  
strategy testing  
environment.*



Further development is underway to improve the microprocessor's interface with a standard NTCIP compliant eight phase controller and also to add networking functions for the controller to harmonize with other microprocessors. Adding these capabilities will allow researchers to develop, and experiment with, new traffic control strategies either within the HILS environment in the lab or in the field with existing controllers. As a result of these capabilities, researchers hope to accelerate control strategy development in general and have them used in practice sooner.

**Other Projects** Dr. Dixon is Co-PI on: KLK716 page 8 with Lead PI: Dr. Ahmed Abdel-Rahim.

**Principal Investigator:** Dr. Richard Wall

**Project:** Closed Loop Operation of Network Based Accessible Pedestrian Signals (KLK719)

**Co-Investigators:** Dr. Michael Kyte and Dr. Brian Johnson

**Student Participation:** Craig Craviotto, Zane Sapp (graduate students, electrical engineering); Cody Browne, Elizabeth Reese (undergraduate students, electrical engineering); and Mathew Stein (undergraduate student, computer engineering)

**University Transportation Center Funding:** \$111,723

#### STRATEGY INVOLVED:

**Strategy 1.4** Take a revolutionary approach to interfacing traffic controllers to field devices such as signal displays and detectors based on distributed traffic control hardware system that supports all potential users of DOT's Vehicle Infrastructure Integration initiative.

On February 16, 2010 at a temperature below 10 degrees, a new Smart Signals Technology design for Accessible Pedestrian Signals (APS) was installed at a public intersection in a suburb of St. Paul, MN. A team of researchers from the University of Idaho that have been involved in the development of the new system were on hand to observe technicians with the Minnesota Department of Transportation install the systems at two intersections. After the hardware installation, the students demonstrated how each signal can be customized using a laptop computer and a conventional web browser. To date, the Advanced Accessible Pedestrian Signals (AAPS) is "chirping" away. (The "chirp" is the locator tone that helps low vision pedestrians locate the pedestrian button.)

Smarts Signals is an enabling technology initially conceived by Professor Richard Wall in 2004 as a means to improve the capability and safety of controlling traffic signals at intersections using distributed microprocessor based controls that use safety critical network design methodologies. The focus has been placed on improving access and safety for low vision and mobility impaired pedestrians. A partnership was developed with Campbell Company of Boise, ID who manufactures the AAPS systems.

AAPS is different from conventional pedestrian buttons in that information is exchanged between the Advanced Pedestrian Controller (APC) in the traffic controller cabinet and each individual Advanced Pedestrian Button (APB) at the rate of four times a second. Power and communication is distributed through the APBs by employing Ethernet over power line technology on an 18VAC power system. The Minnesota installation demonstrated that the AAPS can be easily retrofitted in existing intersection controls using the pre-existing pedestrian button conductors. The internet connectivity allows traffic agency technicians to



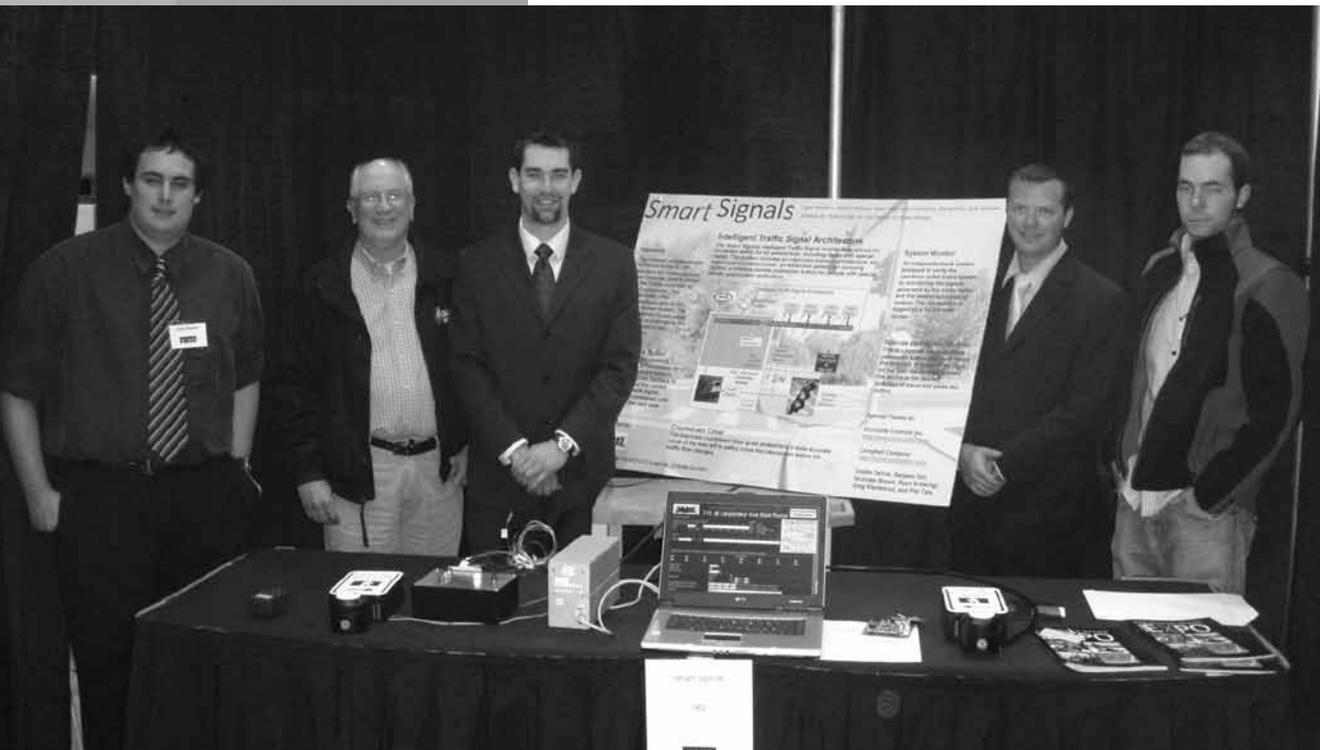
*UI Electrical Engineering graduate student, Craig Craviotto, observes a Minnesota Department of Transportation technician install the first Advanced Pedestrian Controller in St. Paul, MN.*

view the AAPS system operations remotely to determine the current status of individual pedestrian buttons. The operational data that is logged by the APC can also be viewed over the internet. This data includes hardware failures and the number of calls placed by individual APBs.

Feedback from the Minnesota installation has been very positive and constructive. Although the installed AAPS is fully functional, ideas for improvement were recorded and have already been integrated with the new design. Many ideas arise from the statement "Since we have network communications, can we now do ...". Without a tight rein on our imaginations, "feature creep" would never allow us to get out of the laboratory. One of the ideas recently implemented is the ability to update the application program remotely, thus allowing Campbell Company to update existing systems over the internet. The web interface reduces hardware costs and physical size by eliminating displays and keypads.

The step of street deployment is important to the future of Smart Signals because it demonstrates that such systems are extensible by being capable of easily providing advanced features. The communications with the terminal devices (lights, detectors, pedestrian buttons, etc.) facilitates early failure detection. Future research will focus on further simplifying the system installation in order to make the system truly "plug and play."

**Other Projects** Dr. Wall is Co-PI on: KLK717 page 10 with Lead PI: Dr. Michael Dixon.



*The Smart Signals Team, (left to right: Cody Browne, Dr. Richard Wall, Craig Craviotto, Zane Sapp, Mat Stein, and Elizabeth Reese-not shown), received the Award for Excellence in Booth Presentations at the 2010 Engineering Expo.*

# CENTER FOR CLEAN VEHICLE TECHNOLOGY

**Principal Investigator:** Dr. Karen Den Braven

**Project:** Development of an Ethanol Blend, Two-Stroke, Direct-Injection Snowmobile for Use in the Clean Snowmobile Challenge and National Parks (KLK760)

**Co-Investigators:** N/A

**Student Involvement:** Peter Britanyak, Parley Wilson (graduate students, mechanical engineering); Dylan Dixon, Eric Buddrius, Alex Fuhrman, Neil Miller (undergraduates, mechanical engineering); Cole Bode (undergraduate, electrical engineering); Sam Smith (undergraduate, PTTE-technology education option); and Joel Frazier (high school intern).

**University Transportation Center Funding:** \$85,070

## STRATEGY INVOLVED:

**Strategy 2.1:** Advance state-of-the-art in transit, recreational, and hybrid vehicle design.

**Strategies 3.2 and 3.3:** Increase opportunities to engage undergraduate and graduate students in transportation problems.

Due in part to stringent noise and air pollution control measures imposed on snowmobiles by the EPA and the National Park Service, the Society of Automotive Engineers (SAE) instituted a student competition called the Clean Snowmobile Challenge (CSC) in 2000. The University of Idaho NIATT-supported Clean Snowmobile Team first competed in the CSC in 2001. SAE sponsored competitions are an excellent and popular educational tool in engineering programs, since they promote a positive hands-on working environment for students.

**PEOPLE:** Students on the CSC team learn not only how to solve a technical problem, they also learn the value of teamwork and leadership. They must learn to balance the competing requirements of fuel economy, engine power, noise and pollution reduction, handling and consumer acceptance. A portion of the score in the CSC is based on both written and oral communication skills. Students learn the importance of proper communication with everyone from a manufacturer, to a snowmobile racer, a land manager, or a child who is interested in having fun on a snowmobile. The competitions are open to the public where manufacturers spend time visiting the student teams and observing what the students have done. Students often receive internship and permanent job offers from this experience. In addition, the National Park Service, SAE and the EPA closely watch the results of the student sleds while developing potential performance requirements for snowmobiles in sensitive areas.



*Team captain Dylan Dixon waits for the start of the fuel economy run at the Clean Snowmobile Challenge. The lack of snow made conditions difficult.*

The University of Idaho CSC team has excelled in the competition. In addition to winning First Place in 2002, 2003, and 2007, the team has also achieved an overall Second Place in 2008, and Third Place in 2009 and 2010. The team has also been awarded over fifty trophies in such areas as Best Fuel Economy, Best Value, Best Ride, Quietest Snowmobile, Best Acceleration and Handling, and Most Sportsmanlike Conduct over ten years of competing.

**PRODUCTS:** The UI CSC achieved First Place in 2002 and 2003 with a snowmobile powered by a four-stroke BMW motorcycle engine. At that time, the manufacturers began producing snowmobiles with four-stroke engines. In 2004-05, the UI team turned its attention to the more difficult problem of a two-stroke engine.

The team decided to begin development of a two-stroke snowmobile engine which is direct-injected. Technical challenges included proper design on the cylinder head and developing precise electronic control of the fuel pump and injectors. Direct injection can lessen the effects of charge and exhaust gas mixing, and significantly reduce short-circuited fuel. In a gasoline direct-injected engine, fuel is injected into the cylinder when the exhaust ports are nearly or completely closed. Air-assisted or high pressure fuel injectors are used to ensure that the fuel atomizes quickly for combustion.

Several years of intensive effort by the students to develop the direct-injected two-stroke engine came to fruition in March 2007, when the UI CSC team once again brought home First Place and nine other awards. Throughout the 2007 CSC, NIATT-sponsored snowmobiles used E10 as a fuel. E10 is a blend of 10 percent ethanol mixed with 90 percent gasoline.

In 2008, the teams were required to use an E85 blend. The UI team improved the combustion chamber to reduce exhaust emissions and improve fuel efficiency. It was rewarded with overall second place and five additional trophies including a best paper award.

In 2009, competing snowmobiles were required to be flex-fuel, that is, able to run on any ethanol/gasoline blend from E10 to E85. The composition was varied several times throughout the competition from E11 to E55. For 2009, the UI team was unable to program the direct injection system for flex-fuel, so the team instead moved to the slightly less efficient semi-direct injection (SDI) system. The team was able to achieve performance results nearly as good as that of a direct-injection engine. The UI CSC team achieved overall Third Place, also achieving Best Fuel Economy, Best Acceleration and Best Value.

