

# NIATT

## ANNUAL REPORT



PREPARED FOR UNIVERSITY TRANSPORTATION CENTERS PROGRAM

RESEARCH AND INNOVATIVE TECHNOLOGY ADMINISTRATION

U.S. DEPARTMENT OF TRANSPORTATION

FUNDING PERIOD JULY 1, 2008 THROUGH JUNE 30, 2009 - FY09



## 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.

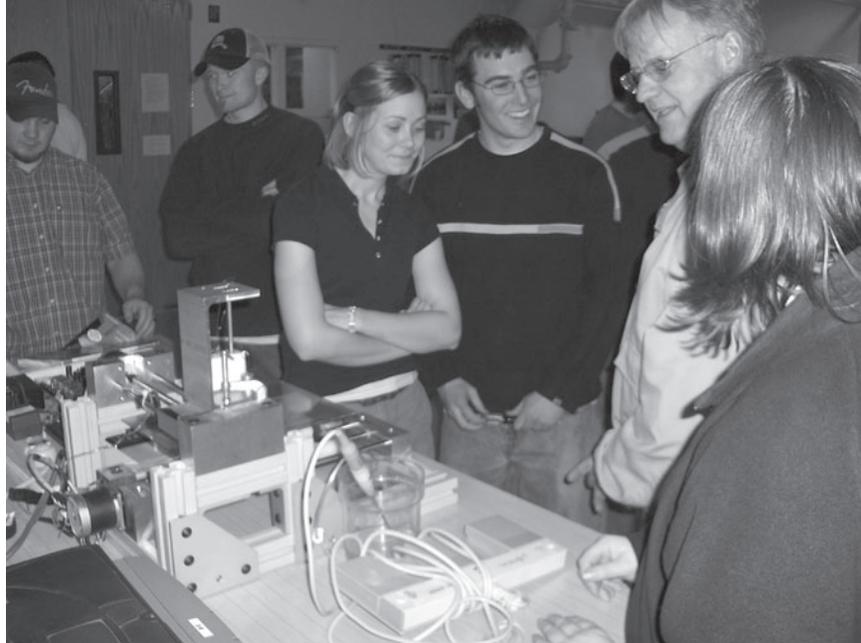
- We are a national leader in developing technology to reduce congestion on arterials, improve the quality and economic viability of biofuels, and reduce the environmental impacts and improve the fuel economy of motorized vehicles (including passenger cars, transit vehicles, and recreational vehicles).
- 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:

NIATT present: (top left) Team Captain Dylan Dixon shows off the UI Clean Snowmobile. (bottom left) Traffic signal operations work improves the flow of traffic.

NIATT future: (right) Planned Engineering Innovations Building at UI is designed to LEED platinum specifications. Photo courtesy of Patano & Hafermann Architects.

*Dr. Edwin Odom with undergraduate students at Design Snapshot Day.*



## TABLE OF CONTENTS

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Director's Letter .....	1
Thoughts from Michael Kyte .....	2
NIATT Advisory Board.....	3
Management Structure.....	7
NIATT Affiliate Faculty .....	8
NIATT UTC Research.....	9
Other Research .....	32
Education .....	34
Our Students.....	39
Activities in the Region X Consortium.....	43
Financial Report.....	45
Status of UTC Projects.....	47

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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*Karen Den Braven, Director*



## DIRECTOR'S LETTER

It is my pleasure to welcome you to our latest UTC Annual Report as the new Director of the University of Idaho's National Institute for Advanced Transportation Technology. I have the honor of succeeding Michael Kyte, who has shepherded NIATT since its inception. Dr. Kyte has returned as a professor to the University of Idaho Civil Engineering department, where he is once again fully engaged in educating the next generation of transportation professionals. I am excited to be stepping up to this new challenge, and I thank all of you who have welcomed me so warmly.

As a researcher in NIATT since 2000, I have seen the direct impact that the University Transportation Center's funding has had on the transportation industry, working professionals, and students. Our focus here at the University of Idaho has always been on technology 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. Our emphasis remains on developing teams of undergraduate researchers, led by graduate students, mentored by faculty. This model of removing the artificial barriers between undergraduates, graduate students and research leaders has created an environment in which all thrive. Our student teams can consist of freshmen through PhD graduate students, often led by faculty from several disciplines. This workforce-focused environment has garnered us partners in regional and national industries, transit, our state transportation department, and other regional UTCs.

This past year the UI civil engineering department added a transportation faculty member with a joint appointment in bioregional planning. This has added focus to our multidisciplinary efforts as we seek to integrate transportation engineering into other planning efforts throughout the state and region.

NIATT and its researchers continue to earn national awards. Especially rewarding this year was the receipt of the "Innovation in Education" award from the Transportation Education Council of the Institute of Transportation Engineers. Our clean snowmobile team also achieved Third Place in the Clean

Snowmobile Challenge, bringing back several other awards in the process. Our graduates continue to achieve employment after graduation, despite the national economic situation.

NIATT researchers continue to be guided by our theme of "Advanced Technology for Sustainable Transportation." In this report, you will see "how we got here." Researchers will take a brief look back at earlier results that have led to their most recent efforts. They will then review current work and spend time looking forward to "what's next."

As we conduct our research, we continue to be guided by our UTC Strategic Plan as approved in 2007. You will see how our research projects support our four stated objectives and specific strategies for achieving these objectives. 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.

Thank you for your support and involvement in our efforts.

Sincerely yours,

Karen Den Braven, Director

## THOUGHTS FROM MICHAEL KYTE, DIRECTOR – 1994 TO 2009



A handful of researchers, spread over the University of Idaho campus, working in such diverse areas as Electrical Engineering, Psychology, Mechanical Engineering, and Civil Engineering, and each with a separate interest in transportation--that was the state of the transportation program at the University of Idaho in the early 1990s. Brought together by the University Transportation Centers program and our work with the Idaho Transportation Department, the National Institute for Advanced Transportation Technology now includes faculty and students from many branches of science and engineering at the University of Idaho, working on transportation problems that are essential to the future of our state and nation.

The University Transportation Centers program has allowed us to focus our work in a few key strategic areas: congestion, energy, and the environment. We have built hybrid electric vehicles and clean snowmobiles, developed new battery technology, and been a leader in biofuels. We have developed tools to better manage traffic flow on city streets that have been used by practitioners and researchers throughout the nation and the world. We have been nationally recognized for our education programs to train new generations of transportation engineers.

I am grateful for the many students and faculty who have worked, and continue to work, together to establish the University of Idaho's reputation as a center of excellence in transportation.

*Michael Kyte*



*Advisory Board meetings provide time not only for formal presentations, but for informal conversations about research issues. Dr. Judi Steciak (left) and Dr. Karen Den Braven (right) of the Center for Clean Vehicle Technology chat with Tom LaPointe, Executive Director of Valley Transit.*

**“NIATT offers world-class research and development. . . . The thing I find refreshing is that NIATT research is unfailingly usable to the profession. I feel that the Advisory Board helps in that process by tweaking research proposals to provide the most utility to practicing professionals.”**

- Anonymous advisory board member

## 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  
*Associate 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  
*Associate Engineer  
Kittelson & Associates*

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*

Stan Teply  
*Professor Emeritus, Civil Engineering  
University of Alberta*

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

Jerry Whitehead  
*President  
Western Trailers*

**“One of the great values of the institute is its focus on education. The research is important and is the fun part of the job. One of your great missions is educating the next generation of transportation professionals. Our nation’s future may well depend on how our transportation system can become more efficient. What you are doing today to impart knowledge and challenge students will contribute to insuring our nation’s future.”**

**NIATT’s annual Advisory Board meeting** was held over three days in April 2009, allowing the Board members to attend and/or judge the Annual University of Idaho Engineering Exposition held the final day.

The first afternoon, a surprise reception was held to recognize Michael Kyte as outgoing NIATT Director. When Kyte made his plans known to “retire” from his directorship and concentrate on teaching and research, foregoing administration, he sent an email putting his future plans in terms of “changing hats.” Guests to the reception were asked to come wearing some type of hat. Attendees were given the opportunity to speak about Dr. Kyte; and many of them did, talking about the way he has influenced their lives, both professionally and private.

The Center for Traffic Operations and Control (CTOC) invited additional traffic professionals to attend:

- Jim Bloodgood, Snohomish County, WA, Traffic Engineering
- Phil Rust, Ada County (ID) Highway District
- Jim Poston, RTC Regional Transportation Commission
- Paul Coffelt, City of Lynnwood, WA, Traffic and ITS Engineer

These professionals gathered that first evening along with the formal board members to review the progress of the research in that center since 2008.



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

“The Idaho Energy Division, a part of the Idaho Department of Water Resources, is the state energy office. It has long been involved in alternative fuel programs and enjoys a close and rewarding working relationship with NIATT and the University of Idaho. We believe that NIATT fills a vital need. Alternative fuel technology has exploded into one of the most exciting segments of the international economic and industrial arenas. It combines national energy security strategies, environmental protection techniques, an engine for economic development, and other critical elements to make it a front burner issue in the United States. The University of Idaho is recognized worldwide as a pioneer and leader in biofuels research.”

– John Crockett, advisory board member

“NIATT has achieved some amazing accomplishments—SILS, HILS, CID, clean engine technology, competitive wins, etc. NIATT can build on those successes in ways that will continue to engender the loyalty of those who have contributed to this success. Success is measured in more than just “efficiencies,” dollars and cents.” – Anonymous advisory board member

Date	ADVISORY BOARD AGENDA	
	Center for Traffic Operations and Control	Center for Clean Vehicle Technology
Thursday, April 30	Continental breakfast Welcome, College of Engineering Dean, Don Blacketter 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	
	5:30 pm: no-host bar 6 pm - NIATT Banquet College of Engineering Dean’s Reception	
Friday, May 1	Engineering Expo	

During the formal meeting the following day, Advisory Board members were specifically asked for what advice they would offer NIATT both for pursuing future research and for marketing its successes. The groups representing the two major areas of NIATT research, traffic operations and vehicle technology, met separately after the initial introductions to review current research and analyze new proposals. When they met after lunch, the participants were asked to respond to six general questions:

1. What are the key traffic operational issues that face the U.S. that we should try to address?
2. What changes are needed in the U.S. traffic operations industry that we should address in our work?
3. How should we apply or leverage the infrastructure and knowledge base that we’ve developed?
4. What weakness do we have that we should address?
5. What are some examples of specific research problem statements that we should address?
6. How do we best deliver the results of our work (knowledge, technology) to practice?

We are pleased to include excerpts taken from the responses, which were provided anonymously:

**“Tucked away amongst the rolling, windy hills of the Palouse is a research institute capable of changing your life—for the better. Uncertainties with Earth’s present and future are being investigated in connection to practical, everyday activities you and I take for granted. Awareness is beginning to sound in the ears of all responsible people and searching questions begin to occupy our thoughts:**

**Is my car harming the environment?**

**Is there another way for me to enjoy activities that involve consuming fuel while preserving the integrity of planet Earth?**

**Answers to these and other transportation concerns have promise of being answered through research at NIATT where some of the world’s most capable experts convene.”**

**“What I have always appreciated about NIATT is its focus on skills for the real world centered on practical applications and field work in an environment that requires team work, sound communications, and mutual respect.”**

**“UI’s NIATT is a proven leader in fostering innovation in transportation technology, such as software-in-the-loop simulation, which allows traffic engineers and students the opportunity to study signal timing changes in a controlled laboratory setting in order to minimize delay to motorists and optimize the existing transportation infrastructure. Countless professionals throughout the US and abroad have received training and mentorship at this prestigious institute. Both in formal college settings as well as informal training opportunities provided to departments of transportation, highway districts, and students contemplating careers in transportation, NIATT excels at touching people who touch the transportation system.”**

**“NIATT is an extremely valuable resource to the Idaho Transportation Department. It brings together faculty and students from a variety of disciplines to address real world problems. We rely on NIATT to conduct research on a variety of transportation-related issues. NIATT plays a role in preparing students for careers in transportation. The concern for the student shown by NIATT faculty and staff has been impressive. NIATT staff are truly committed to student success.”**

– Anonymous advisory board member

*Members of the Advisory Board and other traffic experts invited to learn more about Richard Wall’s accessible pedestrian signals project (left to right, backs of Paul Olson and Jim Larsen, advisory board members; Phil Rust of Ada County Highway District; Zong Tian and Stan Teply, advisory board members; Jim Bloodgood, Snohomish Valley; and Jim Poston of RTC; on the opposite side of the table, (left to right) Paul Coffelt, City of Lynwood, and Michael Kyte.*



## 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.

### 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*

## NIATT AFFILIATE FACULTY

Ahmed Abdel-Rahim  
*Associate Professor, Civil Engineering*

Fouad Bayomy  
*Professor, Civil Engineering*

Steven Beyerlein  
*Professor, Mechanical Engineering*

Donald Blacketter  
*Dean of Engineering*

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

Anthony Davis  
*Assistant Professor, Range Resources*

Karen DenBraven  
*Professor, Mechanical Engineering*

Michael Dixon  
*Associate Professor, Civil Engineering*

Jim Frenzel  
*Associate Professor, Electrical and  
Computer 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*

Axel Krings  
*Professor, Computer Science*

Michael Kyte  
*Professor, Civil Engineering*

Joseph Law  
*Professor, Electrical and Computer  
Engineering*

Michael Lowry  
*Assistant Professor, Civil Engineering*

Stanley M. Miller  
*Professor, Geological Engineering*

Richard J. Nielsen  
*Chair, Civil Engineering*

Edwin Odom  
*Professor, Mechanical Engineering*

Paul Oman  
*Professor, Computer Science*

Karl Rink  
*Associate 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*



*Dr. Ahmed Abdel-Rahim  
talks with the Advisory Board  
members about the progress of  
the research in the Center for  
Traffic Operations and Control.*

# 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 earlier results have led to their most recent efforts. They review current work in terms of meeting specific strategies and then look forward to their plans for the future.