In 2010, the competition used only one fuel, which was an unknown ethanol/gasoline blend between E20 and E29, much like is proposed as a future requirement for passenger cars. While a lack of snow at the competition venue in Michigan hampered several of the events, the UI CSC again achieved overall Third Place, with additional trophies for Cold Start, Best Acceleration, Best Handling, and Best Ride.

**PROCESSES:** The University of Idaho Clean Snowmobile Challenge team has made significant technological advances in the last nine years in engine technology, improving the fuel economy and reducing the pollution and noise emissions from the engines used in snowmobiles. Future plans include continuing to explore the use of alternative fuels in snowmobiles. The direct injection technology looks like it's here to stay in small, recreational engines. The next frontier in the competition is sound reduction. The National Park Service sound reduction requirements are stringent. Even four-stroke powered snowmobiles have difficulty meeting that requirement without a significant modification in performance typically requiring detuning. A snowmobile that needed no modification to be allowed to run anywhere would be a boon to the snowmobile industry, especially to outfitters whose clients may or may not be planning on accessing sensitive National Parks.

**Principal Investigator:** Dr. Brian He

**Project:** Application of Metal Catalysts for High Selectivity of Glycerol Conversion to Alcohols (KLK758)

**Co-Investigator:** N/A

**Student Involvement:** Randy Maglinao (graduate student, agricultural engineering); Sushant Kshetri and Sonam Sherpa (undergraduate students, material science & engineering)

**University Transportation Center Funding:** \$50,056

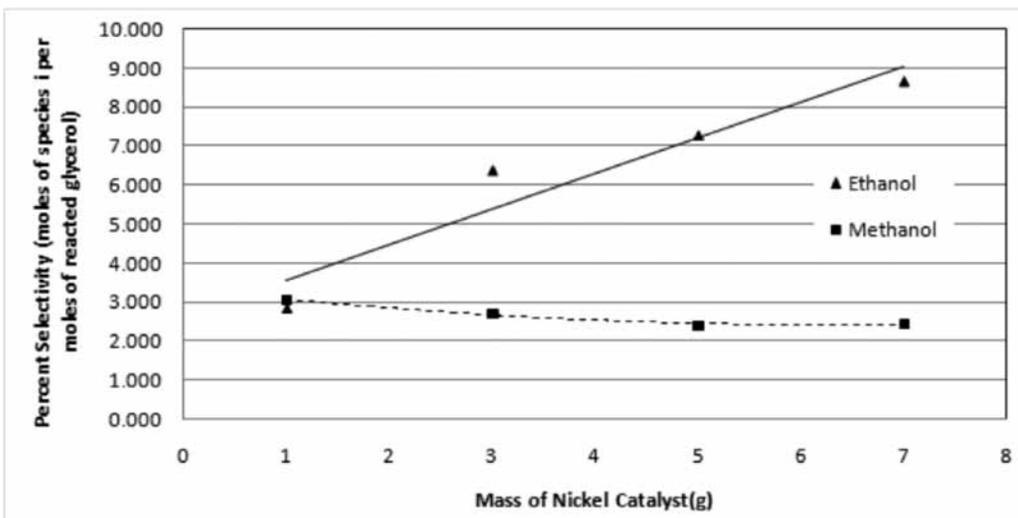
### STRATEGY INVOLVED:

**Strategy 2.3:** Develop new automotive and energy storage sub-systems and components for cleaner, safer, and lighter vehicles.

Converting the surplus, low quality glycerol (a byproduct from biodiesel production) to value-added products remains a hot topic in both the industry and research community. Results from our previous research of “Thermal Processing of Low-grade Glycerol to Alcohols for Biodiesel Production” showed that methanol, ethanol and propanol can be produced from crude glycerol through a hydro-thermal conversion process. Improving the efficiency of the glycerol process becomes a logical next step. Metal-based catalysts have been proven effective in increasing the selectivity and productivity of targeted products in similar processes. This project aims to determine the applicability of metal-based catalysts and optimize the corresponding process conditions for producing primary alcohols from the glycerol from biodiesel production with high selectivity.



*Undergraduate student Sushant Kshetri prepares the samples collected from catalytic thermochemical conversion of glycerol to alcohols for gas chromatograph analysis.*



*Yields of ethanol and methanol at different Raney nickel catalyst applications.*

Commercially available catalysts, specifically Raney nickel, copper, reforming HiFuel R120 catalyst, iron-chrome HiFuel W210 and Pt/C, were acquired and evaluated based on their capabilities in cleaving carbon-to-carbon or carbon-to-oxygen bonds in hydrocarbons. In theory, breaking these types of bonds in glycerol can lead to production of methanol and ethanol. Due to the variation on the designed applications of these catalysts, a wide range of operating conditions have to be investigated in order to broadly examine the catalyst's capability to produce alcohols from crude glycerol. Preliminary results have confirmed that the application of metal catalysts to thermochemical processing of glycerol improves its alcohol selectivity and process energy efficiency, and that nickel catalysts exhibited the best activity towards the production of alcohols, specifically ethanol.

Table 1: Glycerol Conversion to Alcohol at Different Reaction Time

<b>RT (min)</b>	<b>1-P (%mol)</b>	<b>2-P (%mol)</b>	<b>EtOH (%mol)</b>	<b>MeOH (%mol)</b>
<b>15</b>	0.241 ± 0.018	Not detected	4.074 ± 0.254	0.761 ± 0.086
<b>45</b>	0.388 ± 0.028	0.547 ± 0.425	5.679 ± 0.489	0.886 ± 0.154
<b>75</b>	0.484 ± 0.037	0.161 ± 0.051	5.98 ± 0.912	0.673 ± 0.072
<b>105</b>	0.589 ± 0.018	0.225 ± 0.019	6.91 ± 0.135	0.55 ± 0.023

Legends: RT – reaction time  
 1-P – n-propanol      2-P – isopropanol  
 EtOH – ethanol      MeOH – methanol

Based on the results of our preliminary studies, experiments were designed to systematically investigate the effects of major process parameters on alcohol production. Reaction time, reaction temperature, the ratio of solvent water to glycerol, mass application of catalyst, and reducing gas were identified as the influential process parameters. Three different sets of experiments were designed to investigate the effects of these parameters. The first set examined the effect of reaction time, initial amount of water and mass of catalysts applied in the absence of a reducing gas. Carbon monoxide gas was used in the second set of experiments to determine the effect of reducing gases in creating reducing reaction environment and reducing carbon loss to CO<sub>2</sub>. In the third set of experiments, a specially designed feeder was added to reduce the lag-time caused by the batch process for more accurate results on reaction temperature effect.

Our experimental results showed that ethanol production increases with the increases in reaction time and water to glycerol ratios. An effect of proportionally linear relationship was observed on catalyst effect on ethanol produc-



*Graduate student Randy Maglinao working on the reactor-feeder system for catalytic thermochemical conversion of glycerol to alcohols.*



*Undergraduate student Sonam Sherpa determines water content of a sample for catalytic thermochemical conversion of glycerol to alcohols.*

tion. However, catalyst effect leveled off soon after. This is possibly caused by the quantity of catalysts that is able to be suspended in the reaction solution. On the other hand, methanol formation was only significantly affected by the initial amount of water in the reactant. The experiments of both with and without the feeder suggest that reaction temperature influences the amount of alcohol production in the process significantly.

Currently, the research group is continuously conducting experiments on the effects of catalysts on alcohol production and to prepare and test customized catalysts. Upon the completion of these experiments, comprehensive experiments and process analyses will be conducted to optimize the production of alcohols from crude glycerol.

**Other Projects** Dr. He is Co-PI on: KLK759 on page 27 with Lead PI: Dr. Jon Van Gerpen.



*2011 Hybrid FSAE Vandal Racing Team (left to right) Chad Barnes, Tyler Flowers, Matt Montgomery, Justin Shook, Lewis Hamberlin, Jason Stirpe, Sam Wos, and Vincent Hell (undergraduate students, mechanical engineering).*

**Principal Investigator:** Dr. Edwin Odom

**Project:** Hybrid FSAE Vehicle Realization (KLK757)

**Co-Investigators:** Dr. Steve Beyerlein and Dr. Joe Law

**Student Involvement:** Brandon Butsick, Stefan Hovik, Cameron Stefanic (graduate students, mechanical engineering); Leo Luckose, (graduate student, electrical engineering); Alexander Odom (graduate student, computer science); Abraham Shryock (undergraduate student, mechanical engineering); Josh Ulrich and Brett Bashford (undergraduate students, electrical engineering)

**University Transportation Center Funding:** \$69,992.72

#### **STRATEGIES INVOLVED:**

**Strategy 2.1:** Advance state-of-the-art in transit, recreational, and hybrid vehicle design.

**Strategy 3.4:** Develop new ways for sustaining technical and organizational knowledge using research groups and student teams.

#### **ROAD LOAD MODELING**

A road load model for the University of Idaho Hybrid FSAE vehicle has been developed and continues to be refined. The model itself focuses on the endurance portion of the competition which has been identified as the key component for overall success. The transmission gearing, motor gearing and final drive ratios have all been selected and finalized using the road load model based upon several possible combinations available for the design. We have identified several key results that can be obtained using the road load model:

- Fuel usage for event
- Energy usage for event
- Average speeds and lap times

The data we can find using the model allows us to compare various configurations for control system and hybrid assist to make the decisions about fuel and energy storage. We will need to balance our combination of storage potential to remain within the allotment set forth in the rules for the 2011 competition and comparison of the potential options using the model will help us choose the optimum configuration.

To get the most accurate results from the model, we will need to update several key portions of the model. Currently several values for the vehicle properties are assumed and need to be measured and calculated to increase the accuracy of the model data. These properties include:

- Rotational inertia of the vehicle including tires, differential, transmission, etc
- Drag coefficient
- Rolling resistance of tires

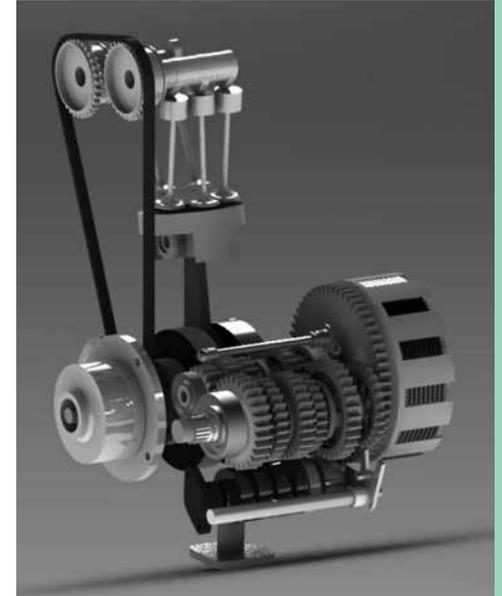
Once these values can be measured and calculated, we can correct the assumed values in the model. This will increase the accuracy of the model predictions as well as provide guidance on areas of improvement that can be made to the vehicle design. Starting early in the fall session, testing will begin using the previous FSAE vehicle to collect the needed data.

## POWERTRAIN

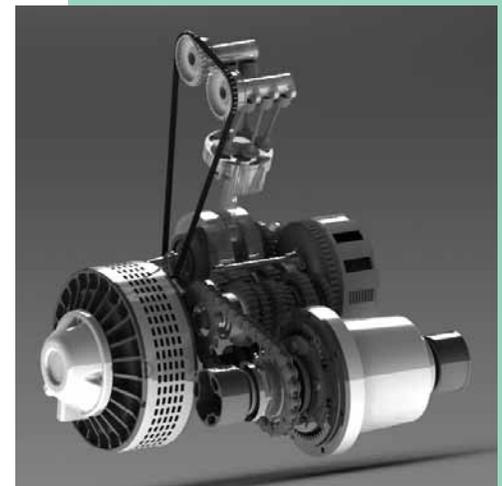
Modification of Yamaha's YZ250F motorcycle engine is underway as the basis for a parallel hybrid drive train for the University of Idaho's entry in the 2011 Hybrid FSAE competition. An electric motor is geared onto the countershaft for the purpose of providing maximum torque at low speeds where the internal combustion engine is less powerful. A custom planetary gear set provides the desired gear reduction. The alignment of the piston is tilted back several degrees to make the drive train more compact. A new crankcase needs to be designed in order to accommodate the changes, and so the use of this solid model is primarily for practical reasons. Using an accurate center finder and a manual lathe, the precise locations of each of the bearings and shafts was found in order to make the model accurate to within less than a thousandth of an inch. The stock engine packaging is shown (top) alongside a proposed electric motor/IC engine packaging that fits behind the roll hoop of the UI vehicle (bottom). RLEM electric motor and Kelly controller selected for the vehicle are currently undergoing performance testing in the Electric Machines Lab (see top of next page).

## SUSPENSION MODELING

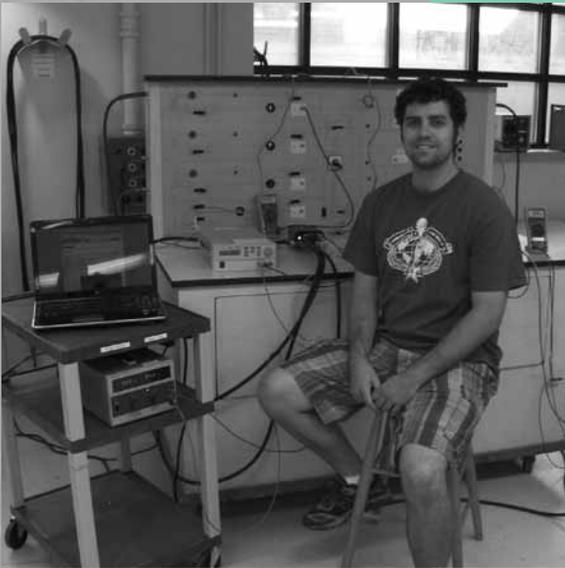
To advance the use of innovative software solutions, we are developing a program to work in conjunction with the Mitchell Software WinGEO suspension analysis program. This new program will make use of previously written ESOP (Evolutionary Structural Optimization Program), but will incorporate a loop for using the WinGEO suspension program to define a configuration's fitness. This will allow certain suspension parameters to be optimized, increasing overall vehicle performance. The development of the program interface is ongoing, but will allow a user to input basic vehicle characteristics, (approximate node locations, CG, overall weight) then will input this data into the WinGEO program for analysis. The simulation will include characteristic cornering, acceleration, and braking maneuvers. The WinGEO program will then output a table of values for various characteristics such as camber, lateral roll center movement, and load transfer. These values will be scored against an established rubric, indicating the current configuration's fitness. This data will then be exported to the ESOP algorithm, which will use a genetic algorithm to continually improve performance through node location variance.



*Stock engine packaging.*



*Electric motor/IC engine packaging.*



*Brett Bashford, electrical and computer engineering student, with DC controller in Electric machines lab. The 120V, 5A DC supply provides power to the controller for operation. The laptop is used for controller configuration through serial connection.*



*Example of CATIA produced worm and spur gear combination.*

### UTILITY FOR GEAR MODELING IN CATIA

Crafting fully-involute gears in the 3D modeling environment is a very difficult task. There are many parameters involved that do not translate seamlessly into the digital world, and because of this there are several third-party vendors that take the real-world information available and manipulate 3D modeling software into creating these complex parts. However, the University of Idaho's Mechanical Engineering Department utilizes Dassault Systeme's CATIA software, and there is currently no software available that can take standardized gear parameters as inputs and have CATIA make an accurate model. This research is setting out to make such a program. CATIA works in the VBScript computing language which means Microsoft Visual Basic is the most appropriate computing language for this particular application. A CATIA-produced macro that contains all of the information necessary to develop the part has been created and is currently being manipulated to fit into the Visual Basic scripting language. At the same time, a graphical user interface is being made to allow end-users to input their available parameters and the software will ascertain whether or not sufficient information exists to make the part. If so, the program will then talk with CATIA and execute the script, therefore creating the true-to-life part that can then be used in modeling, simulation, and manufacturing projects.

### HYBRID FSAE TEAM (SUMMER/FALL 2010)

A Hybrid Suspension/Frame Sub-Team has developed a preliminary design to meet the following targets; comply with the current FSAE-Hybrid rules, low weight to strength ratios, provide maximum mechanical grip, adjustable to different track surfaces and conditions and transmit accurate driver feedback while minimizing driver fatigue.

Anticipating the future induction of frame templates into the FSAE-Hybrid rules, the frame was designed to meet the standards of the 2010 FSAE rules. Triangulation of frame members and shear panels were introduced in the design to increase the torsional rigidity. Careful considerations were made in regard to the load paths and the packaging of suspension, steering, powertrain, and driver.

A fully independent non-parallel unequal length double wishbone suspension was developed to confine the upsets to the wheel and tire experiencing the upset, reduce the positive camber of the laden wheel in roll, and produce a low roll center to limit jacking and decrease weight transfer to the laden wheels. Uprights were designed to comply with the suspension design and offer a package that has high torsional stiffness at a low weight. The goal for the uprights is to meet or exceed the quality of that on the 37 car while placing suspension members in double shear.

The target values and specifications chosen will be given to Stephan Hovik to aid in his master's research. From there he will be developing an optimization program for future suspension and frame designs. The program will allow the user to specify key targets in the desired suspension/frame design and output an optimized configuration and geometry. This output will give the coordinates of the suspension/frame nodes in a three dimensional space. This information can then be used to create a CAD model to design and build the frame and suspension systems.

A Hybrid Powertrain Sub-Team has been focusing their work on six main components of the car. These components include the electric starting system, shifting actuation, electric fuel injection (EFI), clutching, a custom drivetrain case, and an intake/exhaust system. The design and functionality of these systems are all dependent upon each other, and will all work together in the final design.

The functional breakdown of the systems are as follows. The electric starting system of the car consists of a small electric motor that is connected to the car's crankshaft through a ring-gear and gear reduction mechanism. The shifting actuation system will consist of two buttons to control up shifting and downshifting, two electrical boxes to cut the engine, and one shift cylinder to actuate the shift lever. The Rekluse clutch allows full manual override at any RPM, as well as reduced stalling. The EFI kit consists of all parts necessary to convert a carbureted engine to a fuel injected engine, as well as software to tune the system. All of these systems will be attached to an aluminum custom designed casing that will encompass the entire engine.

Within these six systems, many milestones have been accomplished already. These milestones were not easy to reach, and many alternate designs had to be considered in order to reach a final design. When designing the electric starting system, designs to modify the stator and house the one-way clutch were explored and it was finally decided



*Tyler Flowers in dowel mock-up of frame and paper mock-up of repackaged engine in 1:1 side view.*



*Matt Montgomery making a presentation for the Powertrain Team.*

that the wrong crankshaft was being used. Numerous pneumatic and electric shift actuation systems were considered before deciding upon a cost-effective electric system. An EFI system, clutch, and intake/exhaust system were all deliberated upon and designs for each were selected.

Results to date serve as proof that the design of the 2010 FSAE Hybrid car is on track for completion before December 2010 followed by fabrication and assembly by March 1, 2011. Special efforts are underway to document design processes and decisions for future generations of students at the University of Idaho.

**Principal Investigator:** Dr. Judi Steciak

**Project:** Aqueous Ethanol Ignition and Engine Studies, Phase I (KLK761)

**Co-Investigators:** Dr. Steven Beyerlein and Dr. Ralph Budwig

**Student Involvement:** Dan Cordon, Josh Royce, Josh Gibson, Katie Leichter, David Mehaffey, Brad McGary, Victor Christensen; Jason Cyr (graduate students, mechanical engineering); Chad Barnes, Tyler Merritt, Paul Sowinski (undergraduate students, mechanical engineering); and Kevin Oswald and Zane Beckman (Boise high school students)

**University Transportation Center Funding:** \$144,135

#### STRATEGY INVOLVED:

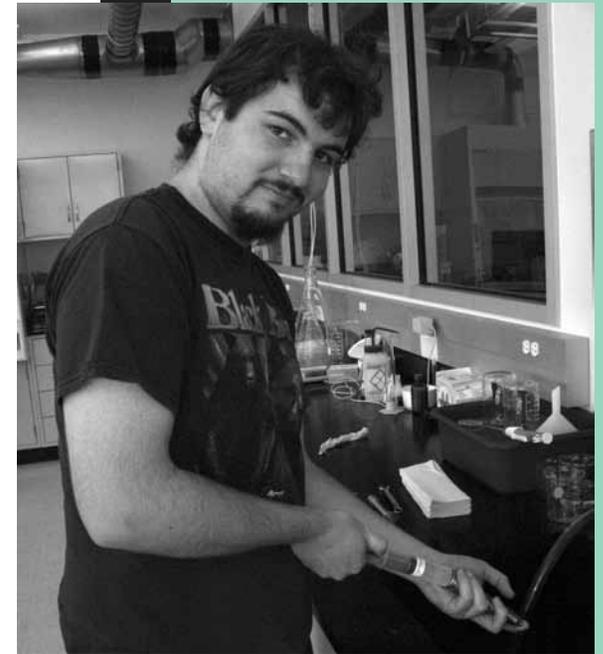
**Strategy 2.2:** Significantly expand vehicle research infrastructure and capabilities.

**Strategy 2.4:** Develop new automotive and energy storage sub-systems and components for cleaner, safer, and lighter vehicles.

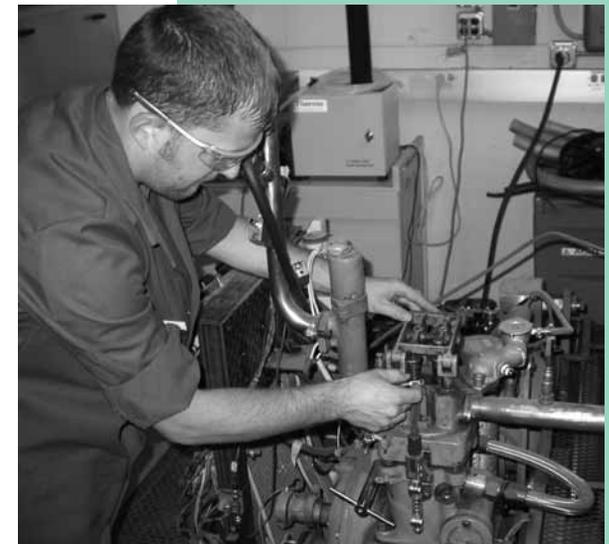
#### PROJECT OVERVIEW:

During the past year, we used our new heavy fuel evaporator and second plug-flow reactor to expand the range of catalysts, alternative biofuels, and ethanol-oxygen mixtures that we could test. In our engine laboratory, we acquired data with our Cooperative Fuel Research (CFR) engine to understand the differences between blended and separate injection of aqueous fuels, began designing/fabricating different igniter configurations for timing studies, and installed a dilution tunnel/TEOM purchased from another grant. We continued to make our laboratories available to other researchers and instructors in the Center for Clean Vehicle Technology.

Outcomes of this work include: 1) key information (light-off temperature and heat generation rate) needed for engineering timing models used to optimize igniter design; 2) design specifications and performance predictions for engine designs that are optimized for igniter systems; and 3) infrastructure improvements that enhance our competitiveness in state and federal funding programs.



*David Mehaffey (MSME candidate) refilling the syringe pump reservoir with ethanol in the Combustion Laboratory.*



*Jason Cyr (MSME candidate) installing catalytic igniter on the CFR engine platform.*



Micro-dilution tunnel designed by Vic Christensen.