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.

## PROJECT: AN ARCHITECTURE FOR IMPLEMENTING IMPROVED QUEUE SPILLBACK CONTROL STRATEGIES (KLK717)

**Investigators:** Dr. Michael Dixon, Dr. Ahmed-Abdel-Rahim and Dr. Richard Wall

**Student Involvement:** Guillermo Madrigal, Asma Tuly, Jean Montesinos, S. K. Monsur, Syed Zillur Rahman, Jorge Jordan Zamalloa; (graduate civil engineering students); Justin Clark (undergraduate student, electrical engineering); and Sanjeev Giri (graduate student, electrical engineering)

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

### STRATEGIES 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

**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.

Several researchers (published in the *Transportation Research Record*) have considered different causes for queue spillback. All present well-defined causes, but none utilize a decision framework that is able to respond to a variety of queue spillback scenarios. To obtain a more comprehensive solution for queue spillback, the causes—or more likely the combination of causes—should be considered. In addition, any solution needs to be implemented and tested in an NTCIP-compliant, fully automated manner. In an effort to expand the capability to address queue spillback conditions, this research will focus on achieving four objectives:

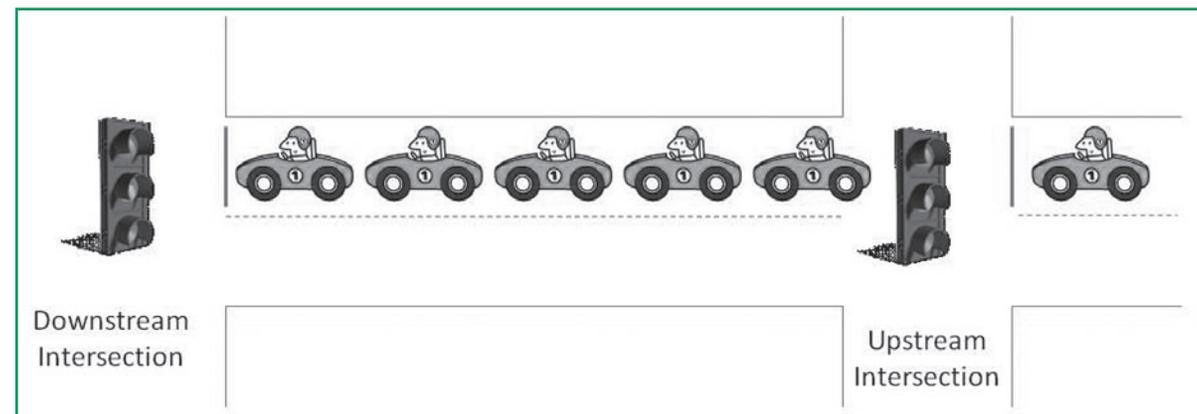
1. Extend control strategies to effectively remedy queue spillback problems, automatically and in real-time within the proposed architecture.
2. Incorporate green time utilization (GTU) in the queue spillback control strategy decision making process used in the proposed architecture.
3. Extend the current architecture developed at NIATT for the Smart Signal System to implement proposed performance monitoring and control strategy decisions automatically.
4. Identify potential opportunities for applying queue spillback performance measurement feedback.

Engineers designing and maintaining traffic signal systems face the increasing challenge to efficiently serve growing traffic demand with static or decreasing resources. To address this challenge effectively, practitioners need cost effective means to assess traffic conditions and respond to reduce delays, motorist frustration, and safety risks.

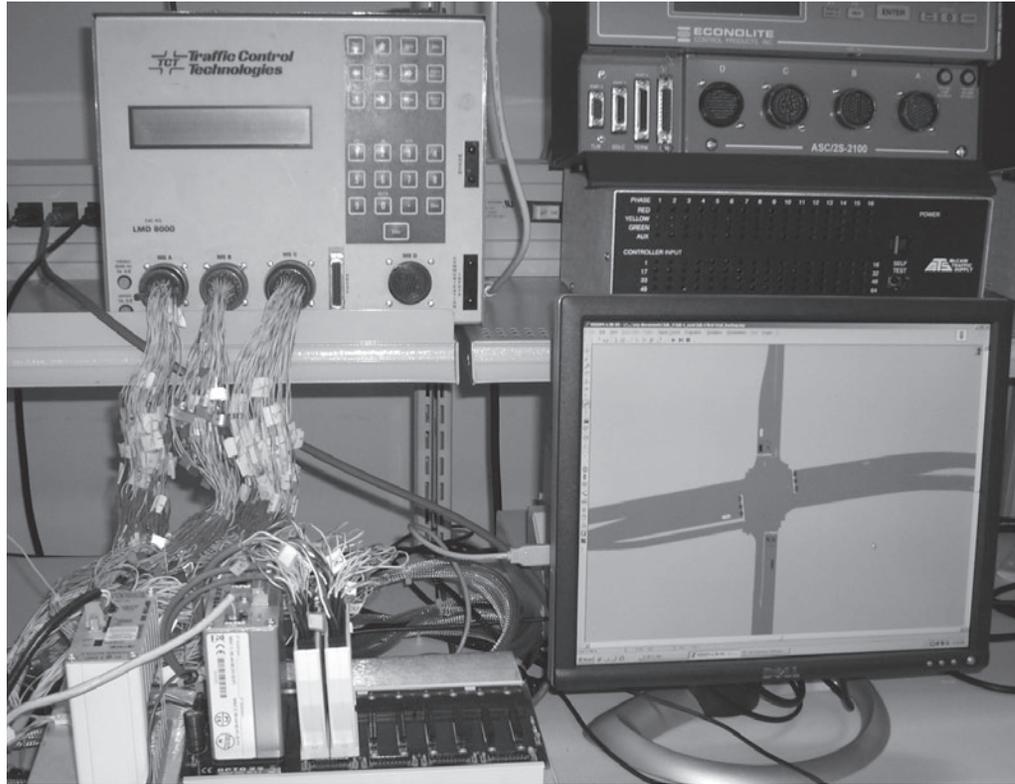
Recognizing that this is a big problem, this research project focuses on three improvements to traffic signal systems control.

- *Expanding traffic condition information quality* by understanding current performance measures better and developing new measures,
- *Increasing controller capability to intelligently use information* by building and testing algorithms that use higher quality information, and
- *Advancing lab and field testing capabilities* by creating portable devices that implement information gathering techniques and algorithms.

We focus on two important areas of information: the efficiency with which vehicles use the intersections and the existence of queues that keep drivers from moving through the intersection. Current traffic controllers and detectors do not analyze detector data to assess efficiency or detect queue conditions other than to detect a vehicle. As a result, we are developing logic for actuated controllers that can perform these tasks in real-time. Furthermore, we are developing traffic control algorithms that can use this improved information to increase intersection efficiency. All of these improvements in information processing and control algorithms are coded and tested in small electronic devices that communicate with the traffic controllers, acquire data, and process the data to obtain information and change the traffic controller control strategy.



*Functional flow diagram of control logic using feedback*



*Traffic control hardware testing environment.*

Current research developed and evaluated methods to automatically classify traffic conditions in terms of congested or uncongested states, detect queues blocking traffic, and estimate when a queue clears the intersection. Researchers also developed and tested algorithms that respond to queues blocking traffic and are now expanding the capability to a network of intersections.

Researchers will progress, in stages, to address more complex traffic control problems that tend to be more pervasive. To do this, researchers will gain more understanding of the relationships between traffic streams and traffic control parameters. Each traffic control technology advancement will be implemented in electronic devices and tested in realistic traffic control settings.

Two papers were submitted to peer reviewed journals, with one accepted for publication and one pending. Two more are being prepared for submission.

This project will benefit the public by advancing traffic controller capabilities to efficiently control signalized intersections.

## PROJECT: COMMERCIALIZATION AND FIELD DISTRIBUTION OF SMART PEDESTRIAN CALL SIGNALS (KLG715)

**Investigators:** Dr. Richard Wall; Dr. James Frenzel; and Dr. Brian Johnson

**Student Participation:** Craig Craviotto, Gabriel DeRuwe and Zane Sapp (graduate students, electrical engineering); Cody Browne, Anne Mousseau, Mat Stein and David Alford (undergraduate students, electrical engineering)

**University Transportation Center Funding:** \$117,357

### 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.

Smart Signals is a term we have coined that refers to an enabling technology that allows for more effective intersection control and adaption to real-time traffic operations requirements to enhance highway performance and/or improve safety. Innovative research on "Smart Signals" concepts started in the fall of 2005 when it was noted that current traffic signal devices display only a limited set of symbols, i.e., walk and don't walk icons for pedestrians and the common green, red, and yellow balls and arrows for vehicles. Signals and sensors that utilize the Smart Signals technology can be used to display a wide range of symbols and information that can change dynamically to reflect current road operations. The difficulty of changing signal displays for temporary traffic patterns often confuses drivers and generates unsafe intersection operations. Back in 2005, it was projected that with Smart Signals, dynamic signaling can communicate information such as system failure modes or changing the traffic control symbols for redirecting traffic during special events or emergencies.

Initially, the Smart Signals research focused on traffic signal devices that used network based distributed control technology with plug and play capability. An advisory board was soon established consisting of traffic signal designers from industry, state and federal traffic engineers, academic researchers, and pedestrian advocacy groups including the Federation for the Blind. Their input was solicited to help guide and direct our research effort as the Smart Signal technology revolved and matured. As a result of the first advisory board meeting, the Smart Signals research directed its attention to the deficiencies in the pedestrian signals and operations. Three major areas for improvement were identified: The consistency and accuracy of countdown pedestrian timers, pedestrian button failure modes that cannot be detected by the traffic controller or malfunction management units (MMU) or conflict monitors (CM), and the inability to adequately serve the visually impaired and mobility handicapped pedestrian community.

In 2006, a team of electrical and computer engineering graduate and undergraduate students successfully demonstrated that a countdown pedestrian timer based on Smart Signals technologies can effectively maintain an accurate time for a wide range of traffic signal operating conditions. These include emergency and transient preemption as well as different time-of-day traffic signal timing plans.

In 2007, based on the advice of our advisory board, the Smart Signals research resulted in developing a distributed control network based on the National Transportation Communications for ITS Protocol (NTCIP). This research resulted in new pedestrian signals distributed around an intersection that is a logical extension for the computer program running in the traffic controller on the street corner.

The integrity of traffic control systems today depend upon the MMU or CM to be able to observe the state of all traffic and pedestrian signals. This is accomplished by monitoring the voltages on the wires that connect the signal lights to the load switches controlled by the traffic controller. Spatially distributing intelligent control makes some of the automated controls unobservable by the MMU or CM. This is certainly the case for signals that operate using Smart Signals technology. Early in 2008, the Smart Signals research tested and implemented a secure distributed real-time control system for safety critical systems by overlaying the time precision protocol on the NTCIP.

However, the people representing pedestrians who are blind or have low vision helped us realize that the audible tones and messages that Accessible Pedestrian Systems (APS) employ have the same required degree of integrity as do the visual walk and wait signal for those with good visual acuity. The microprocessors that are currently used in APS that controls what audible message the pedestrian hear are based upon sensors in the pedestrian signal heads. This alone represents a lapse in observability by the CM or MMU that can result in playing the incorrect audible message thus putting a visually impaired pedestrian at risk.

Based upon the risk to blind and visually impaired pedestrians that is not being addressed by current industry designs, the research for 2008–2009 was initiated to develop an advanced accessible pedestrian system (AAPS) based upon Smart Signals technology where the audible messages can be verified and then provide an indication to the traffic system MMU or CM. One of the specific objectives of this research effort was to identify an established manufacturer of pedestrian signal systems and secure their commitment to helping us to get one or more AAPS installed in a public intersection. The industry partner would help us to establish a set of specification that were progressive in promoting public safety and accessibility through advanced features and enhanced reliability while keeping system cost for installation and maintenance at or below the costs of existing APS installations.

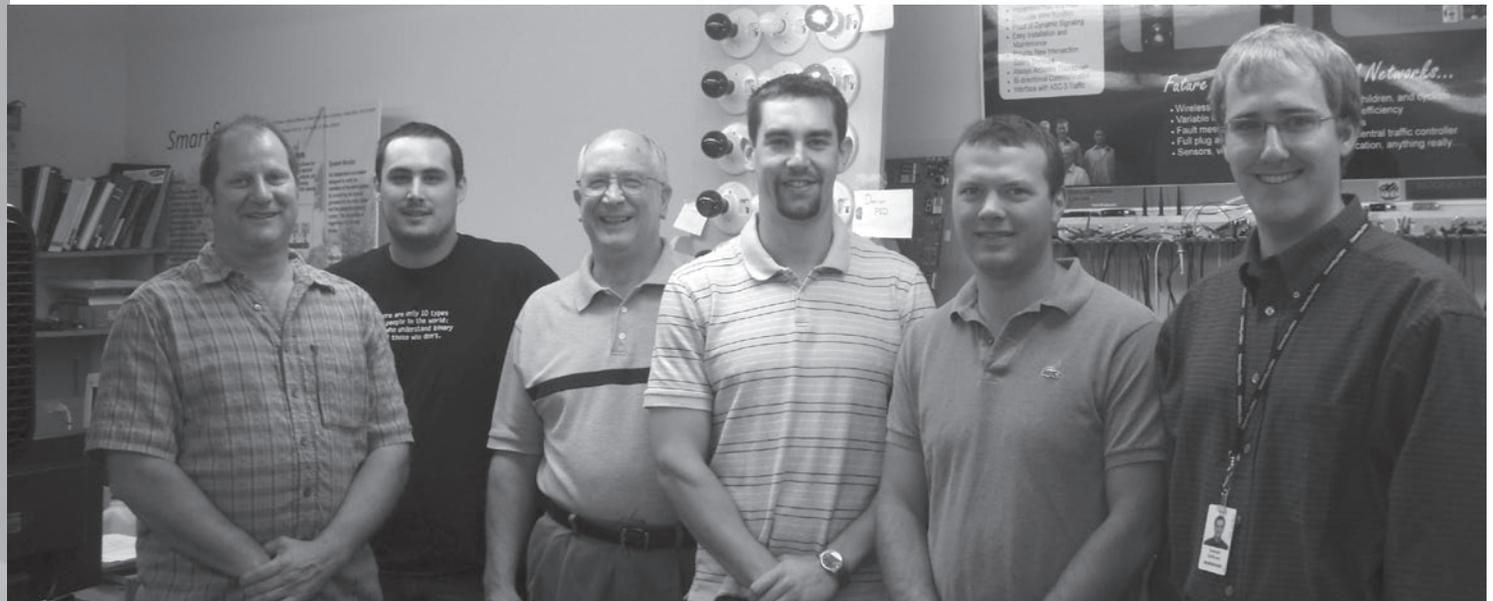
Our success in meeting these goals can be measured by the number of publications, patent applications, acquiring additional external funding, students graduating with advanced degrees and the devices developed for installation on public streets. We are currently working with Campbell Company of Boise, ID, a well know manufacturer of pedestrian systems and APS stations. This company has supplemented our research effort with funding and employed a graduate student at their facility during the summer of 2009. Two patents have been applied for in the area of AAPS and APS systems based on Smart Signals technologies. Two graduate students, who worked on this project, received their Master of Science degrees in Computer Engineering in May of 2009. Their work is currently being continued by two graduate and two undergraduate Electrical Engineering students. Last year, we presented a paper at the 2009 TRB meeting that was accepted for the TRB record. A second paper has been submitted for presentation at the 2010 TRB meeting. Presentations have been made at regional workshops for industry practitioners and meetings for educators of the blind and disabled.



*Electrical engineering graduate students (left to right) Gabriel DeRuwe, Zane Sapp and Craig Craviotto in the Smart Signals lab.*

Finally, our research has resulted in the development of a new generation of Smart Signals pedestrian controls that meet the newest APS guidelines and have extensible capabilities for features not considered at this time. The system is scheduled for beta testing at four intersections in Minnesota in October 2009. One such futuristic feature that the AAPS can support is the ability to integrate remote pedestrian controls to enhance the accessibility for mobility and visually impaired pedestrians. We have tested such a system that can place pedestrian calls, provide navigational aids to help pedestrians stay within the crosswalk, and allow the traffic controller to track the pedestrian's progress across the intersection.

Based upon the reaction to previews of the AAPS at industry trade shows and presentations at meetings for traffic professionals, the suggestions for enhancements seem endless. Our research for the next year is in the area of improved reliability to the extent that the Smart Signals research can begin to be applied to all traffic signal devices. The industry acceptance of this revolutionary technology has been slow and rightfully so because of the risk to life and property because of an undetected system failure. Our future research will continue to look at new ways the Smart Signals technology can improve traffic safety, efficiency, and accessibility. But our main research will be to make certain that what we are doing now represents the lowest risk, the highest availability of service, and the greatest economic benefit. We will develop testing procedures and, if necessary, develop new hardware for testing Smart Signals to assure those responsible for installing, maintaining, and operating Smart Signal based traffic controls of the highest reliability and dependability.



*The Smart Signals Design Team gathered to perform system acceptance testing of the AAPS system. Manufacturing of equipment to be installed at beta test sites is now underway. Left to right is Phil Tate, President of Campbell Company who will be manufacturing and marketing the AAPS systems. Cody Browne, undergraduate electrical engineering student, Richard Wall, Professor, Department of Electrical and Computer Engineering, Craig Craviotto and Zane Sapp, current electrical engineering graduate students, and Gabe DeRuwe, computer engineering student who graduated in May 2009.*

## PROJECT: TRAFFIC AND CONTROLLER DATA COLLECTION SYSTEM ENHANCEMENT, DEPLOYMENT, AND TESTING (KLK711)

**Investigators:** Dr. Michael Dixon, Dr. Ahmed-Abdel-Rahim and Dr. Richard Wall

**Student Involvement:** Asma Tuly; Simon Addei, Jean Montesinos, S. K. Monsur, Uriah Jones (graduate students, civil engineering), and Sanjeev Giri (graduate student, electrical engineering)

**University Transportation Center Funding:** \$90,000

### STRATEGIES INVOLVED:

**Strategy 1.1:** Enhance and utilize new arterial field laboratory to improve our nation's research database and provide professionals with the opportunity to test new traffic technologies.

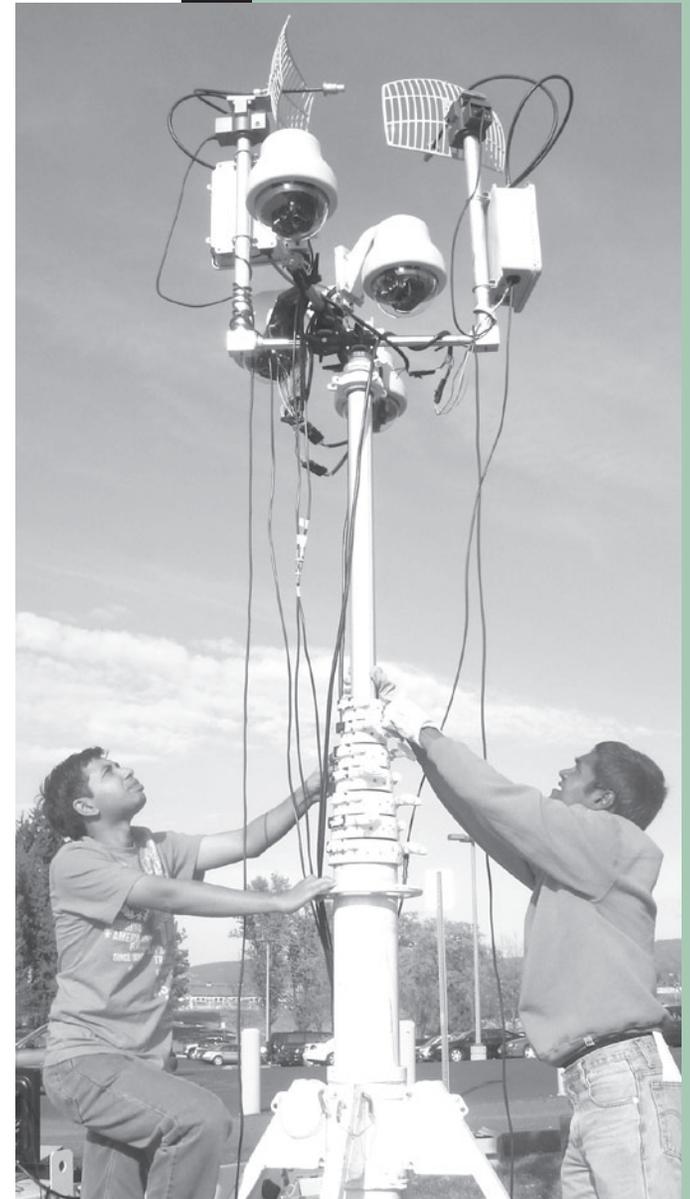
**Strategy 1.3:** Develop practical traffic control strategies to better manage congested arterial flow using our innovative and widely used hardware-in-the-loop traffic simulation system.

### OBJECTIVES

Enhance the ability of research center equipment to obtain high quality traffic operations data at any signalized intersection.

One aspect of this project is designing, building and acquiring the means to store, transport, and install a mobile data collection system. The other aspect is modifying the controller data logging device created in a previous project to enhance the data collection system, logging controller input and output data throughout the data collection time. The technical product of this project will be a data collection system that will obtain high quality high resolution data needed to further NIATT research objectives in three areas: arterial traffic flow theory, improved traffic control strategies, and improved performance measurement.

One product of this project was the mobile data collection system, which can be installed at any location, utilizes enclosures designed to withstand the elements, and is scalable to observe traffic at an intersection or along a one-mile arterial section.



*Syed Zillur Rahman and S. K. Monsur, civil engineering graduate students, set up data collection equipment in the field.*



*S. K. Monsur with the data logging device components in the field.*

Another product of the project was development of a device to access controller information crucial to documenting traffic system operations. This data logging device records any information communication between the controller and the field that suits research and engineering needs. Once the device receives the information, it is then transmitted to, and recorded on, a central computer to finally assess the controller's operation and traffic operations.

Engineers also frequently find themselves needing to adjust traffic controller settings to resolve current traffic problems. The strength of the data logging device is its enormous capacity to access and store information. Unfortunately, the device cannot adjust controller settings. Furthermore, all controllers are proprietary and allow only limited access to their settings and no access to the control logic or algorithms they use. This makes exploration of traffic control algorithm improvements very challenging.

To meet this challenge, researchers developed a microprocessor that can exchange information with controllers that have an Ethernet port and adhere to a specific communication standard. In this project, researchers tested the microprocessor's capability to read controller data and to change controller settings. Research results show that the computing, read, and write capabilities support more advanced research objectives to provide improved information and intelligent algorithm execution.

From these research outcomes, researchers will expand the microprocessor capabilities in terms of information processing and network with other devices. In addition, the data collection system and data logger will be employed to expand research capacity to test information processing and control algorithms to arterial control applications.

This project will benefit the public by improving real-time traffic information that can result in more informed traffic control and reduced congestion.

## PROJECT: IMPROVED SIMULATION OF STOP BAR DRIVER BEHAVIOR AT SIGNALIZED INTERSECTIONS (KLK712)

**Investigators:** Dr. Ahmed Abdel-Rahim and Dr. Michael Dixon

**Student Involvement:** Golam Sarwar; Jorge Jordan Zamalloa (graduate students, civil engineering)

**University Transportation Center Funding:** \$75,896

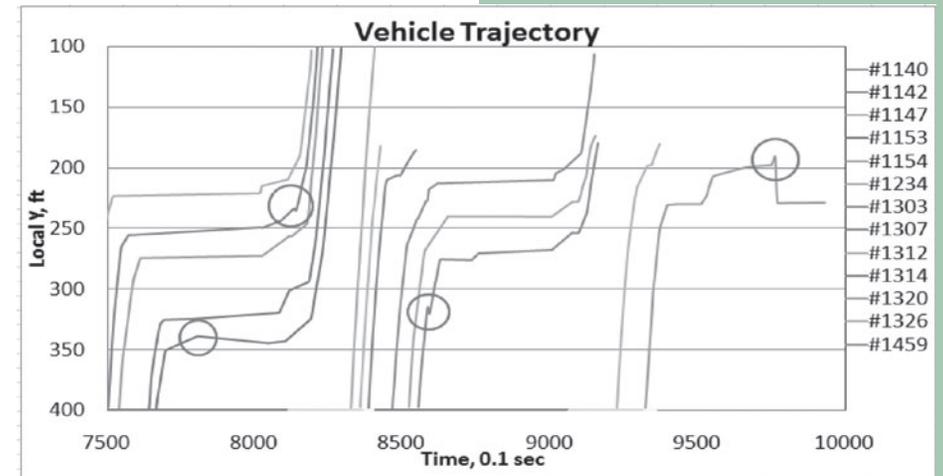
### STRATEGY INVOLVED:

**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 Federal Highway Administration's Next Generation Simulation (NGSIM) program has identified a set of priority algorithms that are yet to be developed. These algorithms include starting/stopping behavior and permitted left turns at signalized intersections.