### TASK DESCRIPTIONS AND PROGRESS:

I.	Task Description	Year 1
I.1	<b>CFR Engine Work:</b> Conduct experiments in the variable-compression ratio (CR) CRF engine to determine the effect of CR on the catalytic ignition of ethanol-water fuel blends. Investigate combustion of pre-mixed aqueous fuels and separate injection of fuel and water.	Tested blended and separate injection of aqueous fuels
I.2	<b>CPT Igniters:</b> Develop local igniter manufacturing process needed to support ignition timing studies.	Refined current igniter design
I.3	<b>Exhaust Gas Analysis:</b> Integrate dilution tunnel and TEOM particulate analyzer.	Installed and calibrated
I.4	<b>Infrastructure:</b> Seek funding to obtain research-quality exhaust gas analyzers for CO, CO <sub>2</sub> , NOx, O <sub>2</sub> , and THC.	Submitted equipment proposals
<b>II.</b>		
II.1	<b>Catalytic Wire Work:</b> Install a high capacity liquid fuel evaporator. Conduct an experimental study of the ignition temperatures of reacting flows exposed to a heated Pt wire over a wide range of fuel-oxygen equivalence ratios and fuel-water blends. Measure the heat release rate due to catalytic surface reactions.	Tested ethanol-water-oxygen mixtures on pure Pt
II.2	<b>Modeling:</b> Conduct CFD and FEA modeling to predict catalyst temperatures, heat generation, and ignition. Use experimental data to verify models.	CFD/FEA modeling refinement
II.3	<b>Infrastructure:</b> Acquire a Thermal Gravimetric Analyzer (TGA) and integrate with CGMS for fuel analysis.	Installed TGA and tested 10 different biodiesels
<b>III.</b>		
III.1	<b>Presentations:</b> Present research at regional, national and international combustion institute conferences.	3 conferences attended
III.2	<b>Papers:</b> Submit papers on fundamental work to Combustion & Flame as well as work on engine testing to ASME and SAE conferences with referred publications.	2 papers accepted by ASME
III.3	<b>Theses:</b> Prepare and defend MSME theses.	1 PhD dissertation and 3 MSME theses completed
III.4	<b>Reports:</b> Prepare annual NIATT reports.	Prior NIATT project report submitted
III.5	<b>Proposals:</b> Respond to RFPs from state and federal agencies.	Invited to submit Murdock Trust proposal

We supported three graduate students full-time for 12 months; two graduate students part-time for 12 months; one undergraduate students for the summer (who received a NIATT internship); and two Treasure Valley Math and Science Center high school senior interns for the academic year.

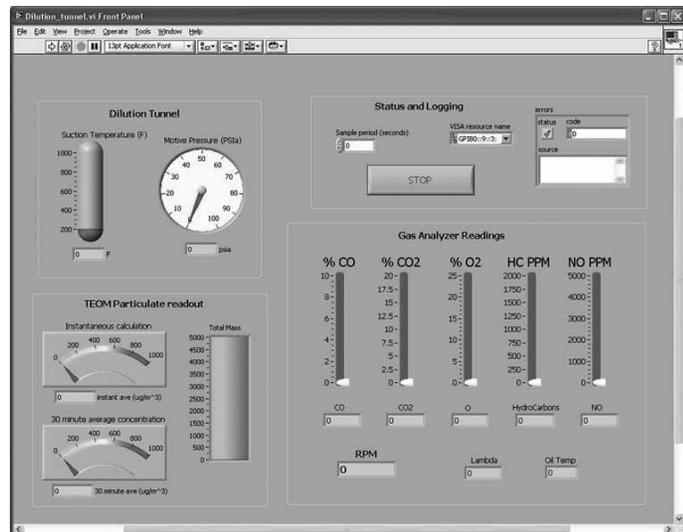
Indirectly, our project impacted all student competition vehicle teams at the University of Idaho who use Small Engine Laboratory equipment to tune their engines and measure exhaust emissions.

We participated in technical meetings of the Combustion Institute (CI), an international organization of researchers, educators, and engineers devoted to enhancing the understanding of combustion phenomena.

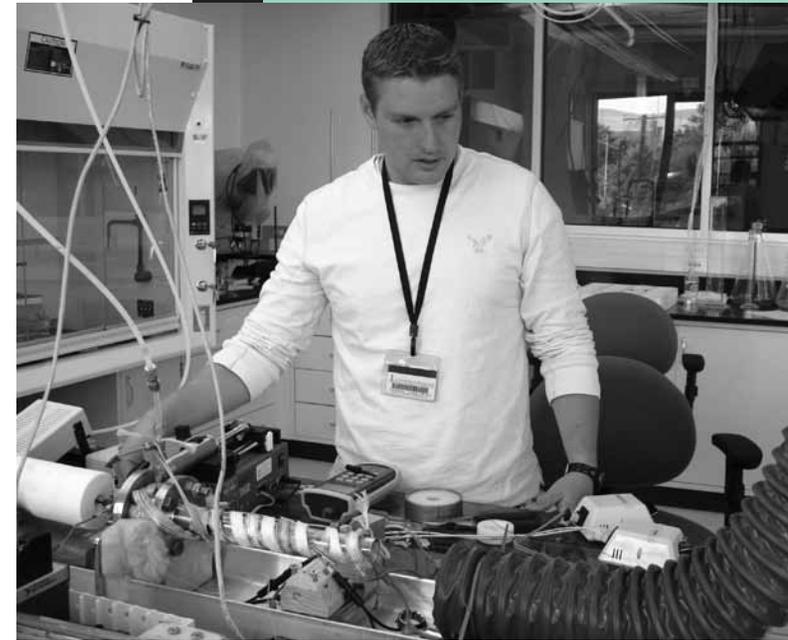
We participated in peer-reviewed conferences of the American Society of Mechanical Engineers (ASME). ASME meetings are attended by major manufactures of engines, government agencies, researchers and engineers focused on exchanging information about cutting-edge transportation vehicle technology.

The interface (below) is divided into four main sections: Dilution Tunnel, TEOM readings, Gas Analyzer readings, and Status and Logging. The Dilution Tunnel box, in the upper left of the interface, provides readings on the two major adjustment points of the dilution ratio, motive pressure, and exhaust temperature. The TEOM Particulate readout, in the lower left of the interface, displays particulate concentration both immediate, and as a 30 minute average. In addition

to these readings, the total mass of particulate on the filter is displayed, as a method to determine when the filter needs to be changed. In the lower right portion of the interface is the display of emissions obtained from the Horiba 5-gas analyzer. This area of the interface displays pollutants such as CO, CO<sub>2</sub>, NO, O<sub>2</sub>, and HCs as well as the calculated parameter Lambda. Additionally, if the Horiba is connected to the inductive RPM sensor, or oil temp sensor, the interface will display this data as well.



*Labview interface for data acquisition using dilution tunnel.*



*Brad McGary (MSME candidate) catalytically igniting biodiesel in the Combustion Laboratory.*



*High school intern Kevin Oswald checking catalytic ignition temperature data in the Combustion Laboratory.*



*Keegan Duff solvent extracts macerated Camelina Sativa seeds with dimethoxyethane ether using a soxhlet apparatus. Extracts are subsequently run through a preparatory column to isolate the glycolipids for qualitative and quantization.*

**Principal Investigator:** Dr. Jon Van Gerpen

**Project:** Measurement and Control Strategies for Sterol Glucosides to Improve Biodiesel Quality – Year 2 (KLK759)

**Co-Investigator:** Dr. Brian He

**Student Involvement:** Keegan Duff (graduate student, biological & agricultural engineering)

**University Transportation Center Funding:** \$70,111

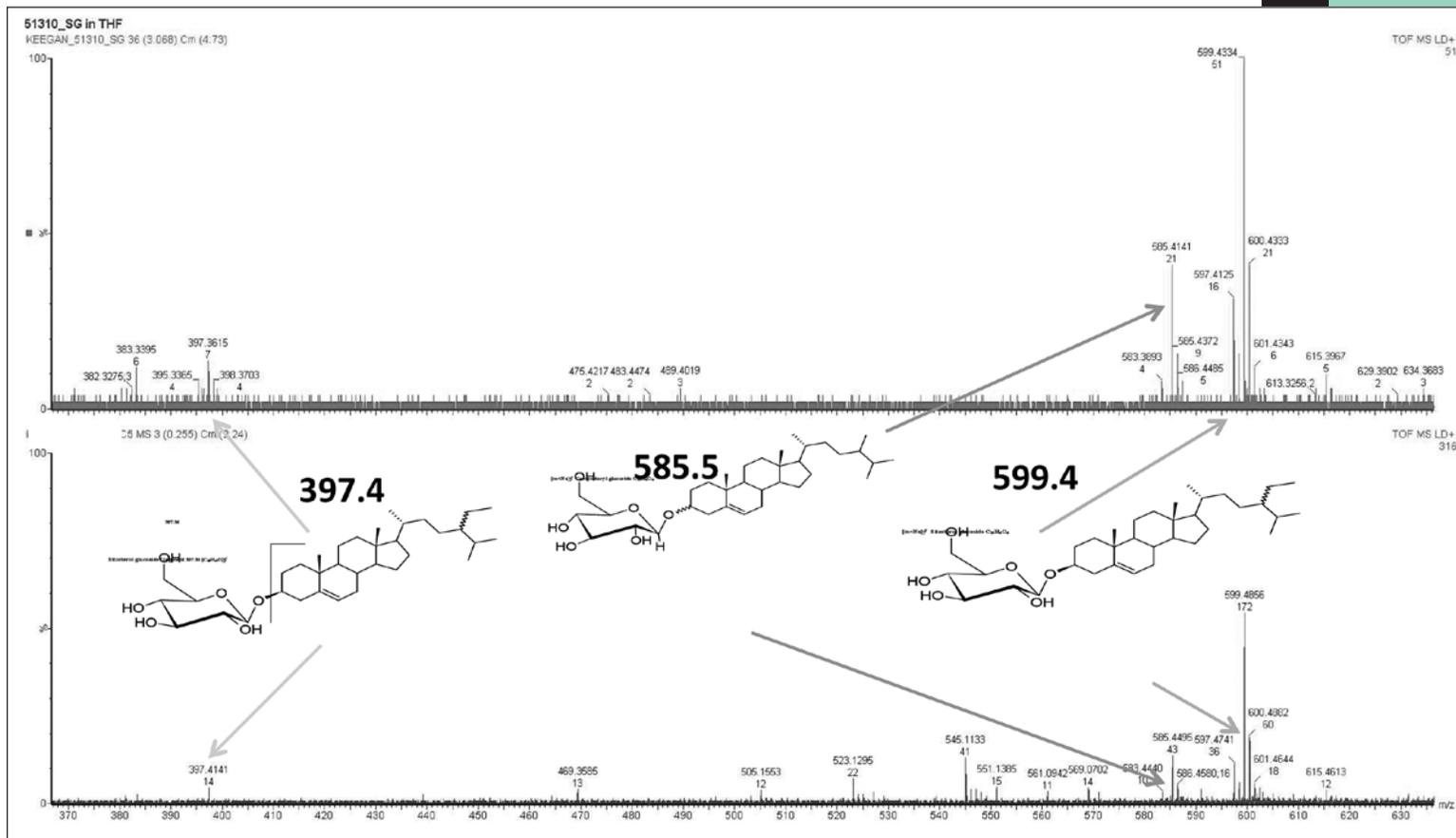
#### STRATEGY INVOLVED:

**Strategy 2.3:** Develop new biofuels production methods and techniques for reducing biofuels emissions.

Biodiesel is an alternative fuel for diesel engines that has achieved success in displacing significant amounts of petroleum fuels in some parts of the United States. Unfortunately, Minnesota and several other states have experienced significant problems with biodiesel at low temperatures. Contaminates have blocked fuel filters in otherwise high quality fuel. Currently, the only certain method to prevent cold flow problems is to winterize the fuel. In this process, the fuel is cooled and sufficient time is allowed for crystallization events to occur. Then, the fuel is filtered to remove any non-liquid materials in the fuel. This is expensive, time consuming, requires specialized infrastructure, and high energy input for fuel production.