This UTC project supports the FHWA's goals of reaching out to the university community in general to support FHWA's research program and specifically to support FHWA's NGSIM program. The project developed new insights on the operation of traffic along arterials, particularly driver behavior at the beginning and end of green. The project used high resolution data sets from Atlanta, Georgia to develop improved insights into driver behavior in the presence of signalized intersections. The project had two objectives, where each objective has a list of driver behavior areas or issues: 1) develop characteristics of stop bar behavior at both the beginning and ending of green such as driver response time, start up lost time, and the probability of stopping given distance to stop bar and beginning of yellow and 2) determine the level of precision with which car following algorithms can be expected to represent vehicle headways and speed such as mid-block driving, decelerating to stop in queue, and accelerating out of queue.

The project team completed an extensive effort to visualize the data, identify systematic discrepancies between recorded data and realistic driver behavior, and correct the discrepancies when possible. Researchers use the vehicle trajectory data visualization to identify vehicle position errors caused by anomalies in the video data extraction procedure. The x-axis represents time as a count of tenth-of-a-second intervals. The y-axis represents location (in feet), where forward vehicle motion is moving from larger to smaller location values (approaching the point of reference). Each line in the illustration represents the location of a specific vehicle at a given time, where the list on the right relates vehicle IDs to each of the lines. Correct vehicle trajectories on an arterial street will proceed downstream, occasionally slowing or stopping for traffic control, other vehicles, or to turn.

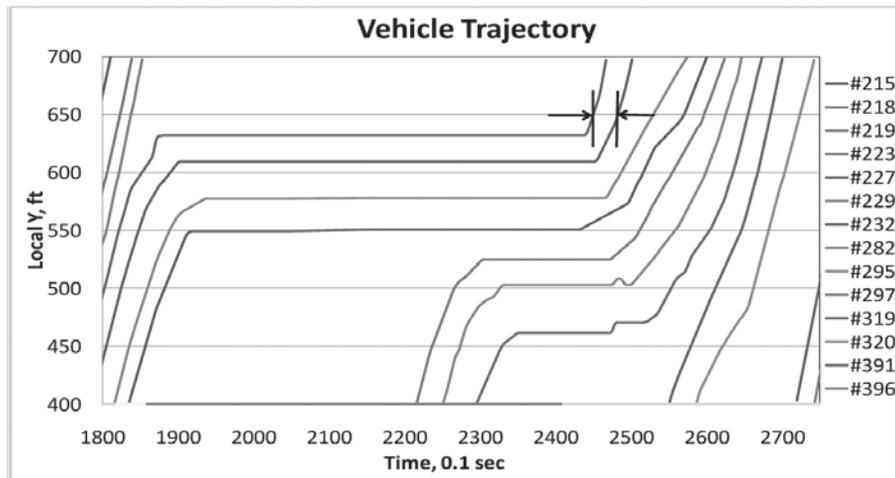


*Illustration for vehicle trajectories and signal timing data used in the analysis.*

Each of the lines in the vehicle trajectory illustration (see page 18) follows this convention, where the lines show vehicles steadily progressing downstream, slowing and then stopping, and accelerating. However, there were instances where trajectories showed vehicles periodically reversing direction, which in reality is very unlikely. Circles highlight examples where reversing direction occurred.

Causes for this anomaly lie in the data extraction procedure and can be explained by reviewing the data extraction procedure. The procedure is automated in computer software that extracts data by processing each video frame. It does this by first recognizing which parts of the current view contain a vehicle. For each vehicle entering the arterial network, it digitally inserts a box. Then the computer tracks the vehicle from one video frame to the next, by comparing the following frame to the previous frame and moving the vehicle's box to its next location. In this way, the computer extracts position by time for each vehicle. The problem lies in how the computer moves the box, which is problematic when the vehicle is moving slowly or stopped. Random variations in the pixels depicting the car and its surroundings can cause the computer to incorrectly move the box introducing data collection errors.

Other major efforts focused on relating the vehicle trajectory data to the signal status data and extracting related driver behavior (see page 20). The vehicle trajectory/signal status relationship is illustrated by superimposing the signal status at the figure base. Each line represents the corresponding phase indication for the phase controlling the vehicle movement to which the vehicles belong. One of the driver behavior parameters measured was vehicle headway from a discharging queue. Headways were measured in seconds between vehicles and one such headway is illustrated here by two arrows and corresponding leader lines.



### *The follow-up headway analysis*

One of the major findings of this project was an affirmation of the great value contained in quality high resolution data. Another was a discovery of the great difficulty contained in collecting accurate high resolution data for many different purposes or measurements.

Future research efforts should further the intent of the NGSIM research area by taking the following actions:

1. Continue data collection efforts with these additions:
  - a. Identify data collection sites where traffic is partially congested, contains heavy vehicles, viewpoints offer full view of the traffic system being observed, some permitted left turns, and coordination is only partially achieved for the major movements.
  - b. Identify specific data collection needs in terms of traffic and/or driver behavior parameters.
  - c. Plan and execute data collection efforts, meeting the data collection needs.
  - d. Add the new traffic data to a comprehensive NGSIM database.
2. Augment the existing video data extraction software by allowing users to stitch together footage from cameras located at different vantage points, closer to the roadway.
3. Based on the existing NGSIM dataset, establish more economical procedures to extract data tailored to meet specific data collection needs.
4. Create a comprehensive database, where data objects are defined to support consistent data collection, incorporation, and sharing.

**“We have an exceptional group of students working on the clean snowmobile team,” said the team’s faculty advisor Dr. Karen Den Braven, mechanical engineering professor.**

**“This program creates an environment where students and faculty can collaborate on design to create a low-emission and fuel-efficient snowmobile. Year after year, the team takes top honors, and team graduates have been hired as engineers by the snowmobile industry.”**

## **PROJECT: DEVELOPMENT OF A FLEX-FUEL, TWO-STROKE, DIRECT-INJECTION SNOWMOBILE FOR USE IN THE CLEAN SNOWMOBILE CHALLENGE AND NATIONAL PARKS (KLK753)**

**Investigator:** Dr. Karen Den Braven

**Student Involvement:** see page 42

**University Transportation Center Funding:** \$83,500

### **STRATEGY INVOLVED:**

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

Due in part to stringent noise and air pollution control measure 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. The CSC is unique among student competition because it addresses not only technological improvements, but the political challenges in the question of snowmobile access to pristine environments.

SAE sponsored competitions are an excellent and popular educational tool in engineering programs since they promote a positive hands-on working environment for students. 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.

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. The team has also been awarded over forty trophies in such areas as Best Fuel Economy, Best Value, Best Ride, Quietest Snowmobile and Most Sportsmanlike Conduct over nine years of competing.

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 reduces 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.

Through the 2007 CSC, NIATT-sponsored snowmobiles used E10 as a fuel. E10 is a blend of 10 percent ethanol mixed with 90 percent gasoline. Starting in 2008, CSC competitors have been required to use higher blends of ethanol. In 2008, the teams were required to use an E85 blend. The UI team improved the combustion chamber to reduce exhaust emissions and increase fuel efficiency. The team was rewarded with overall second place and awards for Best Acceleration, Quietest Snowmobile and Cold Start, Best Oral Presentation and the Kreider Award for best internal combustion technical paper.

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



*The 2009 CSC team captain Dylan Dixon pilots the UI Clean Snowmobile in the handling course.*



*Fine-tuning the Clean Snowmobile: front: Peter Britanyak; rear, left to right: Brian Hansen, Ryle Amberg and Nick Harker.*

less efficient semi-direct injection (SDI) system. In a SDI snowmobile engine, the fuel is injected into the intake just before the port. With proper engine tuning, 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. (Also see page 42)

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. In 2010, CSC teams will be required to use a blend of fuel containing 20+ percent ethanol, as much as what is proposed as a future requirement for passenger cars. 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.

## PROJECT: THERMAL PROCESSING OF LOW GRAD GLYCEROL TO ALCOHOLS FOR BIODIESEL FUEL PRODUCTION (KLK754)

**Investigator:** Dr. Brian He

**Student Involvement:** Randy Maglinao (graduate student, agricultural engineering); and Sushant Kshetri (undergraduate student, agricultural engineering)

**University Transportation Center Funding:** \$63,122

### STRATEGY INVOLVED:

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

The goal of this project is to conduct research to convert the low-grade glycerol derived from biodiesel production to short-chain primary alcohols of methanol, ethanol, and/or propanols, or their mix, and reuse them in the biodiesel production.

### BACKGROUND

Crude glycerol is the major by-product of biodiesel production. Converting the crude glycerol to other useful products could add values to it and ultimately reduce the cost of biodiesel production. The objective of this project is to convert the low-grade glycerol derived from biodiesel production to short-chain primary alcohols of methanol, ethanol, and/or propanols, or their mix, and reuse them in the biodiesel production. If further purified, methanol and ethanol can also be utilized in many applications. During the first phase (Year 1) of the project, a reactor system was designed and constructed. The system consists of a high temperature, high pressure bench-top reactor, temperature/pressure control mechanism, and other auxiliary units. Analytical methods of GC and HPLC have developed to analyze the feedstock and products. Both the reactor system and analytical procedures were thoroughly tested and refined for their capacities in conducting second phase investigation. The major process parameters were identified and evaluated through preliminary experiments. Reaction temperature, initial pressure of the reducing agent, time of reaction and type of reducing agent were identified as the major parameters.

The results of the experiments in the first phase provided valuable information that temperature and time of reaction affect the hydrothermal conversion of glycerol significantly. However, further studies are needed to sufficiently evaluate the effects of the key operating parameters on the conversion reaction. Thus, the objectives in the Year 2 project were to (1) thoroughly investigate the effects of the major process parameters, and (2) to optimize the system for primary alcohol production.



*Graduate student Randy Maglinao collects samples from the glycerol conversion reactor.*

### ACCOMPLISHMENTS OF THE PROJECT (07/08 – 06/09)

During the second year of the project, the results from the first year were examined and used as the guidelines for comprehensively investigating the thermochemical conversion of crude glycerol to alcohols. A surface response experimental design was constructed and experiments were conducted to explore the optimum temperature and reaction time for converting of crude glycerol to desired products. This design assumes that the input factors and response have a second-order relationship. The values of the parameters in the experimental matrix were formulated using the data gathered from the preliminary investigation and the limitation of the reactor system. The yields of bio-oil and alcohol, and conversion rate of glycerol were the response variables. The results were then encoded and analyzed using SAS program. Statistical results showed that the highest ratio of bio-oil to char could be produced at temperature and reaction time of 320°C and 195 min, respectively. However, the amount of alcohols produced varied significantly such that no clear relationship between these parameters with respect to the production of alcohols can be concluded. This variation of data suggests that the process involves complex set of reactions.

To guide the experiments, a response-surface based master model and a predictive model for the conversion of glycerol to bio-oil were proposed. The master model represents the complete quadratic model which includes the effects of the temperature and time and its combined effects. However, not all the parameters are significant statistically in predicting the response (based on a 90 percent confidence level). The large p-value ( $p = 0.8936$ ) for the interactive effect of temperature and time strongly suggests its insignificance. The time and its second-degree effect are significant, thus was included in the predictive model. Based on the experimental results and statistical analysis, a simplified first-order kinetics model was proposed and showed its applicability in describing the conversion of glycerol to different products.

A thorough investigation on the effects of initial pressure and type of reducing agent with a modified feeding mechanism were also conducted. Results provided strong evidence that the initial pressure and type of reducing agent are significant in affecting the amount of bio-oil and alcohols produced. Moreover, experimental data confirmed that thermochemical conversion of crude glycerol occurs at temperatures of 300°C or higher, and the reaction time must be no less than an hour. It is evident that crude glycerol can be feasibly converted to methanol, ethanol and propanol via the hydrothermal conversion process, although the conversion efficiency is not as high to the levels as expected.

### FUTURE PLANS

Although the ultimate plan is to develop a practical technology that converts the low-grade glycerol into alcohols, and to reuse them back to biodiesel production to increase its sustainability, the immediate future plan is to improve the system for better process efficiency. It has been shown that crude glycerol can be feasibly converted to alcohols as expected, however, the process efficiency is low. The possible reasons of low conversion efficiency include (1) the reactions did not go by the pathway expected due to the less favored process operating parameters, and (2) the alcohols produced further reacted and form other compounds through secondary reactions such as dehydration, condensation, and/or transformation. We will look into it and explore more on improving the system and/or re-evaluating process parameters.

Meanwhile, we are going to conduct an investigation on applying applicable catalysts to the conversion system. Metal-oxide based catalysts have been found effective in the production of alkyl alcohols from glycerol and the hydrogenation process in producing alcohols. These types of catalysts may favor the production of alcohols instead of other compounds in the thermochemical conversion of glycerol.

## “HOW DID WE GET HERE?”

It has been a challenging and very exciting project to work on. The project is important and practical to the biodiesel industry because dealing with the excessive glycerol from biodiesel production is a dilemma and there is an urgent demand that alternative yet value-added applications have to be found to ensure biodiesel industry's stronger and healthier growth. The idea of converting the low value by-product glycerol to alcohols and re-used the alcohols back to biodiesel production is novel. The PI believes that successful accomplishment of the project will contribute to the current knowledge base on utilization of crude glycerol and benefit the biodiesel industry.

However, it is a great challenge. To the best of the PI's knowledge, there is no report in the public domain on similar research that has been successfully conducted and implemented; no literature covering the topic is available. Theoretical analysis on the chemical conversion pathways suggests that converting glycerol to primary alcohols is possible (and our experiments have proved that). We are determined the process be explored and believe that we will achieve great progress in contributing to knowledge base on glycerol utilization and ultimately to the growth of biodiesel industry.

In the projects for the past two years, we developed a reactor system that is capable of conducting the hydrothermal conversion of glycerol under temperature (up to 350° C) and pressure (up to 2800 psi). The temperature control system was evaluated for its scheme and reliability, agitation and sampling mechanisms are tested and improved, the process gas input system was implemented, and safe operation of the reactor system was carefully evaluated and corresponding procedures were implemented. Based on the results of preliminary testing, revised feeding method was used to greatly shorten the lag time in process heating-up and improved the reliability and repeatability of the experimental results. Meanwhile, sample handling and analytical procedures were developed, evaluated and validated. Protocols of GC and HPLC analyses were developed and standardized. All these preparations and preliminary testing ensured the safe, smooth operation of the system in the second stage investigation.

In the second stage of the project, graduate and undergraduate researchers have been diligently working on investigating the process, testing the hypotheses that would lead to the desired products. The experiments of evaluating the process of glycerol conversion are time-consuming. Unexpected situations happened, such as largely fluctuated temperature profiles, challenging sample handling techniques, and unexpected gasket leaks, but overcome / corrected by our graduate and undergraduate researchers. Project was then conducted as scheduled and large amount of data were collected. We are now summarizing the project and writing a report on the project. More technical details will be included on the topics we investigated according to our proposal.

We experienced frustrations and discouragements of fruitless days of work, and enjoyed excitements of overcoming difficulties and achieving progress as well. The graduate and undergraduate researchers have learned a lot from the project, so has the PI. We are proud of where we are now, and we will continue moving on to bring the project forward to another level.



*Undergraduate student researcher Sushant Kshetri is preparing samples for GC analysis.*

## PROJECT: COMPRESSION RATIO AND CATALYST AGING EFFECTS ON AQUEOUS ETHANOL IGNITION (KLK756)

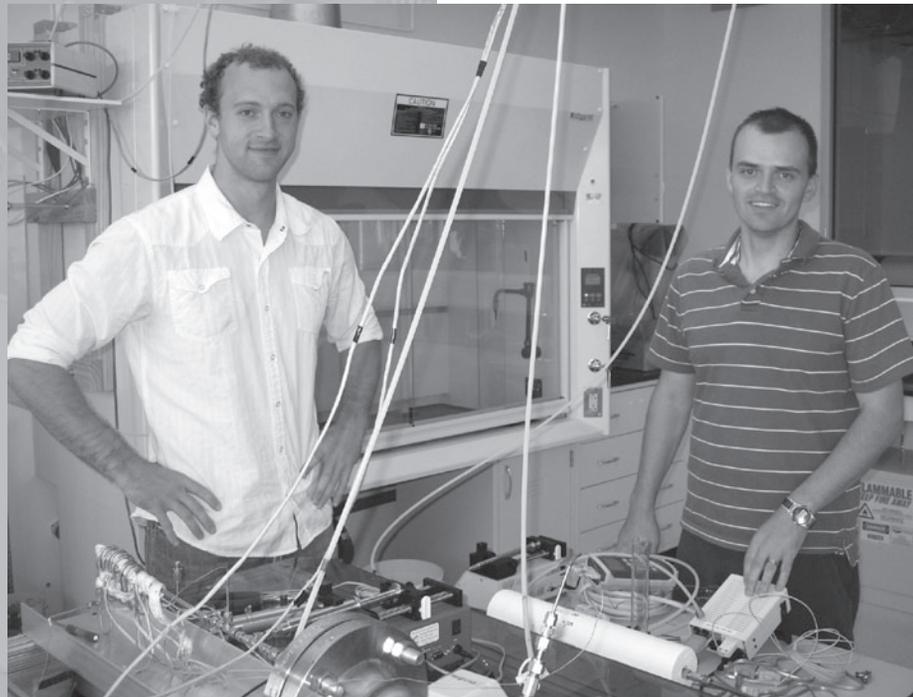
**Investigators:** Dr. Judith Steciak, Dr. Steven Beyerlein and Dr. Ralph Budwig

**Student Involvement:** Dan Cordon, Josh Royce, Josh Gibson, Katie Leichliter, David Mehaffey, Brad McGary, Victor Christensen; Randall Storms and Edwin Anderson (graduate students, mechanical engineering); Casey Bernet, Chad Barnes, Tyler Merritt, Amanda Bolland and Jason Cyr (undergraduate students, mechanical engineering)

**University Transportation Center Funding:** \$123,270

### STRATEGY INVOLVED:

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



*MSME candidates Josh Royce and Josh Gibson checking the heavy fuel evaporator in the Combustion Laboratory.*

Our project seeks to advance catalytic plasma torch (CPT) technology through coordinated reactor studies, engine design, modeling, and engine testing activities.

University of Idaho NIATT researchers first worked with Automotive Resources, Inc. in 1998. That summer, we began investigating the catalytic ignition of aqueous ethanol and air (65 percent to 70 percent ethanol, the balance water) in a 4-stroke 17:1 compression ratio engine that was modified to accept the fuel and ignition system. This preliminary study resulted in improved ignition timing, smoother engine operation, and measurement of low NO<sub>x</sub> emissions.

In a following project, direct comparisons were made between a converted 4-stroke engine operating on aqueous ethanol and a stock engine operating on diesel. These tests yielded significantly reduced NO<sub>x</sub> emissions. Parametric studies using a first-order catalytic ignition model showed that igniter length, core temperature, and compression ratio influence ignition timing, whereas fuel-water concentration in the fuel had little effect.

A 15 passenger commuter van with a four-stroke 8:1 compression ratio engine was converted to a dual-fuel (aqueous ethanol or gasoline) vehicle to provide a single platform for performance comparison. A test protocol was developed to predict on-road emissions by using a series of six weighted test modes on a steady-state chassis dynamometer.

The six mode test matrix was developed to approximate the Federal Test Protocol (FTP) Urban Driving Cycle. Under common road load conditions for the van, gasoline performance and emissions were compared to operation on 90 percent ethanol

and 10 percent water. At a road load corresponding to 50 mph, aqueous ethanol displayed a significant increase in CO<sub>2</sub> and HC emissions as well as a significant decrease in NO<sub>x</sub> and CO emissions compared with gasoline. Similarly,

extensive engine performance and emissions testing with 70 percent ethanol 30 percent water fuel mixtures operating at stoichiometric and fuel-lean conditions showed a substantial reduction in NOx and CO emissions without the use of exhaust after treatment (such as tailpipe catalytic converters) compared to gasoline emissions.

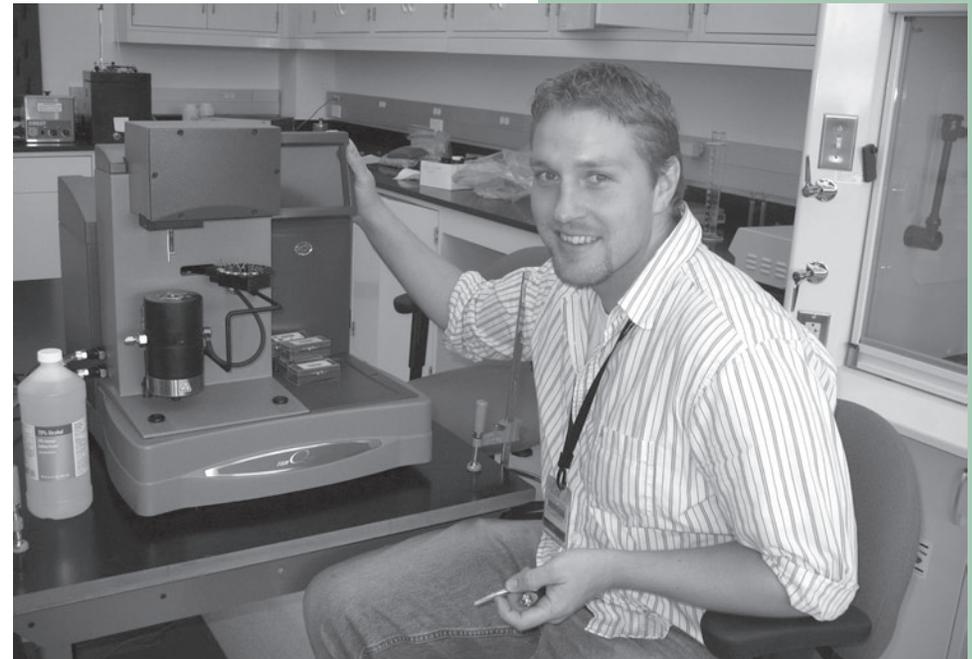
In addition to engine and vehicle development, an effort was begun to better understand the fundamental nature of the fuel-water-Pt ignition process. Detailed modeling permits better engineering modeling of ignition timing. Improved modeling also provides a firm basis for designing igniters for different engine platforms. A flow reactor and mixing nozzle were designed. Experiments of the catalytic ignition of propane-water-air mixtures over Pt were conducted. A finite element analysis (FEA) model of the Pt heat transfer processes was developed as part of this work as well as application of a one-step surface reaction model that gave a first-order prediction of heat release from fuel decomposition on platinum. This was followed by recent experiments with ethanol-water-air mixtures that showed less difference between ignition temperature of dry and aqueous ethanol than expected.

The versatility of the igniter was demonstrated when a small gasoline genset was converted to heavy fuel (kerosene or aviation fuel) operation to help the US Army achieve its 'one-fuel' goal. This project supported further small engine conversion to catalytic operation by the patent holder and may become the first commercially viable application of the technology.

Funding for the above studies was obtained from the US Department of Transportation through NIATT, the Idaho Transportation Department, the Idaho Office of Energy Resources, the National Aeronautics and Space Administration, the Army Research Office, the National Science Foundation, and Idaho's Higher Education Research Council.

The commercial future of catalytic ignition technology can be measured by the interest ARI has received from the military and private industry (i.e., see *Sandpoint Magazine*, Summer 2008, p. 14). Gensets of various capacities have been delivered to the US Army, The Navy and Marine Corps are interested in outboard motor applications and have initiated research and development projects with ARI. The Air Force wants to re-fuel drones in mid-air, which requires operation of small gasoline aviation engines on the JP-8 carried by cargo fuel planes. In addition to automobile manufacturers Honda and Toyota, Dow Chemical (the second largest chemical manufacturer in the world) and AGCO Corporation (a large agricultural equipment manufacturer) have approached ARI about development rights. ICM, Inc. (a company that designs, constructs and supports fuel-grade ethanol production facilities and manufactures 75 percent of the alcohol in the U.S), is greatly interested in technology such as catalytic igniters because they augment the use of ethanol; the ability to burn aqueous ethanol means the distillation process need not go to completion and that molecular sieves (needed to remove the last traces of water) are not required. Thus, considerable savings can be realized in the production of aqueous ethanol for transportation fuel.