The biodiesel industry has reached a consensus that compounds called sterol glucosides (SG), which are known to be present in neat biodiesel, are likely the primary source of the fuel filter plugging problems. These compounds apparently act as seed crystals or agglomeration centers where contaminants can accumulate. Dr. Robert Moreau's team at the USDA has identified sitosterol-glucoside and campesterol-glucoside in residues found in biodiesel storage tanks and filter residues.<sup>1</sup>

Most occurrences of filter failure are not able to be traced back to the fuel source. It is particularly difficult to trace the source back to the specific oil processor and oilseed crop. The prevailing theory is that acylated sterol glucosides (ASG), which are present naturally in plants and oils, are esterified during biodiesel production forming SG. The hexane solvent extraction system used to remove the useful oil from the oilseed crop is optimized to obtain the maximum levels of triglycerides out of oil feed stocks. It is not designed to minimize the removal of contaminants such as ASG. The hexane extraction efficiency of SG or ASG may change due to process or agronomic conditions, and this might be a way to control the level of SG in the biodiesel.



*Sterol glucosides: sitosteryl-glucoside and campesterol-glucoside, MALDI-TOF spectra showing sodium adducts and characteristic fragments of standard SG top and purified residue from a biodiesel plant.*

The level of ASG and SG present in oilseeds is not readily available and in most cases is not known. What data are available is obtained by extraction, multistep derivation and GC-MS evaluation. These are long and involved procedures that have not been adequately shown to characterize the full range of compounds that may be present. There are limited analytical techniques for the evaluation of SG and ASG.

Our research team is currently developing an analytical method for the measurement of SG and ASG. The goal of the project is to determine the levels of ASG and SG in agronomically significant oilseeds of the Pacific Northwest (PNW). With this information, the industry can design their extraction processes to minimize low temperature problems with biodiesel in the PNW. We are currently collaborating with researchers in Microbiology, Molecular Biology, & Biochemistry (MMBB), Plant, Soil, & Entomological Sciences (PSES), and Forest Products to develop this method.



*A modified Craig tube is used for recrystallization of residues with significant sterol glucoside content dissolved in tetrahydrofuran.*

Our research team was asked by a local company (Inland Empire Oilseeds – Odessa, WA) to evaluate a residue that was accumulating throughout their biodiesel plant. This problematic residue resulted in the shutdown of the plant for over two weeks and significant operational problems. The crude and purified residues have been evaluated using a variety of analytical techniques. The target natural products present in oilseeds have been identified in these residues. Sterol glucosides, specifically sitosteryl-glucoside and campesteryl-glucoside, have been positively identified using matrix assisted laser desorption ionization time of flight mass spectrometry (MALDI-TOF). This soft ionizing technique produces adducts and characteristic fragments as seen in the figure on page 28. These spectra match nicely with data in the reported literature where a technique called APCI-MS atmospheric pressure chemical ionization mass spectrometry has been used.<sup>1</sup> Compounds that are chemically related to ASG standards have also been identified in these samples. Additional work is underway to elucidate the structures.

This preliminary work was presented at the American Oil Chemist Society Annual meeting in Phoenix, Arizona in May 2010. More recent work has shown with differential scanning calorimetry that nonreversible phase transitions occur in this purified product. The temperature of these transitions is dependent on the heating rate. Complementary TGA Thermo gravimetric analyses under nitrogen and air indicate that the decomposition is not occurring due to oxidation. These compounds do not undergo melting or oxidation upon heating but undergo polymerization or some other decomposition reaction.

Our team has validated the use of MALDI-TOF for rapid evaluation of SG and ASG. We have evaluated several SPE extraction procedures and plan to evaluate several more preparatory methods using this analytical technique. Preparatory methods are necessary to isolate ASG and SG from the triglycerides and phospholipids in oilseed extracts. Several other preparatory techniques are beginning to be evaluated for creating standards and sample evaluation. After selection of the preparatory procedure using solvent extracts, future work will use HPLC-MS for the evaluation of ASG and SG in oilseed crops of the Pacific Northwest.

<sup>1</sup>Robert A. Moreau, Karen M. Scott, Michael J. Haas, "The Identification and Quantification of Steryl Glucosides," *Precipitates from Commercial Biodiesel*, 6 June 2008.

# EDUCATION

## OBJECTIVES 3 AND 4 OF NIATT'S STRATEGIC PLAN RELATE TO EDUCATION:

**Objective 3.** Increase the number of faculty and students in our research and education programs to enhance the transportation workforce.

**Objective 4.** Transfer the results of our research program to practicing professionals in forms that are usable to them to improve the quality and performance of our workforce.

### KYTE RECEIVES TWO AWARDS IN WASHINGTON, DC



Michael Kyte received the Distinguished Contribution to University Transportation Education & Research Award at the 2010 CUTC Awards Banquet in Washington, DC in January 2010. The award has been given annually since 1998 to honor individuals who have had a long history of outstanding contributions to university transportation education and research. Dr. Kyte is the 12<sup>th</sup> recipient of the award. He served as the director of NIATT for 15 years.

While in Washington, DC, Region X (UTCs from University of Washington, University of Alaska-Fairbanks, Portland State University, and University of Idaho) honored him by naming the Region X student-of-the-year award after him. Region X selects one student from the four UTC's student-of-the-year recipients to be named the "Michael Kyte Region X Outstanding Student of the Year." Yegor Malinovskiy from the University of Washington is the first recipient of the award.

## VIRTUAL TECHNOLOGY AND DESIGN BOOSTS TRAFFIC SIGNAL SYSTEMS EDUCATION

*Written by Joni Kirk, University of Idaho Communications and Marketing*

### **How many cars can make it through an intersection before the light turns yellow? Why did that green light only last 10 seconds? And why do people sometimes hit every red light on the way home?**

Traffic system engineers have asked many of the same questions. And educators have struggled to help engineering students visualize the complex systems for managing traffic flow and safety.

“The industry has been struggling with how to train students to have one eye on traffic and one eye on the traffic controller,” said Michael Kyte, professor of civil engineering at the University of Idaho. “Traffic engineers need to see – to visualize – complex processes to understand the myriad components and design a system more effectively.”

Kyte is principal investigator on MOST, a project to develop curriculum materials and a simulation environment for traffic signal timing, which is funded by the Federal Highway Administration and administered by the National Institute for Advanced Transportation Technology. MOST enables engineering students to directly observe how the signal timing parameters that they select affect the quality of traffic operations at a signalized intersection. While the simulation is helpful, it was missing a key component: more direct visualization of the processes that go on in the traffic controller itself.

“We can’t just take our students to an intersection and allow them to change traffic signals for practice,” said Kyte. “We needed something that allows us to get as close as we can to the real world environment without screwing things up.”

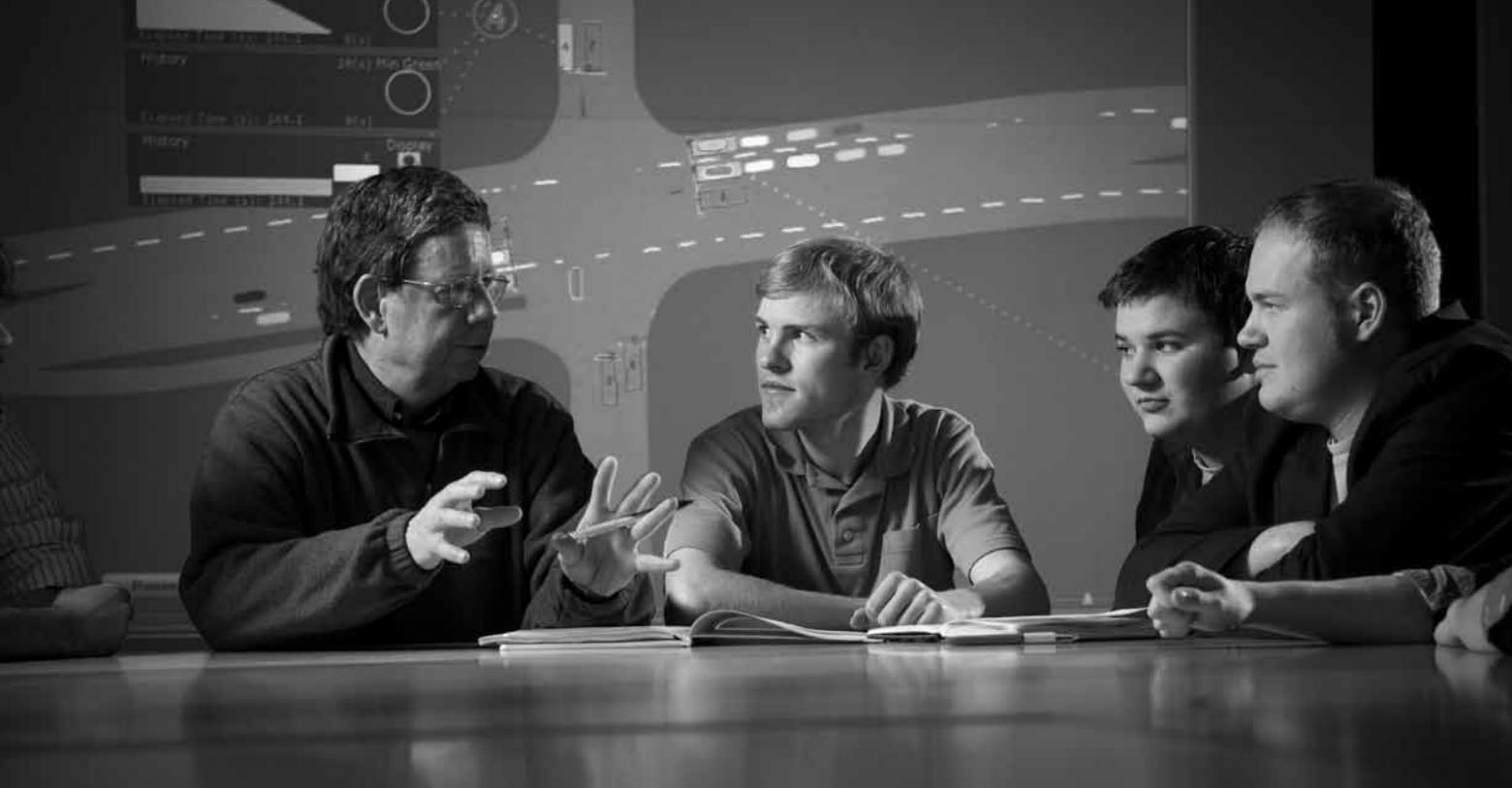
Kyte raised the issue with John Anderson, assistant professor of virtual technology and design (VTD) in the College of Art and Architecture. Anderson’s junior-level design class agreed to create an enhanced simulation environment that would work Kyte’s existing simulation program, but create scalable complexity.

“Virtual Technology and Design emphasizes the use of visual environments to help solve real world problems,” said Bryan Foutch, a junior in VTD from Spokane, Wash. “For our particular project, we wanted to create interactive technologies aimed at education. Traditional teaching mediums are static and good for basic information, but when you factor in complex, simultaneous systems, you need interactive tools.”

The VTD students worked with graduate-level civil engineering students, who have questions associated with the beginning learning process.

“It’s difficult to take years of experience and give that information to someone else. The current tools don’t allow that experience to be transferred,” said Foutch. “The engineering grad students understand the issues facing people new to the discipline. They’re the ones with trouble understanding the current simulation, so their feedback helps us make this tool more effective.”

Working together, the designers and engineers were able to address basic issues.



*Dr. Michael Kyte, civil engineering graduate student Christopher DeLorto, and virtual technology and design students Jake Lauer and Bryan Foutch discuss ideas for graphically displaying signal timing processes.*

Kyte is pleased with the progress this year. “The Virtual Technology and Design students developed a tool that takes some of the data from the initial simulation tool and adds in a cool and informative look at timing process. It allows engineers to make connections between looking at traffic and looking at the timing process,” he noted.