Unfortunately, the current economic recession and plummeting gasoline prices after a \$4/gallon high have devastated the renewable fuel market. In Idaho alone, all known ethanol and biodiesel production has been mothballed.



*Brad McGary (MSME candidate) working with the Thermal Gravimetric Analyzer (TGA) to determine the vaporization temperature range of transportation fuels.*

We have seen ebb and flow in the alternative fuels market over the years leave vehicle manufacturers reluctant to develop engines that can maximize the potential of non-petroleum fuels. However due to environmental issues and dwindling reserves, it is clear that “business as usual” with fossil transportation fuels cannot continue. We think it is possible, with catalytic ignition, to develop multi-fuel engines that can accommodate a variety of alternative fuels cleanly and efficiently.

Several updates to the lab infrastructure and research platforms took place during the first year of this project: the variable compression ratio CFR engine received a new intake and exhaust system, a combustion pressure sensor, crankcase encoder, and a combustion pressure analyzer. Our ethanol-water demonstration van went on tour to regional energy fairs in the upper mid-west. Funding was obtained from Idaho’s Higher Education Research Council for a dilution tunnel and particulate measuring equipment. Publication and presentation of this research was made at the following venues: Western States Section of the Combustion Institute, American Society of Mechanical Engineers 2008 World Congress, and the Society of Automotive Engineers.

*Our newest MSME candidate Dave Mehaffey learns about measuring the temperature when transportation fuels ignite on the surface of a platinum wire catalyst.*



## PROJECT: MEASUREMENT AND CONTROL STRATEGIES FOR STEROL GLUCOSIDES TO IMPROVE BIODIESEL QUALITY (KLK755)

**Investigators:** Dr. Jon Van Gerpen and Dr. Brian He

**Student Involvement:** Keegan Duff, graduate student, agricultural engineering

**University Transportation Center Funding:** \$75,236

### STRATEGIES INVOLVED:

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

Minnesota and several other states have experienced significant problems with biodiesel at low temperatures. Multiple contaminants have blocked filters in otherwise high quality fuel. Currently the only surefire method to prevent cold flow problems is to winterize the fuel. 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 is highly suspicious of sterol glucosides (SG) present in neat biodiesel, which may act as seed crystals or agglomeration centers where contaminants can accumulate. Dr. Robert Moreau's team at the USDA has identified sitosteroyl-glucoside and campesteroyl-glucoside in neat bulk biodiesel tanks and filter residues.<sup>1</sup>

Most occurrences of filter failure are not able to be trace the fuel back to fuel source, oil processor and oil seed crop. The industry assumes that acylated sterol glucosides (ASG) present in plants and oils are esterified during biodiesel production, forming SG. The hexane solvent extraction system is optimized to obtain the maximum levels of triglycerides out of oil feed stocks. The hexane extraction efficiency of sterol glucosides or ASG may change due to process or agronomic conditions and this might be a way to control the level of SG in the oil and ultimately, in the biodiesel.

The level of ASG and SG present in oilseeds is not readily available. What data is available is obtained by extraction, multi-step derivation and GC-MS evaluation. There are limited analytical techniques for the evaluation of SG and ASG.

The research team is currently developing an analytical method for the evaluation of SG and ASG. The goal of the project is to determine the levels of ASG and SG in agronomically significant oil seeds of the Pacific Northwest (PNW). With this information the industry can make more informed designs about how to minimize low temperature problems with biodiesel in the PNW.

The team has evaluated several different schemes for extraction. Seeds have been:

1. Manual ground and solvent extracted;
2. Manual ground and exhaustively solvent extracted with chloroform, methanol (2:1);
3. Ball milled and exhaustively solvent washed with sequential more polar solvents (heptane, ethyl acetate, methanol).



*Graduate student Keegan Duff preparing extracts from oilseeds to isolate the sterol glucosides.*

**Using High Performance Liquid Chromatography-Atmospheric Chemical Ionization (HPLC-APCI) a soft ionization technique--SG and ASG standards have been detected. There is currently only one supplier of ASG standards. The University of Idaho seed breeding laboratory has provided seed from research plots of agronomical significant seed for evolution.**

#### Winter Canola

*Brassica. napus L. cv. Athena*

#### Spring Canola

*Brassica. napus cv. Gem*

#### Spring Rapeseed

*Brassica. napus cv. Sterling*

#### Spring Camelina

*Camelina. sativa L. cv. Columbia*

*Camelina. sativa L. cv. Calena*

#### Spring (Yellow mustard, White mustard)

*Sinapis alba L. cv. Ida Gold*

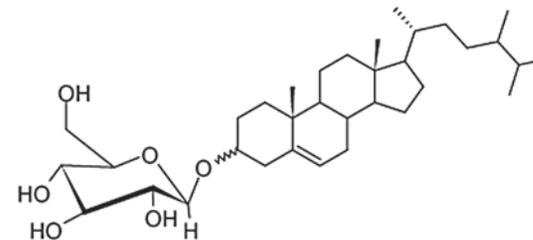
#### Spring (Oriental mustard, Indian mustard, Brown mustard)

*Brassica juncea cv. Pacific Gold*

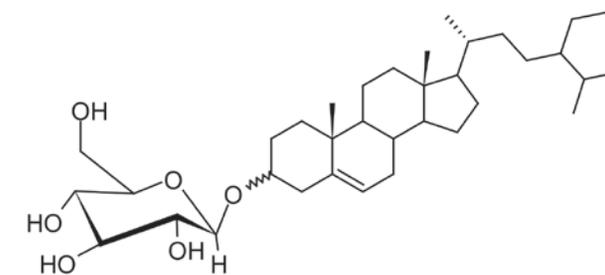
From these extractions several natural products have been identified. The levels of sucrose in canola and camelina were determined after rigorous structure elucidation using  $^1\text{H}$ NMR and  $^{13}\text{C}$ NMR data. The team is currently optimizing a GCMS technique of standards also for use in detection of steroids as a validation tool.

Future work will entail method development of HPLC-MS technique with soft ionization for characterizing and quantifying ASG. One of the aims of this method is direct analysis of natural products rather than evaluation of derivatives. This means that we will determine how much of the potential contaminate is present in the original oilseed so we can investigate different processing techniques to keep it in the meal rather than extract it into the oil. Acylation is typically assumed to occur at the 6th position of the glucose, however South Korean work has demonstrated that in tree extracts the 4th position was acylated.<sup>2</sup>  $^1\text{H}$ NMR and  $^{13}\text{C}$ NMR will likely be required to positively identify the structures. No other researchers have actually identified the chemical structures of the specific compounds represented by ASG. With a method for evaluating these ASG, extraction techniques can be optimized. It may prove necessary to enrich and purify the natural product extracts using size exclusion chromatography for evaluation using soft ionization mass spectrometer.

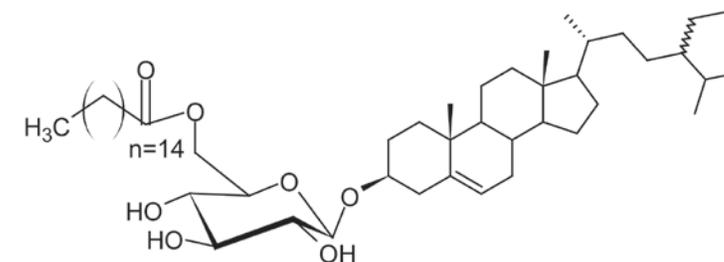
- 1 Robert A. Moreau, Karen M. Scott, Michael J. Haas, "The Identification and Quantification of Steryl Glucosides," *Precipitates from Commercial Biodiesel*, 6 June 2008.
- 2 WenYi Jin, Byung-Sun Min, JongPill Lee, Phuong Thien Thuong, Hyeong-Kyu Lee, KyungSik Song, Yeon Hee Seong and KiHwan Bae, "Isolation of constituents and anti-complement activity from *Acer okamotoanum*," *Archives of Pharmacal Research*, 1976-3786, 2007



Steryl Glycoside(SG), Capesteryl Glucoside, exact mass 562.4



Steryl Glycoside(SG), Sitosteryl Glucoside, exact mass 576.4



Acylated  $\beta$ -sitosteryl glucoside (Palmitic)

*Chemical structures of some typical sterol glucosides (SG) and acylated sterol glucosides (ASG)*

# OTHER RESEARCH

NIATT's UTC success can be measured in part by the fact that it is recognized by organizations outside of DOT. Work ongoing in both the traffic and vehicle research areas were recipients this past fiscal year of additional funding from Idaho's Higher Education Research Council (HERC).

## SUSTAINABLE TRANSPORTATION SYSTEMS

On the vehicle side, an application for funding from Drs. Judith Steciak, Steven Beyerlein, Karen Den Braven and Ralph Budwig received \$550,000 for "Sustainable Transportation Engine and Fuel Systems" (also see page 27). The team worked along with industry partner Automotive Resources, Inc. (ARI) of Sandpoint, ID, the developer of catalytic igniters permitting the use of fuel-lean mixtures in internal combustion engines. The research focused on developing catalytic ignition for the combustion of fuel-lean mixtures in a mixture of basic and applied research. The funding was used to support graduate and undergraduate students as well as to improve capital equipment to strengthen infrastructure and boost their ability to conduct research in sustainable transportation fuels and innovative engine technology. The grant was supplemented with \$2,500 from the University of Idaho's Office of Sponsored Programs for a first-year FLUENT license and computer.

The team is preparing to submit a DURIP proposal to the Army Research Office (ARO) for capital equipment and have been encouraged by ARO officials to also submit a Defense Experimental Program to Stimulate Competitive Research (DEPSCoR) proposal next year.

ARI procured contracts to develop products for commercial and military applications. With ARI, the team of faculty and students presented research results at international conferences. The students showcased our technological innovations at national competitions and conferences.

## INTERACTIVE SIGNALS

HERC also awarded \$75,000 to support the work of the Smart Signals research team for their proposal "Interactive Signals for Able-Bodied and Disabled Pedestrians" (also see page 13). In their report to HERC, researchers Richard Wall and James Frenzel report that a complete Advanced Accessible Pedestrian Signal (AAPS) device was design, constructed and tested within their laboratory. The design uses Ethernet communications to implement a distributed control system. This is an advance over current Accessible Pedestrian Systems (APS) that represent a safety risk factor having undetectable failure modes that could play incorrect audible messages. The AAPS consists of a controller unit housed in the traffic controller cabinet and interfaces to existing National Electrical Manufacturers Association (NEMA) TS1 and TS2 traffic controller cabinets at the field terminals and supports from one to 16 pedestrian stations.

Wall and Frenzel also received additional funding from an industry partner, Campbell Company of Boise, ID, an established manufacturer of APS devices. Campbell provided funding of \$61,535 to oversee the beta field testing, manufacturing, and marketing of the AAPS. In the summer of 2009, a UI graduate student worked at the Campbell manufacturing facility.

## PATENT PENDING

The application of a patent relating directly to the AAPS systems was completed in March 2009. U.S. Patent Application No. 12/411,306 "Advanced Accessible Pedestrian Control System for the Physically Disabled" was filed on the behalf of Richard Wall and Gabriel DeRuwe (who graduated from UI with his MS). A second patent application being prepared will be a joint application between UI and the Campbell Company.



*Graduate student Craig Craviotto explains the operation of the Pedestrian Station to members of the Advisory Board at a meeting in April 2009 in Boise at Campbell Company.*

# EDUCATION

## NIATT HONORED BY ITE FOR INNOVATION IN EDUCATION

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."

The Institute of Transportation Engineers is an international educational and scientific association of transportation professionals who are responsible for meeting mobility and safety needs. ITE facilitates the application of technology and scientific principles to research, planning, functional design, implementation, operation, policy development and management for any mode of ground transportation. Through its products and services, ITE promotes professional development of its members, supports and encourages education, stimulates research, develops public awareness programs and serves as a conduit for the exchange of professional information.

NIATT's Traffic Signal Summer Workshop, held seven consecutive years from 2000-2007 at the University of Idaho campus in Moscow, Idaho, was a five-day, intense hands-on workshop during which participants worked with industry professionals using state-of-the-art traffic control equipment and hardware. The workshop served students and professionals from 26 states. As a result of the workshop's success, FHWA asked NIATT to develop a version for professionals that supports FHWA's signal timing roadmap, awarding a grant of \$705,274.

The "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.



At the ITE August meeting, Kyte was one of four panelists leading a “conversation circle” discussing ways to attract students to become interested and get involved in the transportation industry. He informed the participants about the transportation engineering education conference that had been held in Portland and the action items coming out of that conference (see page 36).