Another bonus is that the virtual tool is scalable. In the works is the ability to add in a railway, pedestrians, multiple intersections or other factors to make the system more complex. “Observing these factors at work at the same time helps our engineering students understand it better,” said Kyte.

Foutch noted that the tool doesn’t replace the expert educators, but complements their teaching. “It’s a flexible tool that allows the expert to expand on a concept and show significance. At the same time, it allows the expert to pick apart the layers, addressing one thing at a time,” he said.

In July, the VTD and engineering team will present the simulation to the Traffic Signal Systems Committee from the Transportation Research Board, a part of the National Academy of Engineering. “We’re excited to receive feedback from experts in the industry,” said Kyte. “This is a simulation we hope to provide to educators across the nation. Anything we can do to improve the learning experience is valuable.”

Kyte is seeking funding to continue the simulation development next year. “We want to be able to work on a traffic system in real time,” he said. “We’re just scratching the surface of what we can do.”

### NIATT TO HOST TRB TRAFFIC SIGNAL SYSTEMS COMMITTEE MEETING

The 2010 TRB Traffic Signal Systems Committee meeting will be held at the University of Idaho campus July 18-20, 2010. Michael Kyte has been diligently working on preparation for the meeting with an anticipated attendance of 50 students and professionals in the traffic industry.

### TRANSED: AN EDUCATIONAL COLLABORATION BETWEEN THE REGION X TRANSPORTATION CONSORTIUM AND THE FHWA

As the transportation workforce ages nationwide, the Federal Highway Administration (FHWA) is looking for innovative ways to train the next generation of transportation professionals. One such program is the Transportation Education Development Pilot Program. As part of the 2006 surface transportation reauthorization, FHWA funded four such pilot programs, including one to be led by the university transportation centers comprising the Region X Transportation Consortium. This project, known formally as the “Development, Deployment, and Assessment of a New Educational Paradigm for Transportation Professionals and University Students”, or TransEd for short, is a four year \$1.2 million effort that includes the University of Idaho, Portland State University, the University of Alaska, the University of Washington, and Washington State University.

The program is based on a new paradigm for educational content delivery—an active, problem-based learning environment conducted at a distance. Supported by educational research and the expertise of the faculty from the proposing institutions, this program seeks to enhance the quality of the learning environment for transportation students, thereby advancing the cause of transportation workforce recruitment, and to provide pedagogically sound, cost effective training to practicing professionals in order to hone essential skills and promote workforce retention.

The objectives of the project are to:

1. Develop a set of four modules (defined below) and the relevant learning materials based on the principles of active, problem-based learning.
2. Develop distance-separated, interactive learning environments based on sound educational practices in which the modules can be deployed and tested.
3. Create teams of students and practitioners to pilot test materials.
4. Design and implement a detailed evaluation and improvement cycle for each module.
5. Assess the learning process and student outcomes.
6. Disseminate what we’ve learned in this project to a national audience.

The project team is developing a set of four course modules, each addressing a critical topic in transportation engineering and planning in the Pacific Northwest. Each module will eventually be delivered over a ten-week period through a distance-separated learning/work environment to both university students and practicing professionals. Each module will be designed as active and problem-based. The course modules that are being developed include:

- Traffic Signal Timing Design (University of Idaho)
- Transportation Data and Analysis (Portland State University)

- Freight Operations and Planning (University of Washington)
- Highway Safety and Design (University of Alaska)

The five university project team began work in Fall 2008. Several team meetings have been held over the past two years in which project team members have learned about the process of learner centered curriculum design. University of Idaho mechanical engineering professor Steve Beyerlein, a nationally recognized expert in engineering pedagogy has led this effort, supported by UI PhD Civil Engineering student Howard Cooley. Beyerlein and Cooley helped to develop the course design process that is being following by all four module development teams.

The University of Idaho pilot tested its module on traffic signal timing design during the spring semester 2010 for six civil engineering senior students. The class was team taught by three UI transportation professors, Ahmed Abdel-Rahim, Michael Dixon, and Michael Kyte. PhD student Cooley recorded each of the class meetings and discussions during the semester and is now evaluating student performance from this pilot test. Project evaluator Shane Brown, from Washington State University, is working with Cooley to complete an evaluation of student performance.

Cooley and Brown presented their initial results at the summer meeting of the Transportation Research Board's Traffic Signal Systems Committee in July 2010. The summer meeting attendees also participated in an assessment of the course materials and provided important feedback to the project team on both course content and course delivery methods. The signal timing design course will be offered again in the spring semester 2011, this time testing some of the distance education components that are part of the overall project objectives.

Course modules developed by the other three universities will be offered during the next two years.

## NIATT RECEIVES ITE'S BEST INNOVATION IN EDUCATION AWARD

The Institute of Transportation Engineers (ITE) recognized NIATT at its 2009 Annual Meeting and Exhibit in San Antonio, Texas, in August 2009, by awarding the Transportation Education Council's *Best Innovation in Education* award. Two educational programs initiated at NIATT by Michael Kyte, the Traffic Signal Summer Workshop and the MOST project, were selected due to the "real life impact" the programs have on attendees. Kyte accepted the award on behalf of NIATT. The educational programs were recognized as an "excellent example of researchers at universities and members of the consultant community coming together to fulfill a need to educating the transportation workforce."

FHWA asked NIATT to develop a version of its Traffic Signal Summer Workshop for professionals that supports FHWA's signal timing roadmap, awarding a grant of \$705,274. That "Mobile (Hands-On Traffic) Signal Timing Training, or MOST, project is a new approach to learning about traffic signal timing. MOST uses a new simulation environment to let users directly observe how the signal timing parameters selected affect the quality of traffic operations at a signalized intersection. The completed MOST on-line course (located at <http://www.webs1.uidaho.edu/most/>) includes seven separate laboratories, with nearly forty individual experiments. Each experiment has one or more specific learning objectives that will guide the user's work during that experiment. Five of the laboratories cover isolated actuated intersection operations, while two cover coordinated signal systems.

# OUR STUDENTS

## NIATT STUDENT-OF-THE-YEAR: HOWARD COOLEY

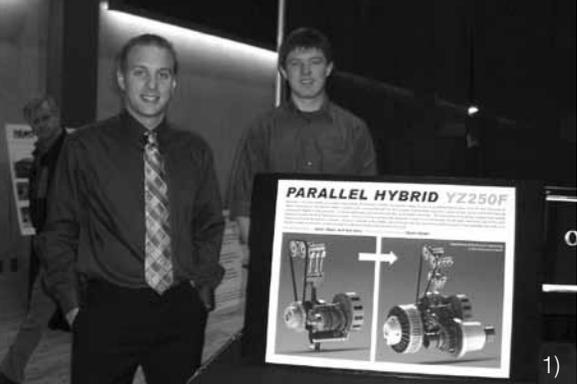
NIATT joins in congratulating the students-of-the-year representing each of their respective UTCs. NIATT's Howard Cooley received the 2009 Student-of-the-Year Award at the 2010 Council of University Transportation Centers Awards Banquet in January. Howard is a civil engineering graduate student at the University of Idaho and has worked with NIATT on a number of research projects. Howard holds three degrees in science and engineering, A.A.S.O. Yakima Valley Community College 2002, BS Washington State University 2004, MS University of Idaho 2007, and is currently working on a PhD.

He is currently involved in a research project for the Federal Highway Administration to develop transportation educational materials for a diverse audience of students, ranging from senior level undergraduates to returning professionals wanting to advance their career. These educational materials are being developed to be delivered in a distance environment.

Howard served three years in the United States Army and worked seven years in private construction as a heavy equipment operator. His construction experience has led him to have broad interests in civil engineering as his course work involved geotechnical, pavements, and traffic elements. Howard is interested in teaching. He has experience as a full time tutor and has taught statics and surveying for the University of Idaho.



*The Council of University Transportation Centers (CUTC) honored the UTC students-of-the-year at the TRB Annual Meeting in Washington, DC. Pictured left to right: Bob Plymale (CUTC President), NIATT's student-of-the-year, Howard Cooley and Peter Appel (RITA Administrator). Photo courtesy of ARTBA.*



1)



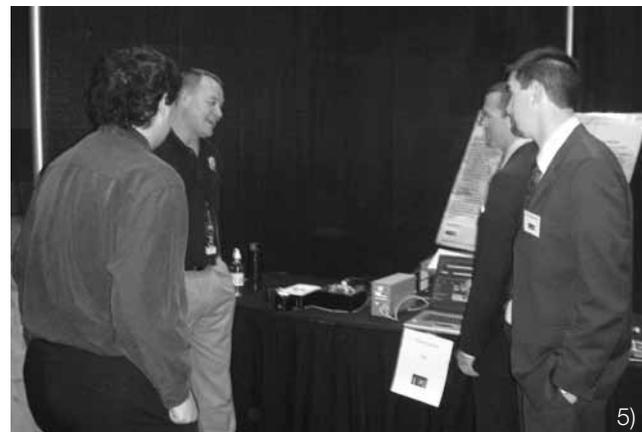
2)



3)



4)



5)

1). Jason Stirpe and Kyle Gray display their parallel hybrid poster at the Expo.

2). Hunter Bloch presented the miniture hybrid powertrain paper at the Expo.

3). Andrew Hooper (left) and Ty Lord (right) present the Clean Snowmobile technical paper at the Expo.

4). Sam Smith (left) and Eric Buddrius (right) explain the clean snowmobile to a guest at the expo.

5). Craig Craviotto and Zane Sapp (electrical engineering graduate students) and left-Cody Browne (electrical engineering undergraduate) interact with an Expo guest about the Smart Signals project.

## COLLEGE OF ENGINEERING EXPO MOMENTS – SENIOR DESIGN PRESENTATIONS

**About Senior Design Projects** - The University of Idaho has a year-long, senior design program between the departments of mechanical and Electrical engineering. Each year this involves over 20 industry-sponsored and research-sponsored projects that produce manufacturing fixtures, test equipment, consumer products, and one-of-a-kind machines. As capstone design coordinator, Dr. Steve Beyerlein has developed a network of companies and contacts that annually contribute more than \$100,000 toward the capstone program at the University of Idaho. The scope of student projects can be seen in the archive at <http://seniordesign.engr.uidaho.edu>. Design products are also shown to the public in the UI Engineering Design Expo each spring. This is the largest academic design show in the Pacific Northwest. Senior design teams are guided by a half-dozen graduate mentors doing research in related areas. Dr. Beyerlein works closely with Dr. Edwin Odom and Russ Porter in mentor training and coaching. The capstone design program has been an excellent tool for recruiting and training graduate students in transportation technology who are well versed in solid modeling, manufacturing processes, and experimental methods. A few of the related projects are featured above (also see page 13).

## WHERE ARE THEY NOW

### 2010

#### VICTOR CHRISTENSEN – BSME '04 MSME '10

**Master's Thesis:** "Design and Validation of a Low Cost, Partial Flow Dilution Tunnel with Tapered Element Oscillating Microbalance"

Currently working for Hummingbird Scientific in Lacy, WA

He is a Design Engineer and creates custom miniature fixtures for holding electron microscope samples.

#### DAN CORDON – BSME '00 MSME '02 PHD '10

**Master's Thesis:** "Multi-fuel Platform and Test Protocols for Over-the-road Evaluation of Catalytic Engine Technology"

**Doctoral Dissertation:** "Exploring the Operating Limits and Performance of Catalytic Ignition with Aqueous Ethanol and Heavy Fuels"

Currently working for the University of Idaho in Moscow, Idaho

Regular readers of NIATT's annual reports should be familiar with the name Dan Cordon. Dan Cordon is well-known and often sought after by many NIATT graduate students and project sponsors. He has been a strong contributor to many engine related theses and student projects over the last ten years. Join us in congratulating Dan on finishing his doctoral degree this past year. His dissertation was a compilation of the five peer-reviewed papers described below.

**Homogeneous Charge Catalytic Ignition of Ethanol-Water/Air Mixtures in a Reciprocating Engine.** This paper was presented at the 2008 ASME International Mechanical Engineering Congress and Exposition. This conference took place in Boston Massachusetts from October 31<sup>st</sup> – November 6<sup>th</sup>. This paper compares two Yanmar engines. One was left stock as a direct injection diesel. The other was converted to a homogeneous charge running on aqueous ethanol fuel (70% ethanol, 30% water by volume) and catalytic ignition. The converted engine was able to match the efficiency of the diesel, produced significantly higher power, and showed marked reductions in carbon monoxide and nitrogen oxides. Hydrocarbon emissions were increased. This work also demonstrated the wide range of air-fuel ratios catalytic ignition was capable of operating over. This work was originally performed with Eric Clarke and published with SAE in 2002. Since that time the data analysis has been updated by using a carbon-balance method to more correctly report emissions in a brake-specific basis (grams/kW-hr).

**Catalytically Assisted Combustion of JP-8 in a 1 kW Low-Compression Genset.** This paper was presented at the 2006 SAE Small Engine Technology Conference. This conference took place in San Antonio, Texas from November 13<sup>th</sup> – 16<sup>th</sup>. This paper covers the conversion of a small, air-cooled, carbureted, spark-ignition gasoline generator to heavy fuel (JP-8) and catalytic ignition. Performance, efficiency, and emissions are compared between a modified and unmodified engine. The engine was able to operate using homogeneous charge of a heavy fuel, but suffered from cold-start problems and reduced peak power. This work was originally done with Matt Walker and was first published at a Combustion Institute meeting in 2004. For the 2006 SAE publication a root sum square analysis was used to estimate error of the brake specific emissions.

**Conversion of a Homogeneous Charge Air-Cooled Engine for Operation on Heavy Fuels [8].** This paper was presented at the 2008 SAE Small Engine Technology Conference. This conference took place in Milwaukee, Wisconsin from September 9<sup>th</sup> – 11<sup>th</sup>. This paper shows a 2<sup>nd</sup> iteration of the JP-8 conversion using a slightly larger displacement engine. Cold starting was improved by using a catalytic fuel reformer during warm-up, and improvements in combustion efficiency were made by using three catalytic igniters equally spaced around the combustion chamber. Three hundred hours of endurance testing were performed on the converted engine. Engine wear was minimal, but long operation at light loads cause some JP-8 to mix in the oil. For light load use, oil change intervals were reduced to 50 hours from the original 100 hour recommendation.

**Measuring and Comparing Accuracy of Emissions Analyzers for use with IC Engines.** This paper was presented at the 2009 ASME International Mechanical Engineering Congress and Exposition. This conference took place in Lake Buena Vista, Florida from November 13<sup>th</sup> – 19<sup>th</sup>. This paper documents the accuracy and precision of several different exhaust emissions analyzers of varying cost brackets by using a variety of calibration gas bottles. The lowest cost NDIR analyzer did a good job of measuring CO and CO<sub>2</sub>, but was not reliable for measurements of NO<sub>x</sub>, O<sub>2</sub>, or hydrocarbons. The more expensive 7-gas analyzer did not measure CO and CO<sub>2</sub> as well as the NDIR analyzer, but did a better job of measuring NO<sub>x</sub>, O<sub>2</sub>, and hydrocarbons. Included in an appendix to this chapter are results for a higher-cost NDIR analyzer and modifications to a FTIR spectrometer that were not part of the originally published paper.

**Distinguishing Among Processes of Problem Solving, Design, and Research to Improve Project Performance.** This paper was presented at the 2007 ASEE Annual Conference. This conference took place in Honolulu, HI from June 24<sup>th</sup> – 27<sup>th</sup>. This paper discusses the difference between processes commonly used by engineers, and why it is important for students to consciously differentiate between them and be aware of what type of task they are performing. Two tools were created that help users understand the differences between these processes. Data taken on student responses to classifying various scenarios, and their feedback was used to improve the clarity of the tools.



**CRAIG CRAVIOTTO – BSEE '08 MSEE '10****Master's Thesis:** "Pedestrian Station Design using Distributed Real-Time Processing"

Currently working for the US Department of the Navy, Pearl Harbor, HI

**ZANE SAPP – BSEE '08 MSEE '10****Master's Thesis:** "Real Time Network Control for Advanced Accessible Pedestrian Systems Using Ethernet Over Power Line"

Currently working for Campbell Company, Boise, ID

**RANDALL STORMS – BSME '07 MSME '10****Master's Thesis:** "Fuel Injection and Intake/Exhaust Sizing of a YZ250F Engine for a Formula Hybrid Vehicle"

Currently working for Lanx Incorporated, Broomfield, CO

**2009****EDWIN ANDERSON – BSME '07 MSME '09****Master's Thesis:** "Co-Operative Fuels Research Engine Modified for Homogeneous Charge Catalytic Ignition of Aqueous Fuels"

Currently working for Lanx Incorporated, Broomfield, CO

He is a Manufacturing Engineer and integrates state-of-the-art CNC equipment and CNC software in the production of next generation surgical implants.

**GABRIEL DERUWE – BSCOMPE '07 MSCOMPE '09****Master's Thesis:** "Pedestrian Assistance Using Distributed Smart Signals Traffic Controls"

Currently working for Schweitzer Engineering Laboratories, Pullman WA

**DUSTIN DEVOE – BSEE '06 MSCOMPE '09****Master's Thesis:** "Application of Intelligent Transportation System Protocols for Controlling a Distributed Network of Advanced Traffic Devices"

Currently working for Econolite Controls Inc, Anaheim, CA



*Craig Craviotto (left) and Zane Sapp at the 2010 Engineering Expo showcasing their Smart Signals poster.*

2007

ANDY FINDLAY – BSME '04 MSME '07

**Master's Thesis:** "Brake Specific Fuel Consumption and Power Advantages for a Turbocharged Two-Stroke Direct Injected Engine"

Currently working for BRP US, Inc., Waukegan, IL

He is a Research Engineer working on two-stroke direct-injected outboard and snowmobile engines.



*Former graduate student and Clean Snowmobile Team captain, Andy Findlay, received his master's degree in mechanical engineering in 2007.*

# FUTURE STUDENTS



*Joel Frazier decided when he was eight years old to become a mechanical engineer when he saw the UI Clean Snowmobile Team.*

## JOEL FRAZIER

**Transportation:** The Next Generation

Education is one of NIATT's four objectives, and we are known for forming teams of faculty with undergraduate and graduate students. This summer we took it one more step by offering an internship to a rising high school junior.

Joel Frazier is sixteen years old, and the son of two former snowmobile racers. When he was just eight years old, both his parents were racing at the Jackson Hole Hillclimb snowmobile race when the Clean Snowmobile Challenge also participated. The University of Idaho that year won the Challenge, and won the Hillclimb, earning the coveted large silver belt buckle for the achievement.

His mother talked with the team and advisor Dr. Karen Den Braven, showing her son the snowmobile and what he could do if he went to the University of Idaho. According to his mother:

*"Joel has actually wanted to be a mechanical engineer and attend the U of I since he saw the Clean Snowmobiles and learned about it when he was little! His interest has not wavered as he's grown, either."*

*It's remarkable how one event can shape someone's life; your team's work inspired a little boy and helped to shape his future."*

Joel jumped at the chance to work with the team on their efforts tuning our direct-injected two-stroke engine. He is returning to finish high school with a better sense of what may be possible for him when he graduates.

Way to go Joel!

*Clean Snowmobile Team members Neil Miller (left) and Eric Buddrius (center) set up the team snowmobile for testing, assisted by high school junior Joel Frazier.*



## JEMS SUMMER PROGRAM

*Written by Mary Lee Ryba, Development Director,  
UI College of Engineering*

The 2009 Idaho Junior Engineering, Math and Science (JEMS) summer program was another great success thanks to JEMS Director and Chairman, Department of Civil Engineering, Richard Nielsen, faculty and staff members and a grant from the Idaho Transportation Department. The focus this year was alternative energy vehicles. The students attended three classes every day learning how to design and race their own vehicles. The students began with an introduction to engineering taught by Professor Bob Rinker. In this class the students received an overview of information that they would need to successfully build their vehicles, including in-depth instruction on circuits. They also attended a SolidWorks computer modeling class taught by master's graduate student Jennifer Hasenoehrl. The students were also fortunate to take an Alternative Energies course taught by Dr. Aaron Thomas, Director, NASA Idaho Space Grant Consortium and NASA Idaho EPSCoR Program, and recipient of National Science Foundation's Presidential Early Career Award. In this class they investigated the alternative energy forms available to them for their cars. The students were then split up into groups of four and each group was assigned a type of alternative energy. They created their vehicles using solar power, steam engines or fuel cells.

The JEMS students were invited to have lunch and tour Schweitzer Engineering Laboratories in Pullman, join a creek restoration with Palouse Student Sub-unit of the American Fisheries Society and take a tour of Lower Granite Dam. The students visited state-of-the-art labs here at the College, mingled with professors and experienced firsthand just how much our university has to offer them.

After two weeks of hard work, the students were able to race their cars in a competition that was judged on several criteria. Each form of alternative energy raced for the top speed in that category. They also were required to give their cars the correct amount of fuel to bring them as close to the goal of 46.5' as possible. The distance winner was only 2.25" away! To conclude the week the students had a poster fair and vehicle demonstration to show off all their hard work to their parents. This was followed by their presentations and a graduation ceremony.



*2009 JEMS Students*

# CONGRATULATIONS TO THE 2010 CLEAN SNOWMOBILE TEAM

## OUTCOME OF THE 2010 CLEAN SNOWMOBILE CHALLENGE

The NIATT Clean Snowmobile team captured the overall 3rd place as well as the following awards:

- Cold Start
- Best Acceleration
- Best Handling
- Best Ride

*Left to right: Cole Bode,  
Dylan Dixon, Neil Miller, Ian  
Lootens, Drew Hooper, Ty  
Lord, Austin Welch, Sam  
Smith, Peter Britanyak, and  
Alex Fuhrman.*



## 2010 CLEAN SNOWMOBILE TEAM MEMBERS

Peter Britanyak  
Graduate mentor; mechanical engineering;  
Bonney Lake, Washington

Parley Wilson  
Graduate mentor; mechanical engineering;  
Alta, Wyoming

Dylan Dixon  
Co-Captain; senior; mechanical engineering;  
Bow, Washington

Alex Fuhrman  
Co-Captain; junior; mechanical engineering;  
Green Acres, Washington

Ryle Amberg  
Sophomore; mechanical engineering;  
Anchorage, Alaska

Josh Bartlow  
Freshman; mechanical engineering;  
Nampa, Idaho

Ben Birch  
Senior; sports science;  
Anchorage, Alaska

Cole Bode  
Junior; electrical engineering;  
Moore, Idaho

Eric Buddrius  
Sophomore, mechanical engineering,  
Blanchard, Idaho

Jared Denton  
Senior; mechanical engineering;  
Twin Falls, Idaho

Christopher Hill  
Junior; mechanical engineering;  
Craigmont, Idaho

Drew Hooper  
Junior; mechanical engineering;  
Rathdrum, Idaho

Ian Lootens  
Junior; mechanical engineering;  
Marsing, Idaho

Ty Lord  
Junior; mechanical engineering  
Arco, Idaho

Neil Miller  
Sophomore; mechanical engineering;  
Saint John, Washington

Sam Smith  
Sophomore; PTTE-technology education option;  
White Bird, Idaho

Giselle Veach  
Sophomore; mechanical engineering;  
Vancouver, Washington

Austin Welch  
Senior; mechanical engineering;  
Peoria, Arizona



*Dylan Dixon winning the Acceleration run.  
Photo courtesy of MTU/KRC.*



*Dylan Dixon winning the Handling run.  
Photo courtesy of MTU/KRC.*



*Dylan Dixon (left) and Peter Britanyak (right) show UI President Nellis the Clean Snowmobile and ten years of awards.*



*Dylan Dixon testing emissions.*

# ACTIVITIES IN THE REGION X CONSORTIUM

**And then there were five!** The Region X Consortium of DOTs and UTCs recently voted to add the Montana Department of Transportation and the Bozeman-based Western Transportation Institute to the consortium. Montana and the northwestern Region X states have similar transportation issues.