*ITE President Kenneth H. Voigt and Michael Kyte at the ITE summer meeting. (Copyright © 2009 Sunrise Images Photography/ITE)*



## REGION X UTCs SPONSOR TRANSPORTATION EDUCATION CONFERENCE

*Participants in the Transportation Education Conference.*

Under the leadership of Michael Kyte of NIATT and Robert Bertini of OTREC, Region X UTCs collaborated with the Institute of Transportation Engineers and the Council of University Transportation Centers to sponsor a conference on undergraduate transportation engineering education held at the University Place Hotel in Portland, Oregon, on June 22-24, 2009. Sixty attendees spent three days discussing their vision for the future of transportation education.

The conference was based on the concept that nearly all of the nation's 224 civil engineering programs have one or two required transportation courses as part of their undergraduate program. For some civil engineering sub-disciplines, there is a logical sequence of courses leading to the required sub-discipline junior level courses such as geotechnical, materials, structures, and hydraulics. For example, the sequence of courses from physics (kinematics), statics, dynamics, and strength of materials lays a solid foundation for the junior structures course. For other disciplines, however, the logic and sequence is less clear or linked. One of these sub-disciplines is transportation, particularly if, as in many programs, the transportation course emphasizes traffic engineering. Often, students arrive in the transportation course with no prior technical experience in or knowledge of transportation, excepting their historical experience as automobile drivers, bus riders, walkers and bicycle riders. The course is often viewed by the students as (1) not connected to their previous courses, (2) too simplistic, (3) not technically challenging, and (4) not relevant to their career goals or interests.

Instructors who teach this course have their own set of complaints beyond the design of curricula:

1. Textbooks are too simplistic in their approach or content;
2. The course lacks real world problems and information about complex problems and case studies;
3. Time and/or facilities for laboratory work is insufficient or non-existent;
4. The course lacks any connection to previous civil engineering courses that students have taken or their engineering or science prerequisites;
5. The course is ineffective as a recruitment tool for advanced elective courses or graduate study; and
6. The course is usually not multimodal in nature.



## Transportation Education Conference

Improve Transportation Engineering Education

Portland, OR  
June 22-24, 2009

HELP PLAN THE FUTURE  
OF TRANSPORTATION  
ENGINEERING EDUCATION!

### What Will We Do?

We have designed a three day program in which you will (1) learn about the latest ideas in transportation engineering education, (2) address three important questions to help us improve how we deliver transportation engineering education, and (3) learn how to improve your teaching skills.

The questions that we will consider are:

1. How do we map the learning domain for transportation engineering?
2. How do we create active learning environments for undergraduate transportation engineering students?
3. How do we develop collaborative tools for sharing transportation engineering curricular materials?

You can also share your current work and innovative ideas in transportation education at a poster session.

**For more information and to register for the conference:**

[www.webs1.uidaho.edu/transportation\\_education\\_conference-2009](http://www.webs1.uidaho.edu/transportation_education_conference-2009)

These collectively often show up as a lack of student interest in transportation engineering.

The first morning's program featured brief presentations introducing new tools, approaches and research efforts focused on creating active learning environments for students:

- "Simulating Transportation for Realistic Engineering Education and Training (STREET)"; David Levinson, University of Minnesota
- "Developing and Engineering Environment Fostering Effective Critical Thinking through Measurements (EFFECT)"; Andrew Nichols, Marshall University
- "What are the 'Understandings' for the Introductory Transportation Engineering Course"; Shane Brown, Washington State University; Michael Dixon, University of Idaho, and Brock Andrews, Washington State University
- "To Be a Transportation Engineer or Not: How Civil Engineering Students Choose a Specialization"; Jennifer Dill, Portland State University
- "Pavement Interactive! A Wiki"; Joe Mahoney, University of Washington
- "Integrating Textbooks and Classroom Goodies"; Karen Dixon, Oregon State University
- "What Undergraduates Should Understand"; Wayne Kittelson, Kittelson and Associates
- "What Do We Currently Teach?"; Rod Turochy, Auburn University

Seventeen poster sessions were offered, and three focused workshops were held during the conference:

- How do we map the learning domain for transportation engineering?  
Led by Shane Brown, Washington State University and Michael Dixon, University of Idaho
- How do we create active learning environments for undergraduate transportation engineering students?  
Led by Karl Smith, University of Minnesota/Purdue University
- What have you learned? How can we work together in the future?  
Facilitated by Barbara Hart of Barbara Hart Consulting

Following the discussion in the third workshop, topics were pulled from the generated list of ideas and suggestions. The topics were honed down to six most relevant, and participants broke into groups for an hour during which they developed specific action plans . . .

On the third day, participants were able to attend an ExCEED Workshop presented by representatives of the American Society of Civil Engineers (also see <http://www.asce.org/exceed/>).

A synopsis of the conference is available on the conference website: [http://www.webs1.uidaho.edu/transportation\\_education\\_conference-2009/](http://www.webs1.uidaho.edu/transportation_education_conference-2009/)



*Mike Dixon at the conference helping instructors create core concept areas.*

## REGION X UTCs TO COLLABORATE ON FHWA-SPONSORED EDUCATION PROJECT

In summer 2007, Michael Kyte submitted an application to the Federal Highway Administration's Transportation Education Development Pilot Program and was awarded a grant that, over four years, could commit up to \$1.2 million towards developing an active, problem-based learning environment conducted at a distance. FHWA funds one year's work at a time; up to three more years will be awarded as the team makes successful progress.

Faculty representing Region X UTCs from the University of Idaho, Portland State University, the University of Alaska, Fairbanks, and the University of Washington, along with faculty from Washington State University will work together to develop four course modules, deliver these modules in a unique distance-based learning environment, test the efficacy of the modules in meeting program goals, and provide a means to transfer materials and lessons learned to other groups around the U.S. In addition, each of the four UTCs in the Region X Transportation Consortium is committed to leveraging FHWA funding by using faculty time and by establishing supporting projects with UTC funds to meet the level of effort described in the proposed work tasks.

The immediate audience will be university students and transportation professionals in the Pacific Northwest. The stated goal of the program is to address pipeline, training and retention issues in the transportation industry. Supported by educational research and the expertise of the faculty from the cooperating institutions, the 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 modules will be learner-centered, built upon our extensive experience in creating active, problem-based learning environments for our transportation students, and validated by pedagogical research funded through the National Science Foundation and others. A substantial body of research demonstrates that problem-based environments produce students who perform better at solving novel problems and other positive learning outcomes.

This learning environment will provide many benefits to both groups. Students and professionals will develop essential communication and collaboration skills in a distance-separated work environment that replicates the work environment at most agencies. Students will network with professionals and gain a real understanding of the field, as well as forge relationships and perhaps, find mentors. Students will benefit from the professionals' perspectives, work ethic and occupational pride. Students will contribute a fresh perspective and technological savvy. Professionals will gain essential training in technical skills by solving generative problems stated in their complex contexts. This professional development can aid in improving job retention by building core competencies and fostering networking. Enhanced learning and self-assessment skills, developed in both groups, will contribute to the creation of an engineering workforce of "life-long learners." According to the National Academy of Engineering, this is an imperative for the 21<sup>st</sup> century.

# OUR STUDENTS

## DAN CORDON HONORED

Regular readers of NIATT's annual reports should be familiar with the name Dan Cordon. Dan was NIATT's student-of-the-year in 2004. The most recent acknowledgement of his many achievements at the University of Idaho came at the University of Idaho's annual Excellence Awards Banquet held in April 2009. At the ceremony held at the Best Western University Inn, Dan Cordon was awarded the Outstanding Graduate Student Teacher Award. A mechanical engineering doctoral candidate, Cordon is a great proponent of active learning using a variety of in-class activities; his primary goal is to help his students become self-learners. He takes pleasure in watching students develop the ability to use their knowledge and new skills to take steps forward on their own. Drs. Steven Beyerlein, John Crepeau and Karen Den Braven noted in his nomination letter, "Undergraduate students enjoy Dan's playful demeanor, his vast theoretical and hands-on knowledge of engine systems, his interactive learning activities, his informative lab exercises, his meaningful modeling assignments, his thoughtful integration of web technology and his accessibility outside of class. His teaching evaluations are comparable to the best instructors in our department."

Cordon has been a student at the university since 1996, and has progressed from freshman to doctoral candidate; he expects to graduate this year. As an undergraduate, Cordon worked on a number of UTC-funded projects: including NIATT's FutureTruck. As a graduate, Cordon was an active mentor in the IEWorks (Idaho Engineering Works). Since 2006, along with his teaching and research, he has managed the Small Engine Research Facility, working with students developing NIATT's clean snowmobile, using the dynamometer to test various engines, and designing and constructing a new dilution tunnel to be used in engine research.



*Dan Cordon (center) with UI Provost Doug Baker (left) and President Stephen Daley-Laursen (right) at the awards banquet.*

### **Cordon has taught the following classes:**

**ME 301 - Computer Aided Design Mechanical Methods**

**ME 430 - Senior Laboratory**

**ME 433 - Internal Combustion Engine Systems**

**ENGR 220 - Dynamics**

**ENGR 320 - Engineering Thermodynamics and Heat Transfer**

**ENGR 350 - Engineering Mechanics of Materials**



*The Council of University Transportation Centers (CUTC) honored the UTC students-of-the-year at the TRB Annual Meeting in Washington, DC.*

## **NIATT STUDENT-OF-THE-YEAR: NICK HARKER**

NIATT joins in congratulating the students-of-the-year representing each of their respective UTCs. NIATT's student-of-the-year Nick Harker, was highlighted in last year's Annual Report for his various skills. In 2007, he was team captain of the Clean Snowmobile team, which was awarded the Most Sportsmanlike trophy after Nick stopped the Idaho snowmobile in the middle of the Challenge to help a competitor whose snowmobile was on fire.

Nick received his BS in mechanical engineering in May 2007 and his MS in May 2009. Nick began his new career working at the Idaho National Laboratory in the summer of 2009.

Nick was named Mechanical Engineering's Outstanding Senior in May 2007 and has been an outstanding leader in the IEWorks as a mentor. He was involved with the UI-CSC Team for five years, leading the engine development and calibration efforts. His senior capstone team designed, fabricated, installed, tuned and tested a direct injection cylinder head for a two-stroke snowmobile engine which doubled fuel efficiency and reduced emissions 80-95 percent.

## CONGRATULATIONS TO THE 2009 CLEAN SNOWMOBILE TEAM—ONCE MORE!



*Over the years, the team has amassed quite a few trophies that were recently displayed.*

### OUTCOME OF THE 2009 CLEAN SNOWMOBILE CHALLENGE

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

Michigan Snowmobile Association Endurance Award	Lightest Snowmobile
NGK Spark Plugs Cold Start Award	Best Subjective Ride
Best Fuel Economy, with 13.3 mpg on ethanol blend fuel	Second Best Oral Presentation
Best Acceleration	Second in Handling
Best Value	Best Ride (IC class)
	Second Best Design Paper

### 2009 CLEAN SNOWMOBILE TEAM MEMBERS

#### **Nick Harker**

Graduate mentor; mechanical engineering; Idaho Falls, Idaho

#### **Peter Britanyak**

Graduate mentor; mechanical engineering; Bonney Lake, Washington

#### **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

#### **Zach Battles**

Sophomore; finance; McCall, Idaho

#### **Ben Birch**

Senior; sports science; Anchorage, Alaska

#### **Coleman Bode**

Sophomore; electrical engineering; Moore, Idaho

#### **Amanda Bolland**

Junior; mechanical engineering; Ashton, Idaho

#### **Brian Hansen**

Junior; mechanical engineering; Orofino, Idaho

#### **Christopher Hill**

Sophomore; mechanical engineering; Craigmont, Idaho

#### **Drew Hooper**

Sophomore; mechanical engineering; Rathdrum, Idaho

#### **Karrick Kelly**

Junior; mechanical engineering; Buhl, Idaho

#### **Ty Lord**

Sophomore; mechanical engineering; Arco, Idaho

#### **Theodore McJunkin**

Sophomore, mechanical engineering; Anchorage, Alaska

#### **Samuel Smith**

Sophomore; mechanical engineering; White Bird, Idaho

#### **Giselle Veach**

Sophomore; mechanical engineering; Vancouver, Washington

**Edwin Anderson** won an outstanding graduate student award from UI's Graduate and Professional Student Association for accomplishment in teaching & research. His involvement in evolving our solid modeling software (CATIA) course as well as establishing collaboration with IBM on a post-processor so that we can send CATIA models directly to our computer numerically controlled mill used by mechanical engineering students were key accomplishments.

**Dylan Dixon** interned during the summer of 2009 at Bombardier Recreational Products (BRP), an international manufacturer of motorized sports vehicles. BRP has significantly contributed to NIATT research and education by supporting the clean snowmobile research and offering internships to our students. Director Karen Den Braven spent part of her sabbatical working with BRP.

**Naresh Pachauri** left the UI with his Master's Degree to work with Vert Biodiesel in Los Angeles, CA.

**S. K. Monsur** took his civil engineering MS degree to work at DKS and Associates in Bellevue, WA.



*Front Row: Ty Lord, Karrick Kelly, Nick Harker (on sled), Alex Fuhrman, Drew Hooper, Dylan Dixon. Back Row: Cole Bode, Chris Hill, Sam Smith, Amanda Bolland, Peter Britanyak, Zach Battles, Giselle Veach, Theo McJunkin, Brian Hansen.*

# ACTIVITIES

## ACTIVITIES IN THE REGION X CONSORTIUM

There are four state DOTs and UTCs in Region X Transportation Consortium. A memorandum of understanding (MOU) establishing the consortium was signed by the eight members in September 2007. The memorandum outlines five intentions of the consortium: to meet twice yearly to conduct the business of the consortium; to regularly exchange information on research and educational needs, interests, and programs; to promote interest in transportation related fields within the region; to leverage research funding through pooled fund projects and other opportunities; and to develop shared educational and training programs.

The consortium also established a transportation pooled fund program with the objective of developing regional solutions to common transportation problems. The program will harness the financial, professional, and academic resources of the region and use them to conduct research and develop improved methods of dealing with common problems in the planning, design, construction, maintenance, management and operation of transportation systems in the participating states. Collaborative projects involving PIs from two or more UTCs will be awarded approximately \$100,000, equally matched by the selected UTCs.

The first of those Request for Research Approach (RRA) was released late in 2008 with proposals due in February. Suggested topics were

- Climate Change Impact Assessment for Surface Transportation in the Pacific Northwest and Alaska
- Gathering Low ADT Highway Storm Water Quality Data

Washington DOT personnel coordinated the RRA, and contracts for the first research under this program are in negotiation.



The Sixth Annual Region X Student Conference was held at the University of Washington on November 7, 2008. 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 Dr. Stephen D. Van Beek, president and CEO of the Eno Transportation Foundation. A panel discussion of professionals in transportation spoke about the changes in transportation careers fueled by the push toward sustainability.

The four UTCs also joined together to host a reception at the 88<sup>th</sup> TRB Annual Meeting in Washington, DC, in January 2009. Representatives from the universities were there to talk to guests about the research being done at the UTCs.

## The Region X Transportation Consortium

invites you to our reception at the 88th Annual Meeting of the Transportation Research Board.

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



The annual reception provides an opportunity for transportation professionals, educators and students to visit with colleagues from Alaska, Idaho, Oregon and Washington. Join us for appetizers, interact with our partners, meet our outstanding students of the year, and learn more about our active region.

Sunday, January 11, 2009  
6:00-7:30 pm  
Maryland A & B  
Marriott Wardman Park Hotel



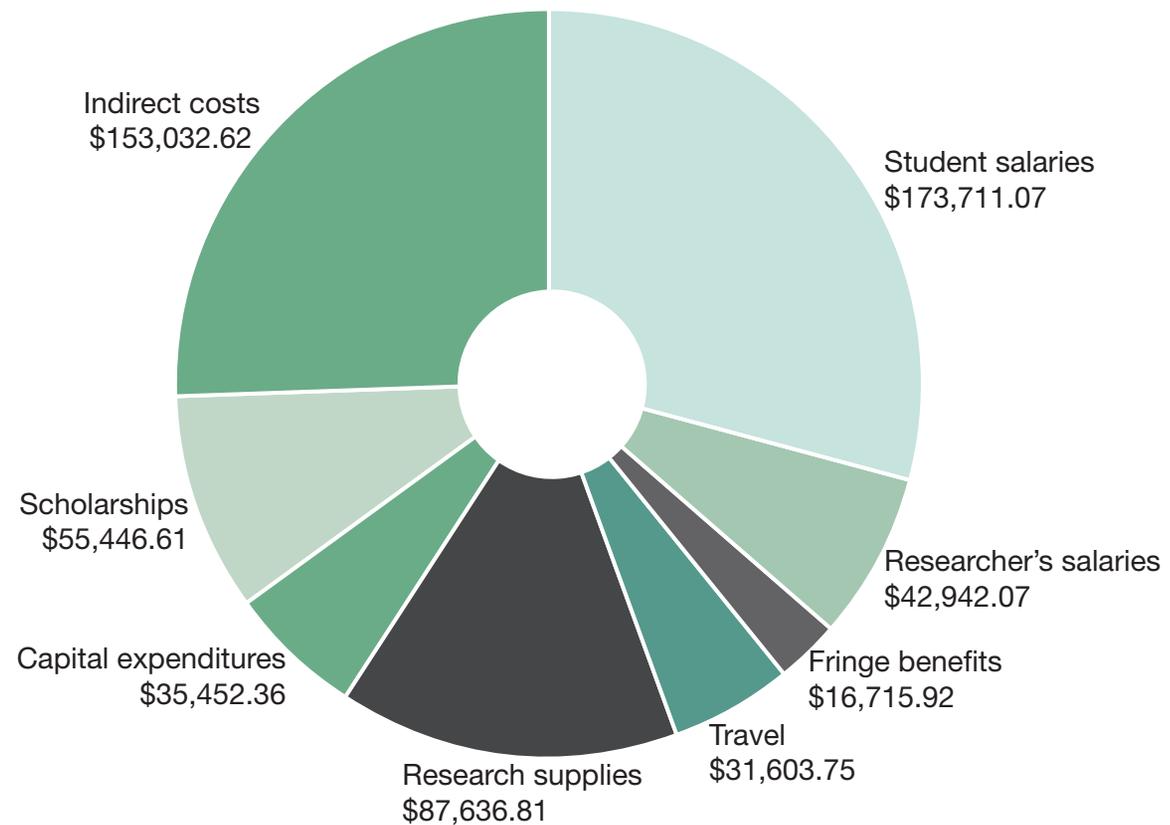
For more information visit: <http://www.transnow.org/regionx>

For directions visit: <http://www.marriott.com/hotels/maps/travel/wasdt-washington-marriott->

# FINANCIAL REPORT

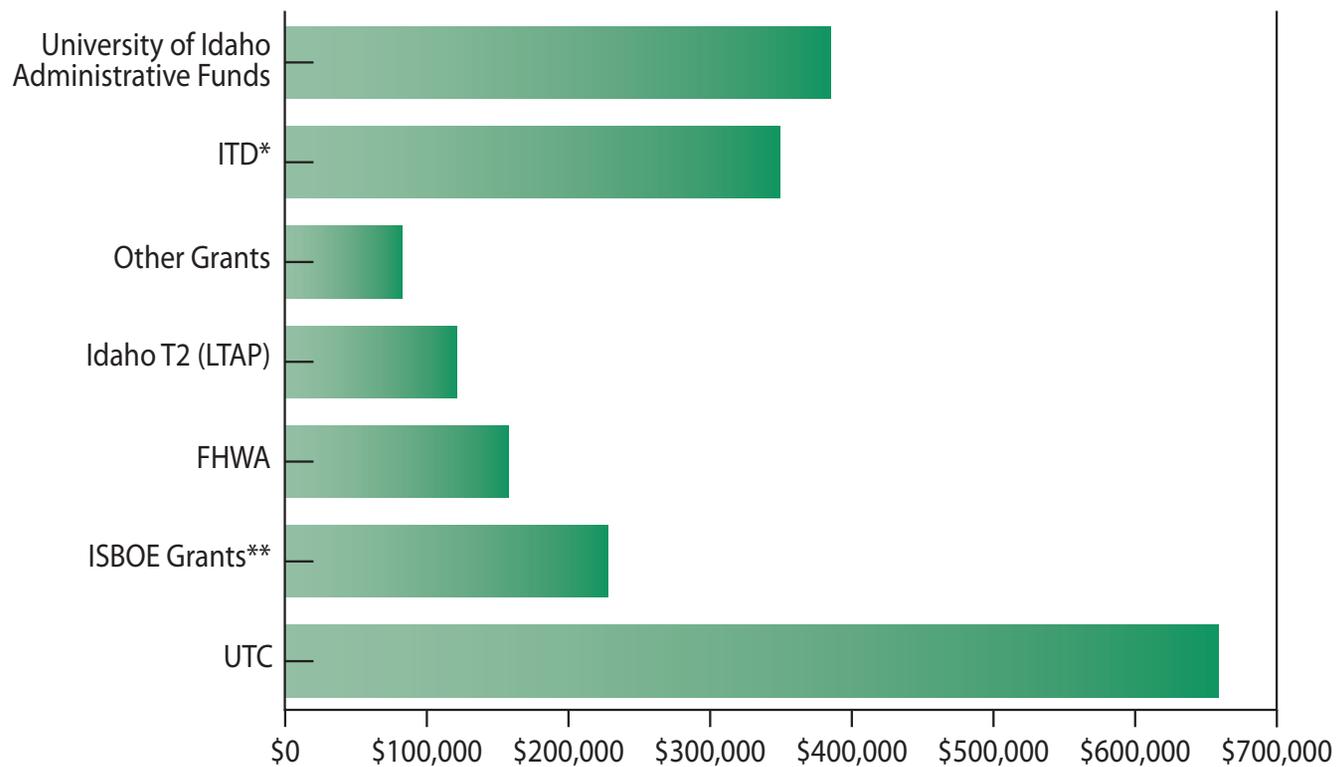
## EXPENDITURES--FY09

In fiscal year 2009, NIATT research project expenditures once again focused on student support. Fifty-two percent of University Transportation Funds expended (excluding indirect costs) were used for student salaries and scholarships. That percentage does not include the costs of fringe benefits paid for students. NIATT director and staff salaries were paid from matching funds, as were faculty research salaries during the academic year.



## SOURCES OF NIATT FY09 EXPENDITURES

The chart below shows the source of NIATT expenditures from FY09. In January 2009, the Idaho T2 Center (LTAP) was relocated to Boise and is no longer a part of NIATT. 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 Transportation Department

\*\* Idaho State Board of Education

## PROJECT STATUS

### PROJECTS BEGUN IN FY09 - YEAR 2 OF DTRT07-G-0056

- KLK714 Geometric Design - Subcontract to WSU**  
Center for Traffic Operations and Control  
Dr. M. Dixon
- KLK715 Commercialization and Field Distribution of Smart Pedestrian Call Signals**  
Center for Traffic Operations and Control  
Drs. R. Wall & J. Frenzel
- 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
- KLK753 Development of a Flex-Fuel, Two-Stroke, Direct-Injection Snowmobile for Use in the Clean Snowmobile Challenge and National Parks**  
Center for Clean Vehicle Technology  
Dr. K. Den Braven
- KLK754 Thermal Processing of Low-Grade Glycerol to Alcohols for Biodiesel Production, Phase II**  
Center for Clean Vehicle Technology  
Dr. B. He
- KLK755 Measurement and Control Strategies for Sterol Glucosides to Improve Biodiesel Quality**  
Center for Clean Vehicle Technology  
Drs. J. Van Gerpen & B. He
- KLK756 Compression Ratio and Catalyst Aging Effects on Aqueous Ethanol Ignition, Phase II**  
Center for Clean Vehicle Technology  
Drs. J. Steciak, S. Beyerlein & R. Budwig

### PROJECTS CONTINUING FROM FY08

- 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
- KLK712 Improved Simulation of Stop Bar Driver Behavior at Signalized Intersections**  
Center for Traffic Operations and Control  
Drs. M. Kyte, M. Dixon & A. Abdel-Rahim
- KLK713 Developing and Applying Collaborative Tools for Improving "Understanding" in the Introductory Transportation Engineering Course**  
Center for Traffic Operations and Control  
Drs. M. Kyte, M. Dixon & A. Abdel-Rahim

### PROJECTS COMPLETED - FINAL REPORTS IN REVIEW

- KLK710 Street Deployment of Pedestrian Control Smart Traffic Signals**  
Center for Traffic Operations and Control  
Drs. R. Wall, J. Frenzel & B. Johnson
- KLK750 Thermal Processing of Low-Grade Glycerol to Alcohols for Biodiesel Production**  
Center for Clean Vehicle Technology  
Dr. B. He
- KLK751 Development of an Ethanol-Fueled, Two-Stroke, Direct-Injection Snowmobile for Use in the Clean Snowmobile Challenge and National Parks**  
Center for Clean Vehicle Technology  
Dr. K. Den Braven
- KLK752 Compression Ratio and Catalyst Aging Effects on Aqueous Ethanol Ignition**  
Center for Clean Vehicle Technology  
Drs. J. Steciak, S. Beyerlein & R. Budwig



*Thank you Michael Kyte for the past  
15 years of dedication to **NIATT** and  
the next generation of transportation  
professionals!* (see pages 2 and 4)

# NIATT

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**University of Idaho**