Members of the Region X Consortium held their annual meeting in Portland at Portland State University, and were hosted by OTREC. The emphasis of the meeting was on finding common problems. Several common themes emerged:

- Pooled fund projects of common interest should be continued: the process needs to be streamlined and projects should be larger and more focused.
- Continuing Education: States need continuing education. We should consider a Transportation Leadership Program using multi-university programs and use state expertise more often.
- Summarize expertise for UTCs for states to use.
- Push toward multi-modal approach to a sustainable and livable transportation system.
- Boldly look for opportunities through marketing and collaboration.

The Consortium has an ongoing Pooled Fund Study on the effects of climate change on transportation systems.

The Consortium also modified the management structure, realizing that the groups consist of more than just UTCs. Ongoing, activities and responsibilities in the group will be evenly split between the DOTs and UTCs.

The Region X Education Project also continues, as described in detail elsewhere in this report. PSU and Idaho continue to spearhead this effort, led by former NIATT director Michael Kyte. Workforce development issues continue to be an important concern nationally, and this effort is important as it will assist us in “training the next generation of transportation professionals.”

The four UTCs once again hosted the reception at the 89<sup>th</sup> TRB Annual Meeting in Washington, DC in January 2010. The first Region X Student of the Year (SOY) Award was chosen from the SOYs of the regional UTCs. Rechristened the “Michael Kyte Region X Student of the Year Award”, the first award was given to Yegor Malinovskiy of the University of Washington. Congratulations Yegor!



Sponsored by the University Transportation Centers of Alaska, Washington, Oregon and Idaho

## Region X Transportation Consortium Reception Invitation

During the 89<sup>th</sup> Annual Meeting of the Transportation Research Board

Monday, January 11, 2010  
 6:00 – 7:30 pm  
 Marriott Wardman Park Hotel  
 Stone's Throw Private Dining Room  
 Washington DC

Join us for appetizers, interact with our partners, meet our outstanding students of the year, and learn more about our active region. Enjoy interaction with colleagues from Alaska, Washington, Oregon and Idaho.

The 2011 CUTC meeting will be held in Portland June 13-15, 2011. Since much more emphasis is being placed nationally on collaboration, Region X may be a good example of what is possible as work continues to identify areas of mutual interest among participants.

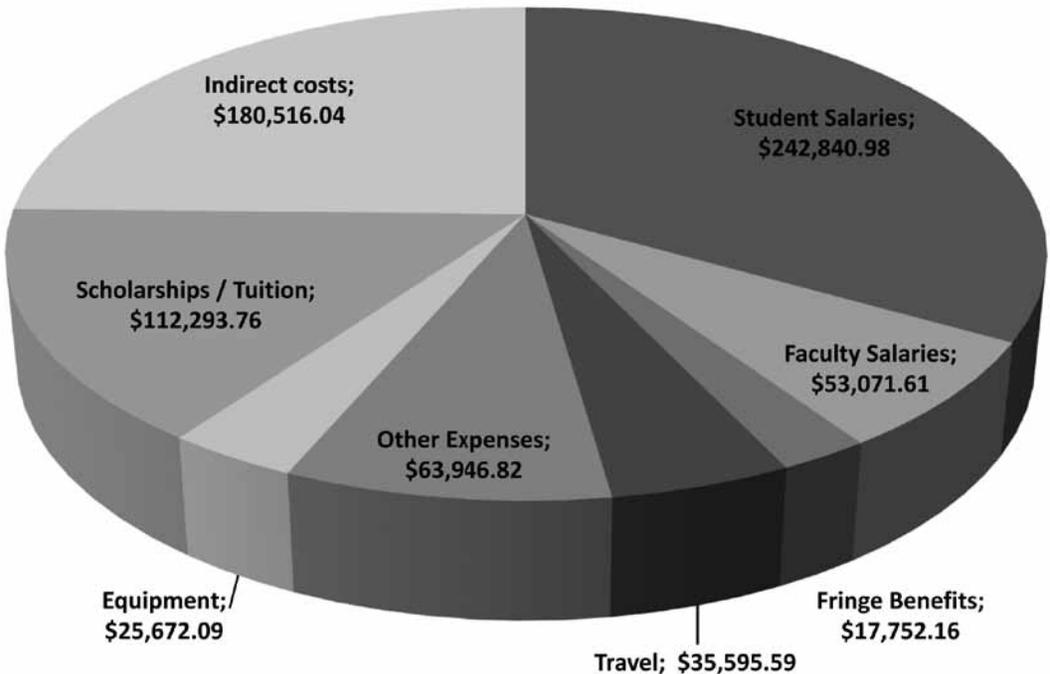
The Seventh Annual Region X Student Conference was held at the University of Oregon in Eugene, OR on November 13, 2009. The annual conference provides a forum for the graduate students to share their research with each other as well as make professional connections with each other and representatives of the other sponsors (Transpo Group, Parsons Brinkerhof). The keynote speaker at the conference was Jim Whitty from the Oregon Department of Transportation. A panel discussion of professionals in transportation discussed the difficulties and progress in moving people intermodally.

UTC's Region X Transportation Consortium joined together to host a reception at the 89<sup>th</sup> Annual Meeting of the Transportation Research Board in Washington, DC, January 11, 2010. Representatives from the universities were there to talk to guests about the research being done at the UTCs.

# FINANCIAL REPORT

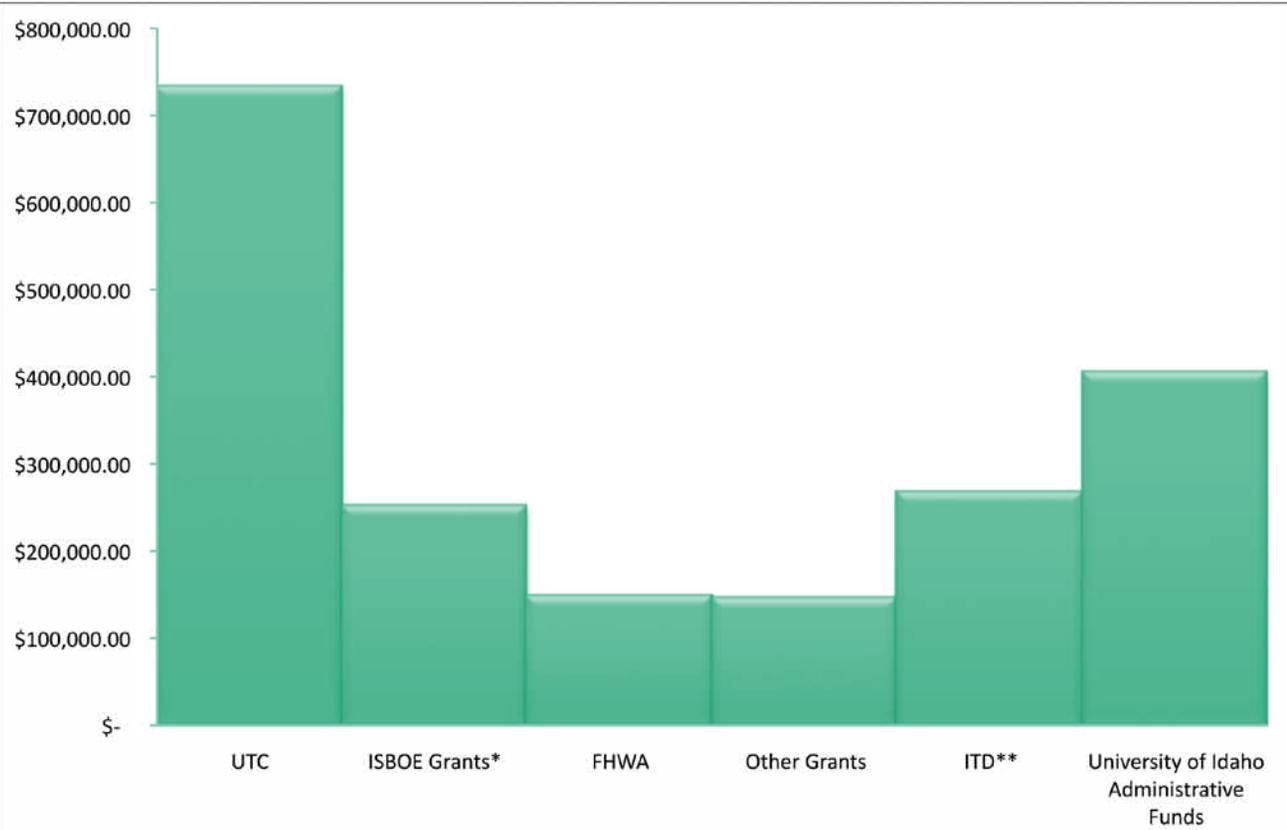
## EXPENDITURES – FY10 UTC EXPENSES

In fiscal year 2010, NIATT research project expenditures once again focused on student support. Sixty-four percent of University Transportation Center funds expended (excluding indirect costs and fringe benefits) were used for student salaries and scholarships/tuition. NIATT director and staff salaries were paid from matching funds, as were faculty research salaries during the academic year.



# SOURCES OF NIATT FY10 EXPENDITURES

The chart below shows the source of NIATT expenditures from FY10. The “other grants” represent funding from Campbell Company, NSF, USDOT, and other sources. The chart does not reflect University of Idaho support used for cost-sharing.



\* Idaho State Board of Education

\*\* Idaho Transportation Department

## PROJECT STATUS

### PROJECTS BEGUN IN FY10 - YEAR 3 OF DTRT07-G-0056

- KLK719 Closed Loop Operation of Network Based Accessible Pedestrian Signals**  
Center for Traffic Operations and Control  
Drs. R. Wall, M. Kyte & B. Johnson
- KLK757 Hybrid FSAE Vehicle Realization**  
Center for Clean Vehicle Technology  
Drs. E. Odom, S. Beyerlein & J. Law
- KLK758 Application of Metal Catalysts for High Selectivity of Glycerol Conversion to Alcohols**  
Center for Clean Vehicle Technology  
Dr. B. He
- KLK759 Measurement and Control Strategies for Sterol Glucosides to Improve Biodiesel Quality – Year 2**  
Center for Clean Vehicle Technology  
Drs. J. Van Gerpen & B. He
- KLK760 Development of an Ethanol Blend, Two-Stroke, Direct-Injection Snowmobile for Use in the Clean Snowmobile Challenge and National Parks**  
Center for Clean Vehicle Technology  
Dr. K. Den Braven
- KLK761 Aqueous Ethanol Ignition and Engine Studies, Phase I**  
Center for Clean Vehicle Technology  
Drs. J. Steciak, S. Beyerlein & R. Budwig

### PROJECTS CONTINUING FROM FY09

- KLK716 Improved Simulation of Driver Behavior: Modeling Protected and Permitted Left-Turn Operations at Signalized Intersections**  
Center for Traffic Operations and Control  
Drs. A. Abdel-Rahim, M. Kyte & M. Dixon
- KLK717 An Architecture for Implementing Improved Queue Spillback Control Strategies**  
Center for Traffic Operations and Control  
Drs. M. Dixon, A. Abdel-Rahim & R. Wall

### PROJECTS COMPLETED - FINAL REPORTS IN REVIEW

- KLK711 Traffic and Controller Data Collection System Enhancement, Deployment and Testing**  
Center for Traffic Operations and Control  
Drs. M. Dixon, A. Abdel-Rahim & R. Wall
- KLK755 Measurement and Control Strategies for Sterol Glucosides to Improve Biodiesel Quality**  
Center for Clean Vehicle Technology  
Drs. J. Van Gerpen & B. He



*Thank you Judy LaLonde for your ten plus years of dedication to NIATT, faculty, staff, and students!*

*Judy pictured with students at her surprise retirement party last year.*





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**University of Idaho**